

REPORT ON MIGRATING AND WINTERING PIPING PLOVER ACTIVITY ON LITTLE ST. SIMONS ISLAND, GEORGIA IN 2003-2004 AND 2004-2005.

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INTRODUCTION

The Piping Plover, *Charadrius melodus*, is a federally listed species with distinct breeding populations in the Great Lakes region, the northern Great Plains, and along the northeastern Atlantic coast as far south as South Carolina (U.S. Fish and Wildlife Service, 1996). Virtually all the conservation-related research on this species has focused on the breeding grounds, although Piping Plovers spend only 3-4 months out of the year there. The remaining 8-9 months are spent on migration and on the wintering range. Increasing development and recreational beach use along the south Atlantic coast makes the collection of data on the winter distribution and ecology of the Piping Plover a high priority (Plissner and Haig, 1997). A rare survey of wintering plovers on the Atlantic coast (Nicholls and Baldassarre, 1990) found that Georgia had the highest number (105 of 222 Piping Plovers observed), frequency (69.2% of sites surveyed in Georgia), and density per km surveyed (0.77) of wintering Piping Plovers. Nicholls and Baldassarre (1990) also found that Little St. Simons Island had the largest concentration (35 of 222 Piping Plovers observed) on the Atlantic Coast. In addition, during the 2001 international wintering census, Georgia had the highest number of Great Lakes plovers banded the previous summer of all the states covered (Ferland and Haig, 2002). Furthermore, although Piping Plover numbers declined 27% from the 1996 international census (relative to the 1991 census), there were 68% more wintering Piping Plovers reported in Georgia and the Carolinas (Plissner and Haig, 2000). These data suggest that the barrier islands of Georgia are a significant wintering area for these threatened plovers. In fact, the U.S. Fish and Wildlife Service (2001) designated Little St. Simons Island and other barrier Islands in Georgia as 16 of the 142 areas along the south Atlantic coast and Gulf coast that provide critical habitat for wintering Piping Plovers.

Developing an effective recovery plan for the three breeding populations of Piping Plovers is hindered by the lack of knowledge about their winter distribution and winter habitat use along the Atlantic coast (Plissner and Haig, 1997). Little St. Simons Island (LSSI), located at the mouth of the Altamaha River, is an important site along the Georgia coast. The Altamaha River is the second largest river basin in the southeast and drains nearly a third of the state of Georgia. The entire estuarine system contains four undeveloped Islands, Wolf Island National Wildlife Refuge, Sapelo Island, Egg Island Bar and Little St. Simons Island. The Altamaha River's continuous outflux of

sediments to the beaches, resulting in expansive tidal flats, provides optimum wintering habitat for Piping Plovers. The Western Hemisphere Shorebird Reserve Network (WHSRN) designated this delta system as the 42nd International Shorebird Reserve Site. In addition, the National Audubon Society and American Bird Conservancy named this site as one of the top 500 Important Bird Areas in the country. Unfortunately, there have been no studies on the winter distribution, migration habits, site fidelity, or habitat use of the three separate breeding populations of Piping Plovers in this important region.

This report will quantify critical aspects of the winter ecology of the Piping Plover on LSSI, especially the endangered Great Lakes population. This is a summary of the 2003-2004 and 2004-2005 migrating and wintering study years. Based on our own observational data, we defined fall migration to be July through the end of October, and spring migration to be March to May. In addition, the wintering season was declared to be November through February for the purpose of this report. These temporal designations were used to address four specific questions: (1) How many Piping Plovers were on Little St. Simons Island monthly throughout each field season, and what was the relative abundance of plovers from the endangered Great Lakes population?, (2) What was the spatial distribution of Piping Plovers and did individuals exhibit site fidelity within each season and over consecutive seasons on Little St. Simons Island?, (3) What were the home ranges of wintering color-banded Piping Plovers on Little St. Simons Island?, and (4) What were the physical characteristics of the habitat utilized for migrating and wintering Piping Plovers on Little St. Simons Island? This report is unique in that it provides a detailed assessment of the migrating and wintering distribution and behavior of Piping Plovers, including individuals from the endangered Great Lakes population. In addition, it will facilitate the development of sound management plans for this species on its wintering grounds.

STUDY AREA AND METHODS

This study was conducted on LSSI (Fig. 1), Glynn County, Georgia (ca. 31° N, 81° W). Little St. Simons Island is a 5260-ha privately owned, undeveloped barrier island located at the southern branch of the Altamaha River Delta. The United States Fish and Wildlife Service designated LSSI, GA-13, as critical wintering habitat for Piping Plovers (U. S. Fish and Wildlife Service 2001). These data were collected over the 2003-2004 and 2004-2005 migrating and wintering study years (from arrival of the first migrants in July until the departure of the last plovers in May). Two opportunistic surveys were done at Egg Island Bar (Fig. 1) in 2005. Egg Island Bar is located between Wolf Island and LSSI in the Altamaha River Delta. This small Island, GA-12, was also designated as critical wintering habitat for Piping Plovers (United States Fish and Wildlife Service 2001). A considerable number of plovers have been documented here with some color-banded plovers detected in previous years by the Georgia Department of Natural Resources, including plovers from the endangered Great Lakes population.

How many Piping Plovers were on Little St. Simons Island monthly throughout each field season, and what was the relative abundance of plovers from the

endangered Great Lakes population? We quantified population densities of Piping Plovers monthly by conducting beach surveys at least once per week (Surveys were done every 6 to 7 days with a range of 1 – 13 days). Each week we attempted to survey the entire 11 km of beach on LSSI by foot, bicycle, or ATV. Using binoculars and spotting scope, we located and counted all Piping Plovers on Little St. Simons Island. The mean number of plovers was calculated per month. Surveys were conducted primarily at low tide (defined from 2 hours after high tide up to 2 hours before high tide), to maximize observability of plovers, but for comparison we surveyed at high tide at a minimum of once a month. Surveys were carried out at a sufficiently rapid pace to minimize double counting of plovers (minimize the chance that plovers will have moved to new parts of the beach during the surveys). Significant numbers of Piping Plovers are color-banded on their breeding grounds, especially in the Great Lakes region. During each survey, we recorded all Great Lakes individuals detected and calculated the mean number of Great Lakes individuals per month.

What was the spatial distribution of Piping Plovers and did individuals exhibit site fidelity within each season and over consecutive seasons on Little St. Simons Island? Little St. Simons Island was split up into four distinct sections of beach. During each census survey, we counted all color-banded and unbanded plovers for each section of beach and the mean number of all plovers and Great Lakes individuals for each section was calculated per month. We also mapped the approximate position of all individually marked Piping Plovers observed on LSSI using accurate maps of Little St. Simons Island. From these observations, we calculated a percentage of the frequency in which each individual was seen within the same section of beach where that individual was most commonly documented. A grand fidelity mean for each breeding population and all recognizable marked plovers was calculated from the total sightings within the same section of beach by the total sightings for all individuals, as oppose to averaging the percentage of frequencies for each individual. Additionally, we calculated the mean detection rate of all individuals over each study year from the first sighting to the last sighting (presumed departure date or mortality), and a mean detection rate for all individuals that were present during both study years from the first sighting to the last sighting. Aforementioned, a grand detection rate mean for each breeding population and all recognizable marked plovers was calculated from the total sightings (from first sighting to last sighting) by the total surveys conducted for each individual. The detection rates demonstrate the frequency in which individuals were documented over an entire study year and multiple study years. Thus, by accumulating mapped locations over an entire study year, we were able to determine the relative frequency with which plovers used different areas of Little St. Simons Island. Furthermore, we were able to determine whether individual plovers exhibited site fidelity within and between years when present on Little St. Simons Island.

What were the home ranges of wintering color-banded Piping Plovers on Little St. Simons Island? We quantified the home-range size of wintering color-banded Piping Plovers using Global Positioning System (GPS) coordinates of individually banded plovers. When recording GPS coordinates, we were an average of 20 m away from the individual. Additionally, the hand-held unit used (Garmin GPS 12 Personal Navigator),

had a standard distance error of 15 m. We used Spatial Analyst and Animal Movement Extensions (Hooge and Eichenlaub, 1997) in Arcview. Using the adaptive kernel method (AK) in the Animal Movement Extension (Hooge and Eichenlaub, 1997), we calculated the 95% and 50% (core area) home range contours (Worton, 1989). The fixed kernel method was used because Seaman and Powell (1996) suggest this method produces home-range size with less bias relative to other commonly used home-range estimators. For reference, we included 95% and 50% minimum convex polygon (MCP, Hooge and Eichenlaub, 1997). The home-range sizes were calculated in square kilometers (km²) as a comparison to other studies. Home-range sizes were calculated for individuals from each study year (2003-2004, 2004-2005) and for individuals that used LSSI both study years. Aware of plovers habitat use (intertidal flats and beaches) and our lack of 100% detection for all color marked wintering individuals throughout the study, we calculated a mean linear distance for all marked individuals wintering on Little St. Simons Island. The mean linear distance was calculated from each individual's northernmost location to the southernmost location in our study area. The grand fidelity mean and mean detection rates are included as reference to our home range and mean linear distance findings.

What were the physical characteristics of the habitat utilized for migrating and wintering Piping Plovers on Little St. Simons Island? We described the different sections of beach that were used by Piping Plovers throughout the wintering seasons and took aerial images at high and low tide of all sections of beach utilized by Piping Plovers on Little St. Simons Island.

RESULTS

PIPL Abundance

During two years of weekly surveying (July-April, 2003-2005), there was a mean number of 53.4 Piping Plovers with 9.1 Great Lakes individuals detected per survey during each month on Little St. Simons Island. The highest number of plovers detected during one survey was 109 in 2003 (19 Sep) and 126 in 2004 (3 Oct). In addition, the highest number of color-banded plovers detected during one survey was 20 in 2003 (22 Oct) and 26 in 2004 (3 Oct). The highest number of Great Lakes individuals detected during one survey was 14 in 2003 (19 Sep) and 19 in 2004 (3 Oct), respectively. During the wintering season (November through February), the fewest number of plovers detected during one survey was 29 in 2004 (9 Feb) and 20 in 2005 (23 Feb). In addition, the fewest color-banded plovers detected during one survey was 5 in 2004 (25 Jan) and 7 in 2005 (23 Feb and 24 Feb). The fewest number of Great Lakes individuals detected during one survey was 3 in 2004 (25 Jan) and 5 in 2005 (23 Feb). Throughout both study years, 53 separate individuals from the Great Lakes population were confirmed to have migrated through or wintered on Little St. Simons Island. Two opportunistic trips were made, Mar 2005 and Apr 2005 (Table 1), to Egg Island Bar (Fig. 1) during the 2004-2005 study year. There were 4 Great Lakes individuals seen during these trips, with 3 individuals documented on the north end of LSSI in each of those months, and 1 individual detected only on Egg Island Bar during these surveys.

Spatial Distribution

During two years (2003-2005) of data collection, LSSI resulted in 4.85 PIPL/km beach surveyed and 0.83 Great Lakes individuals/km of beach surveyed (calculated from the mean number of 53.4 Piping Plovers with 9.1 Great Lakes individuals detected per survey per month over the entire 11 km of beach). During the height of fall migration (September), there were 7.94 PIPL/km and 0.99 Great Lakes individuals/km of beach surveyed, respectively. Based on plover distribution throughout the island, LSSI was split into four separate sections of beach (Fig. 3) for each survey throughout the entirety of the study in order to map approximate locations used by Piping Plovers. Throughout both study years, all attempts were made to survey all 11 km of LSSI, regardless of plover distribution and sections of beaches.

These four sections of beach were delineated based on plover density over consecutive seasons. Section 1 (Sancho Panza Beach) was separated from section 2 (Bass Creek), due to two creeks (Sancho Panza Creek and Bass Creek) physically separating these two beach areas. No sections for mapping spatial distribution of plovers were delineated between section 2 and 3 (> 60%), and section 3 and 4 (> 75%), due to the lack of consistent plover use (% surveys that resulted in no plovers) during both study years. Section 3 (Middle Bar) was delineated due to a high density of plover presence during the 2003-2004 study year. Section 4 (Rainbow Beach) was the largest section, which included the beach at the drainage of a creek (Mosquito Creek) to the south end of the Island.

Throughout both study years, 2003-2004 and 2004-2005, the highest number of plovers was detected in section 1 (Sancho Panza Beach) at low tide and section 2 (Bass Creek) at high tide. Section 4 (Rainbow Beach) was covered with greater intensity in the 2004-2005 study year, resulting in a fewer number of plovers than the other sections during the wintering season (November to February), however during the migrating season (July to October and March to May), section 4, along with all sections, did support more plovers than the wintering months.

Section 1 (Sancho Panza Beach)

Surveys were not done at low tide in Jul 2003, or at high tide in Nov 2004 and Feb 2005. A majority of the plovers observed on Sancho Panza Beach were actively foraging on the large tidal flats at low tide (Fig. 9). During two years of weekly surveying (July-April, 2003-2005), there was a mean number of 24.1 Piping Plovers with 5.5 Great Lakes individuals detected per low tide survey during each month (Fig. 4). The highest number of plovers detected at low tide during both study years was 52 in 2004 (15 Sep). The highest number of plovers detected at high tide during both study years was 34 in 2004 (22 Sep). The highest number of Great Lakes individuals detected during one low tide survey was 12 in 2004 (3 Mar) and 2005 (6 Apr), respectively. During the wintering season (November through February), the fewest number of plovers detected during both study years at low tide was 1 in 2003 (21 Dec) and 2005 (11 Jan). In addition, the

fewest number of plovers detected during both migrating and wintering seasons at high tide was 1 in 2004 (26 Jan) and 2005 (13 Jan). The fewest number of Great Lakes individuals detected during one low tide survey was 1 in 2003 (21 Aug, 12 Dec, and 21 Dec), and 0 in 2005 (11 Jan).

Section 2 (Bass Creek)

We were unable to conduct a survey at low tide in Jul 2003, and at high tide in Jul 2003 and Feb 2005. A majority of the plovers observed at Bass Creek were documented roosting in a large washover zone (Fig. 13 and 14). During two years of weekly surveying (July-April, 2003-2005), there was a mean number of 23.2 Piping Plovers with 4.6 Great Lakes individuals detected per high tide survey during each month (Fig. 5). The highest number of plovers detected at high tide during both study years was 77 in 2004 (31 Aug). The highest number of plovers detected at low tide during both study years was 50 in 2004 (3 Oct). The highest number of Great Lakes individuals detected during one high tide survey was 10 in 2003 (11 Sep), and 12 in 2004 (4 Aug), respectively. During the wintering season (November through February), the fewest number of plovers detected during both study years at low tide was 0 in 2004 (8 Dec) and 2005 (16 Feb and 23 Feb). In addition, the fewest number of plovers detected during both study years at high tide was 11 in 2004 (4 Dec). The fewest number of Great Lakes individuals detected during one high tide survey was 1 in 2004 (12 Mar and 17 Apr) and 0 in 2004 (8 Sep).

Section 3 (Middle Bar)

Only one survey was done at high tide in Jan 2005. We were unable to conduct a high tide survey in Feb 2005. During two years of weekly surveying (July-April, 2003-2005), there was a mean number of 15.5 Piping Plovers with 1.5 Great Lakes individuals detected per low tide survey during each month, and 18.4 Piping Plovers with 2.6 Great Lakes individuals detected per high tide survey during each month (Fig. 6). The highest number of plovers detected at low tide during both study years was 34 in 2004 (20 Mar). The highest number of plovers detected at high tide during both study years was 55 in 2004 (26 Aug). The highest number of Great Lakes individuals detected during one low or high tide survey was 8 in 2003 (29 Jul) and 6 in 2004 (13 Jul), respectively. During the wintering season (November through February), the fewest number of plovers detected during both study years at low tide was 0 in 2005 (9 Jan, 11 Jan, 9 Feb, 16 Feb, and 23 Feb). In addition, the fewest number of plovers detected during both study years at high tide was 4 in 2004 (26 Jan). Twenty-three of seventy low tide surveys from both study years resulted in 0 Great Lakes individuals detected, yet no high tide survey from both study years resulted in less than 1 Great Lakes individual detected.

Section 4 (Rainbow Beach)

We were unable to survey Jul 2003 through Dec 2003 at high tide and didn't start surveying at low tide until Oct 2003 due to limited access (Fig. 7). During the second study year (2004-2005), we were unable to survey in Feb 2005 at high tide, and data

from low and high tide in Jan 2004, are from one survey. During two years of weekly surveying (October-April, 2003-2004, and July-April, 2004-2005), there was a mean number of 4.8 Piping Plovers with 0.6 Great Lakes individuals detected per low tide survey during each month (Fig. 7). The highest number of plovers detected at low tide during both study years was 16 in 2004 (23 Aug). The highest number of plovers detected at high tide during both study years was 17 in 2004 (14 Mar). The highest number of Great Lakes individuals detected during both study years during one low or high tide survey was 2 in 2004 (9 Mar, 28 Mar, 19 Apr, and 20 Apr) and 2004 (17 Jul and 23 Aug), respectively. During the wintering season (November through February), the fewest number of plovers detected during both study years at low tide was 0 in 2003 (12 Dec) and 2005 (9 Jan, 11 Jan, and 21 Jan). In addition, the fewest number of plovers detected during both study years at high tide was 0 in 2005 (15 Jan). Nineteen of thirty-six low tide surveys from both study years resulted in 0 Great Lakes individuals detected, yet only seven of twenty-three high tide surveys from both study years resulted in 0 Great Lakes individuals detected.

Site Fidelity

A color-banded bird was considered to have wintered on LSSI if it was detected beyond November of each study year. Throughout the two wintering study years (2003-2004 and 2004-2005), a minimum of 29 separate color-banded individuals (Table 2) were documented wintering on Little St. Simons Island. Of these 29 individuals, 23 were Great Lakes, 3 were Great Plains, and at least 3 were individuals believed to be from the Atlantic Coast population. Seven of the 23 from the Great Lakes, 2 of the 3 from the Great Plains, and possibly 3 individuals from the Atlantic Coast populations wintered both study years on Little St. Simons Island. One of the Atlantic Coast individuals from the 2003-2004 season was recaptured on its breeding grounds in 2004, and the distinctive bi-colored metal band was removed, resulting in just a metal (USFWS) band on one leg (Amirault and McKnight, 2004). The other individuals presumed to be from the Atlantic Coast had just metal (USFWS) bands on one of their legs, making it impossible to recognize individuals.

A color-banded bird was considered to have migrated through LSSI if it was detected at least once July through October or March through May, but not documented November through February of each study year. Throughout two migrating study years (2003-2004 and 2004-2005), a minimum of 54 separate color-banded individuals (Table 2) were documented migrating on Little St. Simons Island. Of these 54 individuals, 37 were Great Lakes, 7 were Great Plains, and at least 10 individuals were believed to be from the Atlantic Coast population. Two of the 7 from the Great Plains, possibly 4 of the 37 Great Lakes, and possibly 5 individuals from the Atlantic Coast populations migrated through LSSI both study years. The 4 individuals from the Great Lakes, and 5 individuals believed to be from the Atlantic Coast, did not have individually recognizable band combinations.

Within each of the two study years, we used the definitive band combinations (breeding adults, or if we knew there was only 1 individual present with a particular band

combination) of individuals. From these observations, we calculated a percentage of the frequency in which each individual was seen within the same section of beach (Fig 3) where that individual was most commonly documented. Additionally, we calculated a percentage of the frequency each individual was detected over each study year from the first sighting to the last sighting (presumed departure date or mortality), and a frequency for each wintering individual that was present during both study years from the first sighting to the last sighting. For the individuals classified as migrants, a minimum of three sightings were required to calculate fidelity and detection percentages.

During the 2003-2004 study year, there was a mean of 25.7 observations per wintering Great Lakes individual (range 10 – 39), 35.0 observations per wintering Great Plains individual (range 34 – 36), and 27 observations for the wintering individual believed to be from the Atlantic Coast. The following study year (2004-2005), there was a mean of 37.2 observations per wintering Great Lakes individual (range 12 – 58), 23.0 observations per wintering Great Plains individual (range 19 – 27), and no recognizable wintering individuals from the Atlantic Coast.

2003-2004 study year

During the wintering season (November to February), there were 15 recognizable Great Lakes individuals, 3 Great Plains individuals, and 3 individuals believed to be from the Atlantic Coast that were confirmed to have wintered. Two of the fifteen wintering Great Lakes individuals had the same band combination, making it impossible to separate individuals just by observation. All but one of the thirteen individually recognizable Great Lakes birds were documented at least 75% of the time within the same section of beach (range 63.6% - 100%). The one individual had a total of 11 observations (63.6% site faithful), four of which were at section 2, and seven at section 1. With this individual removed from the total of thirteen, all observations outside each individual's section of beach occurred during migrating months (July to October and March to May). Of the three recognizable Great Plains individuals, only one of the three individuals exhibited fidelity numbers, 85.3% (29/34 sightings), similar to that of the Great Lakes (Table 3). The other two individuals were 63.9% (23/36 sightings) and 68.6% (24/25 sightings) site faithful. There were two individuals believed to be from the Atlantic Coast, which possessed only a metal band (USFWS) on one leg, with other individuals migrating through with these combinations making it impossible to separate individuals. The one recognizable Atlantic Coast individual had one sighting outside its section of beach that occurred during a migrating month (Mar 2004).

The mean detection rate from first sighting to last sighting for all thirteen recognizable wintering Great Lakes individuals was 58.3% (range 34.1% - 78.0%). The mean number of surveys was 43.7 surveys (range 25 – 57). The detection rate for the three wintering Great Plains individuals was 62.5% (30/48 surveys), 68.0% (34/50 surveys), and 68.8% (33/48 surveys), and the one wintering Atlantic Coast individual was 64.3% (Table 3). The mean detection rate during the wintering months (November to February) for all thirteen recognizable Great Lakes individuals was 54.7% (range 19.0%

- 90.5%). The mean number of surveys was 19.5 surveys (range 6 – 22). Eight of the thirteen individuals were detected at least 50% of the time. The wintering detection rate for the three Great Plains individuals was 57.1% (12/21 surveys), 61.9% (13/21 surveys), and 66.7% (14/21 surveys), and the one Atlantic Coast individual was 76.2% (16/21 surveys).

There were 2 Great Lakes individuals labeled as winter mortalities. These individuals were not reported on their breeding grounds in 2004 (Stucker, 2004). There was no evidence to suggest that any color-banded individuals from the Great Plains or individuals believed to be from the Atlantic Coast populations resulted in winter mortalities. One of the Great Lakes individuals labeled as a winter mortality was observed with an injured leg, which was banded, and activity became more arduous for the individual leading up to its last sighting in early Mar 2004. The other Great Lakes individual was no longer detected after late Jan 2004.

During the migrating season (July to October and March to May), there were 16 recognizable Great Lakes individuals, 5 Great Plains individuals, and 7 individuals believed to be from the Atlantic Coast. Two of the sixteen migrating Great Lakes individuals had the same band combination as two wintering individuals, making it impossible to separate individuals just by observation. Only three of the remaining fourteen individuals were documented at least three times during the migrating season, exhibiting site faithfulness of 47.1% (8/17 sightings), 50.0% (2/4 sightings), and 66.7% (2/3 sightings). Of the five recognizable Great Plains individuals, two individuals exhibited 66.7% (2/3 sightings) and 100.0% (3/3 sightings) site faithfulness. Of the seven individuals believed to be from the Atlantic Coast, four individuals were documented three times or more, exhibiting site faithfulness of 50.0% (3/6 sightings), 71.4% (5/7 sightings), 100% (3/3 sightings), and 100% (3/3 sightings).

The detection rate for migrating individuals was lower than that of wintering individuals. The detection rates for the three recognizable migrating Great Lakes individuals was 33.3% (4/12 surveys), 42.9% (3/7 surveys), and 63.0% (17/27 surveys). The detection rate for the two Great Plains individuals was 37.5% (3/8 surveys) and 42.9% (3/7 surveys), and the detection rate for the four Atlantic Coast individuals was 41.2% (7/17 surveys), 50.0% (3/6 surveys), 60.0% (3/5 surveys), and 66.7% (6/9 surveys).

2004-2005 study year

During the wintering season (November to February), there were 15 recognizable Great Lakes individuals, 2 Great Plains, and 3 individuals believed to be from the Atlantic Coast. Two of the fifteen wintering Great Lakes individuals had the same band combination as some other migrants, making it impossible to separate individuals by just observation. Ten of the remaining thirteen individuals were documented at least 75% of the time within the same section of beach. The three other individuals were 50% (2/4 sightings), 69.4% (34/49 sightings), and 68.4% (26/38 sightings) site faithful, with two individuals abandoning section 3 and one individual alternating between sections 1 and 2. Most of the observations outside an individual's section of beach

occurred during migrating months (July to October and March to May), however unlike the 2003-2004 study year, there were sightings during the wintering months (November through February) outside their most commonly documented section of beach. Of the two recognizable Great Plains individuals, one individual (same from the previous season) was 84.2% (16/19 sightings) site faithful, whereas the other individual was 55.6% (15/27 sightings) site faithful (Table 4). All three of the individuals believed to be from the Atlantic Coast were impossible to recognize individually. Two individuals had only a metal band on their left leg and one individual had only a metal band on their right leg.

The mean detection rate from first sighting to last sighting for all thirteen recognizable wintering Great Lakes individuals was 74.3% (range 50.0% - 90.2%). The mean number of surveys was 46.5 surveys (range 23 – 61). The detection rate for the two Great Plains individuals was 69.2% (18/26 surveys) and 72.7% (24/33 surveys), and there were no recognizable individuals from the Atlantic Coast to calculate a detection percentage (Table 4). During the wintering months (November to February), the mean detection rate for all thirteen recognizable Great Lakes individuals was 71.4 % (range 45.5% - 90.0%). The mean number of surveys was 16.9 surveys (range 4 – 22). Eleven of the thirteen individuals were detected at least 50% of the time. The wintering detection rate for the two Great Plains individuals was 66.7% (6/9 surveys) and 80.0% (8/10 surveys). There were no recognizable individuals believed to be from the Atlantic Coast to calculate a detection percentage.

There were 6 Great Lakes, 2 Great Plains, and 1 individual believed to be from the Atlantic Coast labeled as winter mortalities. These individuals from the Great Lakes and Great Plains were not detected on their breeding grounds in 2005 (Stucker 2004 and Gratto-Trevor 2005). The five Great Lakes individuals were no longer detected after Dec 2004, Jan 2005, and Feb 2005, with the Great Plains individuals not detected after mid to late December. Six of these seven individuals (including both Great Plains individuals) wintered on LSSI the previous study year (2003-2004). The individual believed to be from the Atlantic Coast was last observed in late Jan 2005, and it is unknown if this individual was seen or not seen on its breeding grounds in 2005.

During the migrating season (July to October and March to May), there were 25 recognizable Great Lakes individuals, 4 Great Plains individuals, and 8 individuals believed to be from the Atlantic Coast. Six of the twenty-five migrating Great Lakes individuals had the same band combination as two wintering individuals and one migrating individual, making it impossible to separate individuals just by observation. Ten of the remaining nineteen individuals were documented at least three times during the migrating season, exhibiting a mean of 66.0% (70/106 sightings) site faithfulness (range 41.7% - 100.0%). The mean number of sightings was 10.6 (range 4 – 25). Six of the ten migrants were 75% site faithful or more. Of the four recognizable Great Plains individuals, two individuals were documented more than three times, exhibiting 50.0% (5/10 sightings) and 80.0% (12/15 sightings) site faithfulness. Of the eight individuals believed to be from the Atlantic Coast, four individuals were documented

three times or more, exhibiting site faithfulness of 40.0% (4/10 sightings), 60.0% (3/5 sightings), 62.5% (5/8 sightings), and 66.7% (2/3 sightings).

Similar to the first study year (2003-2004), the detection rate for migrating individuals was lower than that of wintering individuals. The mean detection rate for the ten recognizable migrating Great Lakes individuals was 68.0% (range 29.2% - 100.0%). The mean number of surveys was 15.3 surveys (range 4 – 31). Two individuals with 100% detection rates were calculated from 4/4 surveys and 12/12 surveys. The detection rate for the two Great Plains individuals was 93.8% (15/16 surveys) and 100.0% (10/10 surveys), and the four Atlantic Coast individuals were 42.1% (8/19 surveys), 66.7% (4/6 surveys), 83.3% (10/12 surveys), and 100.0% (3/3 surveys).

2003-2004 and 2004-2005 study years

There were 9 confirmed color-banded individuals (7 from the Great Lakes, and 2 from the Great Plains) that wintered on LSSI both study years. All individuals wintered within the same section of beach both study years, but six of these nine individuals were labeled as winter mortalities in the 2004-2005 study year. All seven of the Great Lakes individuals that returned for a second season of wintering, were breeding adults that were banded no later than 2002 (Stucker, 2004). Only one Great Lakes individual was not documented at least 75% (range 61.7% - 93.4%) of the time within the same section of beach. The one Great Lakes individual (37/60 sightings) was one of the six winter mortalities from the 2004-2005 study year, along with three other Great Lakes individuals. Three of these four individuals were most commonly detected in section 3 (Fig 3). The two recognizable Great Plains individuals, which were both labeled as winter mortalities, exhibited 61.3% (38/62 sightings) and 84.9% (45/53 sightings) site faithfulness (Table 5). Both of the Great Plains individuals were breeding adults banded in 2002 and 2003 as adults (Gratto-Trevor, 2004).

The mean detection rate from first sighting to last sighting for all individuals documented wintering on LSSI was 70.4% (Table 5). The mean detection rate for all seven recognizable Great Lakes individuals was 71.1% (range 55.8% - 81.1%). The mean number of surveys was 89.4 surveys (range 43 – 109). The detection rate for the two Great Plains individuals was 66.7% (54/81 surveys) and 68.9% (51/74 surveys). During the wintering months (November to February), the mean detection rate for all seven recognizable Great Lakes individuals was 69.1% (range 50.0% - 85.7%). The mean number of surveys was 33.7 surveys (range 10 – 43). The detection rate for the two Great Plains individuals was 64.5% (20/31 surveys) and 70.0% (20/30 surveys). Between successive study years, Great Lakes individuals were 10.1% less site faithful in 2004-2005, yet 16% more detected (58.3% to 74.3%), and Great Plains individuals were 9.4% less site faithful in 2004-2005, yet 4.8% more detected (66.4% to 71.2%).

Site faithfulness and detection rates could not be calculated for individuals that were present over both migrating study years from the Great Lakes population or the Atlantic Coast population. There were four individuals from Great Lakes population with the same band combination from both study years, but these particular band combinations

are used on fledglings, resulting in multiple individuals with these band combinations. There were five individuals believed to be from the Atlantic Coast population that had band combinations that could not be individually recognizable. One individual from the Great Plains population was 77.8% (14/18 sightings) site faithful and detected 78.3% (18/23 surveys) over both migrating study years.

Home range

Home-range size of all color marked wintering individuals was calculated using GPS coordinates recorded throughout each field season. These GPS coordinates (standard error of 15 m recording and 20 m observation) were converted to UTM's for ease of use with Arcview software. Aware of plovers habitat use (intertidal flats and beaches) and our lack of 100% detection for all color marked wintering individuals throughout the study, we calculated a mean linear distance for all marked individuals wintering on Little St. Simons Island. The mean linear distance was calculated from each individual's northernmost location to the southernmost location on Little St. Simons Island. The grand fidelity mean and mean detection rates are included as reference to our home range and mean linear distance findings.

Mean home-range size (95%MCP and 95%AK) and mean core area (50%MCP and 50%AK) for Great Lakes individuals was smaller (Table 6) than Great Plains individuals during the 2003-2004 study year and the 2004-2005 study year. During the 2003-2004 study year, the range of MCP's for Great Lakes individuals was 0.001 – 0.178 km² (50%MCP) and 0.154 – 3.561 km² (95%MCP). The range of AK's was 0.038 – 0.669 km² (50%AK) and 0.470 – 3.736 km² (95%). During the 2004-2005 study year, the range of MCP's was 0.004 – 0.362 km² (50%MCP) and 0.145 – 4.064 km² (95%MCP). The range of AK's was 0.046 – 2.477 km² (50%AK) and 0.221 – 9.903 km² (95%). Great Lakes individuals that were present both study years (2003-2004 and 2004-2005) range of MCP's was 0.045 – 1.292 km² (50%MCP) and 0.656 – 2.860 km² (95%MCP). The range of AK's was 0.098 – 0.955 km² (50%AK) and 0.482 – 2.543 km² (95%).

During the 2004-2005 study year, the mean core area was smaller for Great Plains individuals, but there were only two individuals. One individual exhibited a very low core area (0.02 km²), with the other resulting in a much higher core area (0.16 km²). However, the sample size is larger for Great Lakes plovers (n=22) compared to Great Plains and Atlantic Coast plovers combined (n=3). Based on field observations, plovers were more mobile during migrating months compared to wintering months. During the wintering months, plovers seemed to be less likely out of their familiar sites. Mean home-range size (95%AK) was lower for Great Lakes and Great Plains individuals (Table 6) that were present during both study years (2003-2004 and 2004-2005).

The mean linear distance was less (Table 7) for individuals from the Great Lakes population during the 2003-2004 study year. There were only three individuals from the Great Plains population (range 1.8 – 4.7 km) and one individual believed to be from the Atlantic Coast population (3.7 km) compared to thirteen Great Lakes individuals (range 1.0 – 6.3 km). During the 2004-2005 study year, the mean linear distance was not less

for individuals from the Great Lakes population (Table 7). However, there were only two individuals from the Great Plains population (1.7 km and 5.3 km) compared to the thirteen individuals from the Great Lakes population (range 1.0 – 8.1 km). There were no recognizable individuals from the Atlantic Coast population during the 2004-2005 study year. During both study years (2003-2004 and 2004-2005), the mean linear distance was not less for individuals from the Great Lakes population. There were only two individuals from the Great Plains population (1.9 km and 5.3 km), compared to seven individuals from the Great Lakes population (range 2.0 – 9.1 km).

HABITAT DESCRIPTIONS

Section 1 (Sancho Panza Beach)

We suggest Sancho Panza Beach is the most important section of beach on LSSI for Piping Plovers and other shorebirds. This beach resulted in the highest number of plovers on a consistent basis at low tide throughout both migrating and wintering study years (Fig. 4). This beach, only ca. 1.5 km long, continues to exhibit net growth every year due to continuous sediment deposition from the Altamaha River, a gradual continental slope, and the lack of major hurricane strikes to the Georgia coast in the last century. The north end consists of the Altamaha River (Fig. 8), and the south end consists of two creeks (Sancho Panza Creek and Bass Creek), which drain a majority of the north end salt marshes of the island. The inter tidal flats of this beach are more expanse (Fig. 9), with a high frequency of nutrients draining out of the Altamaha River. We believe this results in a higher prey density for not only the Piping Plover, but also other species of shorebirds. Due to the continuous growth, this section of beach has changed over consecutive field seasons, and will continue to change topographically.

Section 2 (Bass Creek)

Bass Creek, only ca. 1 km long, resulted in the highest number of plovers during both migrating and wintering study years at high tide, especially during fall migration (Fig. 5). Two creeks, Sancho Panza Creek and Bass Creek, drain out at the northern border of this beach (Fig. 12). The designated southern border of this section of beach was a piece of an old wooden boat. Historically (prior to 2001), Bass Creek emptied into the Atlantic Ocean further south, ca. 3 km, then the current location. Some plovers were documented over both study years foraging at the old mouth of Bass Creek (Fig. 15), but they were not observed in this area consistently enough (< 40% surveys resulted in plovers) to designate this area as a section of beach. Bass Creek is a low-grade elevation beach with a frequent washover zone during higher tides (Fig. 13). There is a lack of vegetation and any kind of dune development above the mean high tide mark (Fig. 14). Due to this large washover zone, we believe plovers and other shorebirds prefer this section of beach for roosting at high tide.

Section 3 (Middle Bar)

Middle Bar, ca. 2 km long, is a point that had recently formed from an emergent sandbar. The northern border of this section of beach is on the northwest side of the point (Fig. 16) and the southern border is the beach access (Fig. 18) used by the guest of Little St. Simons Island. Inside the point, there are tidal pools that repeatedly changed dependent on tides throughout the study. Sand movement is abundant here resulting in potential food abundance and scarcity dependant on nutrient and tidal input. There are washover zones (Fig. 17) where plovers were commonly observed roosting during the 2003-2004 study year and at the beginning of the 2004-2005 study year, but after Nov 2004, the usage dropped dramatically (Fig. 6). This section of beach has the highest potential for human disturbance by guests of LSSI, due to the primary beach access being on the southern end of this section. Plovers were observed foraging at the beach access and south of it over both study years, but most commonly were found around the tidal pools and flats around the point. Little St. Simons Island will only permit 30 people per day. However, for an unknown reason, this section of beach was no longer used for foraging or roosting, after late Nov 2004, on a consistent basis.

Section 4 (Rainbow Beach)

Rainbow Beach, ca. 4.5 km long, resulted in the fewest number of plovers during both study years. The northern border of this beach is at the mouth of Mosquito Creek (Fig. 19) and the southern border is at the southern tip of Little St. Simons Island (Fig. 24). This beach has larger dunes and more of a representative beach slope than the other three sections of beach with no washover zones or distinct tidal pools. There are two areas within this large section of beach plovers were commonly observed, but for simplicity (Fig. 7), this beach was labeled as only one section. One location where plovers were consistently observed was near a washed up tugboat (Fig. 20), which seemed to provide wet tidal flats for foraging (Fig. 21). The second location where plovers were consistently observed was at the southern tip of the Island, where the Hampton River empties into the Atlantic Ocean. This beach resulted in the highest potential human disturbance from recreational boaters using this beach and Pelican Spit (Fig. 22) throughout the migrating months. However, we believe the prey abundance is less than other sections of beach, which leads to the lower numbers of plovers present on this beach. Near the southern end of this beach there are large emergent sandbars (Fig. 23) that form at low tide that provide foraging habitat for other species, and potentially Piping Plovers, but due to being offshore, these emergent sandbars were not surveyed.

DISCUSSION

In 2001, the U. S. Fish and Wildlife Service designated Little St. Simons Island as critical wintering habitat for Piping Plovers (U.S. Fish and Wildlife Service, 2001). However, this is the first extensive study on the island to document seasonal abundance, with an emphasis placed on the presence of individuals from each breeding population, particularly the endangered Great Lakes population. It is apparent that LSSI supported a substantial number of migrating and wintering Piping Plovers, especially individuals from the endangered Great Lakes population. According to a 2004 breeding

survey, the Great Lakes population is composed of 55 breeding pairs and 90 surviving fledglings, for a total of approximately 200 plovers (Stucker, 2004). During the 2004-2005 study year we documented 40 Great Lakes individuals, a significant percentage (ca. 20%) of the entire breeding population. Over two study years we detected and confirmed 53 individuals from the Great Lakes population, which is consistent with the findings from the international winter census of 2001 that Georgia supported the highest concentration of Great Lakes plovers detected (Ferland and Haig, 2002). Nicholls and Baldassarre (1990) suggested that LSSI supported 0.77 Piping Plovers per km of beach during wintering months, yet we found it to support 4.85 plovers per km of beach and 0.83 Great Lakes individuals per km of beach throughout both study years. In addition, during the height of fall migration (September) there was an average of 7.94 plovers per km of beach and 0.99 Great Lakes individuals per km of beach for both study years.

The spatial distribution of plovers suggests that two sections of LSSI beach are particularly important for migrating and wintering plovers. Throughout this study, Sancho Panza Beach supported a consistently higher number of plovers foraging at low tide (Fig. 4), and Bass Creek supported a consistently higher number of plovers roosting at high tide (Fig. 5). A third section, Middle Bar, was used heavily by plovers during the 2003-2004 study year, but was used much less often after November 2004 (Fig. 6) in the 2004-2005 study year. This change in spatial distribution of plovers could be related to hurricane damage to the beaches (Hurricane Charley, Frances, Ivan, and Jeanne), random events from year to year, higher predatory activity, or to a fuel spill (around 25 Nov 2004) off the coast of Savannah (ca. 29 km) that might have contributed to a reduction in prey abundance. This change in habitat use by plovers could have contributed to the winter mortality of three Great Lakes individuals that were documented using this section of beach faithfully during the 2003-2004 study year and up until November 2004 in the 2004-2005 study year. Two of the three individuals were seen using this section of beach up until early Jan 2005. They were never seen at this section of beach again, but were seen erratically at section 1 and 2 multiple times. One individual was not detected after 1 Jan 2005, with the other not being detected after 17 Feb 2005. The third individual was not seen after 11 Nov 2005, even though this individual spent the entire previous wintering season (2003-2004) and start of the second wintering season (2004-2005) within this section of beach. Additionally, this individual was documented on LSSI during the 2000-2001 and 2001-2002 migrating and wintering years (Winn 2005). None of these individuals were documented on their breeding grounds in 2005 despite having nested there in previous summers (Stucker, 2005). Although anecdotal, these observations suggest that habitat suitability for plovers can change at a relatively fine spatial scale from season to season.

Piping Plovers from all populations showed a substantial degree of site-faithfulness to particular sections of Little St. Simons Island (Table 5). The one recognizable Atlantic Coast individual from the 2003-2004 study year was 96.3% faithful (i.e., 96.3% of sightings were from the same beach section) with a 60.2% detection rate. Great Lakes individuals averaged 85.3% site-faithfulness (range 50.0%-100%) and 66.3% detection (range 34.1% - 90.2%), and Great Plains averaged 69.9% site-faithfulness (range 55.6%-85.3%) and 68.8% (range 62.5% - 72.7%) throughout the study. However, the

sample size was larger for the Great Lakes individuals than the Great Plains individuals. Although the one recognizable Atlantic Coast individual from the 2003-2004 study year was 96.3% faithful, six of the twenty-six individuals from the Great Lakes population during both study years exhibited higher percentages, three of which were 100%. One of the three Great Plains individuals was 85.0% faithful (68.6% detected) for both study years, but the other individuals weren't comparable. One individual did not return to winter as he died on his breeding grounds (Gratto-Trevor, 2004), and the other was erratic both study years moving between Sancho Panza Beach, Bass Creek, and Middle Bar, exhibiting 62.9% site-faithfulness (74.4% detected). Both of the Great Plains individuals present during both study years were classified as 2004-2005 winter mortalities with one frequently using Middle Bar. The change in habitat use could have contributed to the winter mortality of at least one of these individuals. Additionally, the overall site fidelity percentage numbers (Table 3 and 4) could have been affected by the alteration at Middle Bar, as three of the thirteen individuals from the Great Lakes were documented abandoning this section of beach in the middle of the wintering season. Coincidentally, all three of these Great Lakes individuals were labeled as winter mortalities during the 2004-2005 study year. All marked plovers during the study exhibited 83.1% site faithfulness (67.2% detection). Individuals that were documented both study years on LSSI exhibited 80.5% site faithfulness (Table 5) with a mean detection rate of 70.4%.

Piping Plovers that migrated through LSSI did not show the same degree of site fidelity as wintering individuals. More color marked individuals (Table 2) and plovers were documented migrating through LSSI during the 2004-2005 study year. There were not enough sightings (3 required) to calculate a majority of the first study year (2003-2004) migrants. Throughout the study, individuals from the Great Lakes population averaged 60.3% site-faithfulness (range 41.7% - 100.0%) and 57.2% detection (range 29.2% - 100.0%), Great Plains averaged 69.9% site-faithfulness (range 55.6%-85.3%) and 68.8% detection (range 37.5% - 100.0%), and individuals from the Atlantic Coast averaged 68.8% (range 40.0% - 100.0%) and 63.8% detection (range 41.2% - 100.0%). The sample size was larger for the Great Lakes population (n=13) than the Great Plains population (n=4), but comparable to the Atlantic Coast population (n=8). Only one individual of all migrants, Great Plains individual, was recognizable during both study years, exhibiting 77.8% site faithfulness with a detection rate of 78.3%.

Using radio-marked Piping Plovers, Drake et al. (2001) found that plovers exhibited strong site fidelity throughout the fall, winter, and spring. Our site fidelity percentage numbers echo these findings. Drake et al. (2001) reports mean home-range size of plovers (based on 95% of locations), in Texas, to be 12.6 km² with a mean core area (50% of locations) of 2.9 km². On LSSI, our mean home-range size (based on 95% of locations) during the study for all marked plovers was 2.9 km² (Table 6) and 1.2 km² (individuals present both study years). In addition, our mean core area (50 % of locations) during the study for all marked plovers was 0.6 km² and 0.4 km² (individuals present both study years). We did not use radio-marked plovers for this study (mean = 33 observations, range = 69-283 days), whereas Drake et al. (2001) averaged 54 observations over 36-68 days. Thus, our home ranges are based on fewer

observations but longer periods of time. Primary Piping Plover habitat on the Georgia coast appears to be linear, and aware of our lack of 100% detection rates for wintering individuals (67.2% detection), we calculated the mean linear distance for all marked plovers to be 3.5 km (Table 7) and 4.5 km (individuals present during both study years) throughout the study. Although we did not use radio-marked plovers for this study, we believe the mean linear distance represents an indicative range of plover habitat. These smaller home range sizes that we report could be attributable to high habitat quality and/or low human disturbance on LSSI.

In summation, LSSI, to the best of our knowledge, supports one of the largest concentrations of plovers on the Atlantic Coast, especially individuals from the endangered Great Lakes population (ca. 20% of the breeding population). Not only is LSSI an important site during migration, but it also supports a mean number of 53.4 plovers with 9.1 Great Lakes individuals detected per survey per month. Observations of color-banded Great Lakes plovers suggest these individuals exhibit strong site fidelity with small home-range sizes and core areas when detected on Little St. Simons Island. In addition, some individuals spend as long as 283 days (more than 9 months) on Little St. Simons Island; June is the only month when Piping Plovers are absent from our study area. With increasing development and recreational beach use along the south Atlantic coast, the collection of data on the winter distribution and ecology of the Piping Plover is a high priority (Plissner and Haig, 1997). Oil spills, dredging, construction of sea walls and jetties, expansion of inter-coastal waterways, hurricanes, beach restoration and dune stabilization have all been documented to negatively impact Piping Plovers on their wintering grounds (Nicholls and Baldassarre, 1990; Haig and Plissner, 1992; U.S. Fish and Wildlife Service, 1994). These findings from LSSI provide the opportunity to model the habitat needs to better protect and preserve suitable migrating and wintering grounds on the Atlantic coast for the Piping Plover.

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Table 1. Total number of Piping Plover individuals documented from the endangered Great Lakes population each month during the 2003-2004 and the 2004-2005 migrating and wintering study years on Little St. Simons Island.

	Total Great Lakes individuals documented		Total Great Lakes individuals documented
Jul 2003	8	Jul 2004	21
Aug 2003	16	Aug 2004	27
Sep 2003	27	Sep 2004	26
Oct 2003	17	Oct 2004	23
Nov 2003	17	Nov 2004	18
Dec 2003	14	Dec 2004	12
Jan 2004	14	Jan 2005	14
Feb 2004	14	Feb 2005	11
Mar 2004	16	Mar 2005	14 ^a
Apr 2004	17	Apr 2005	15 ^a

^a 1 individual documented on Egg Island Bar that was not documented on LSSI

Table 2. Color-banded Piping Plovers from each breeding population confirmed to have migrated or wintered on Little St. Simons Island within study years and between both study years.

	2003-2004	2004-2005	2003-2005
Great Lakes ^a	15	15	7
Great Lakes ^b	16	25	4 ^c
Great Plains ^a	3	2	2
Great Plains ^b	5	4	2
Atlantic Coast ^a	3	3	3 ^c
Atlantic Coast ^b	7	8	5 ^c

^a Confirmed wintering individuals

^b Confirmed migrant individuals

^c Band combinations the same over both study years, but not individually recognizable

Table 3. 2003-2004 total sightings for recognizable wintering individuals from each breeding population within and outside their most commonly documented (more than 50%) section of beach. The detection rate for each breeding population and all marked plovers over the entire 2003-2004 study year is reported as a percentage.

	n	Sightings within section of beach	Sightings outside section of beach	% Site Faithful	% Detected
Great Lakes	13	295	39	88.3	58.3
Great Plains	3	76	29	72.4	66.4
Atlantic Coast	1	26	1	96.3 ^a	64.3 ^a
All marked plovers	17	466	69	85.2	60.2

^a % from 1 individual (15 out of 42 surveys this individual was not detected)

Table 4. 2004-2005 total sightings for recognizable wintering individuals from each breeding population within and outside their most commonly documented (more than 50%) section of beach. The detection rate for all individuals of each breeding population over the entire 2004-2005 study year is reported as a percentage.

	n	Sightings within section of beach	Sightings outside section of beach	% Site Faithful	% Detected
Great Lakes	13	397	86	82.2	74.3
Great Plains	2	31	15	67.4	71.2
Atlantic Coast	0 ^a	Unknown	Unknown	Unknown	Unknown
All marked plovers	15	428	101	80.9	74.1

^a 3 banded plovers believed to be from population, but not individually recognizable.

Table 5. 2003-2005 total sightings for recognizable wintering individuals from each breeding population within and outside their most commonly documented (more than 50%) section of beach over both study years (2003-2004 and 2004-2005). The detection rate for all individuals of each breeding population over both study years is reported as a percentage.

	n	Sightings within section of beach	Sightings outside section of beach	% Site Faithful	% Detected
Great Lakes	7	384	81	82.6	71.1
Great Plains	2	83	32	72.2	67.7
All marked plovers	9	467	113	80.5	70.4

Table 6. Mean home-range size and core areas of recognizable color marked individuals by breeding population and all recognizable marked plovers during each study year, and for individually recognizable individuals that wintered both study years. Site fidelity and detection rates are included as reference.

	n	50% MCP km ²	95% MCP km ²	50% AK km ²	95% AK km ²	% Site Faithful	% Detected
<i>2003-2004</i>							
Great Lakes	13	0.06	0.86	0.34	1.75	88.3	58.3
Great Plains	3	0.28	1.03	0.37	2.79	72.4	66.4
Atlantic Coast	1 ^a	0.01	0.17	0.17	0.83	96.3	64.3
All marked plovers	17	0.09	0.85	0.34	1.88	85.2	60.2
<i>2004-2005</i>							
Great Lakes	13	0.16	1.51	0.77	3.79	82.2	74.3
Great Plains	2	0.09	1.95	1.48	5.35	67.4	71.2
All marked plovers	15	0.15	1.57	0.87	4.00	80.9	74.1
<i>2003-2005</i>							
Great Lakes	7	0.33	1.86	0.44	1.10	82.6	71.1
Great Plains	2	0.43	1.68	0.60	1.50	72.2	67.7
All marked plovers	9	0.35	1.82	0.47	1.19	80.5	70.4

^a 1 individual, so data are not representative of a true mean

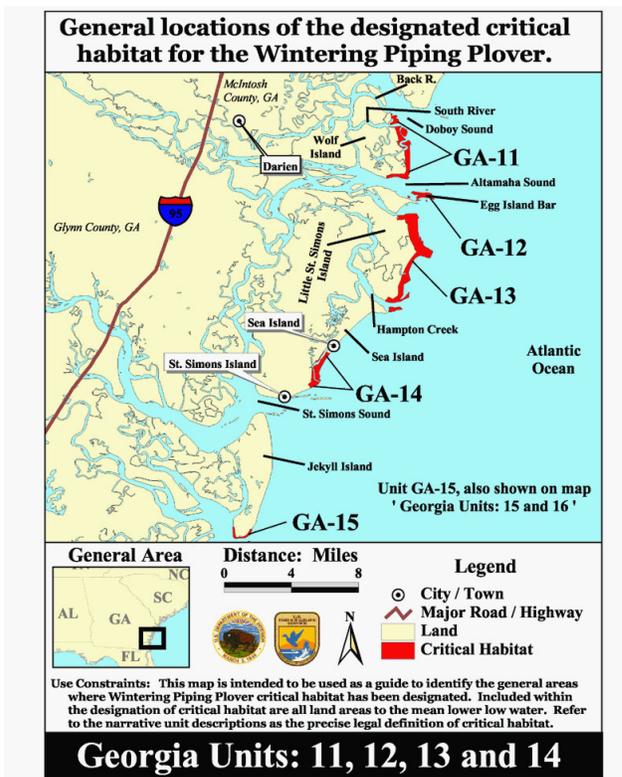
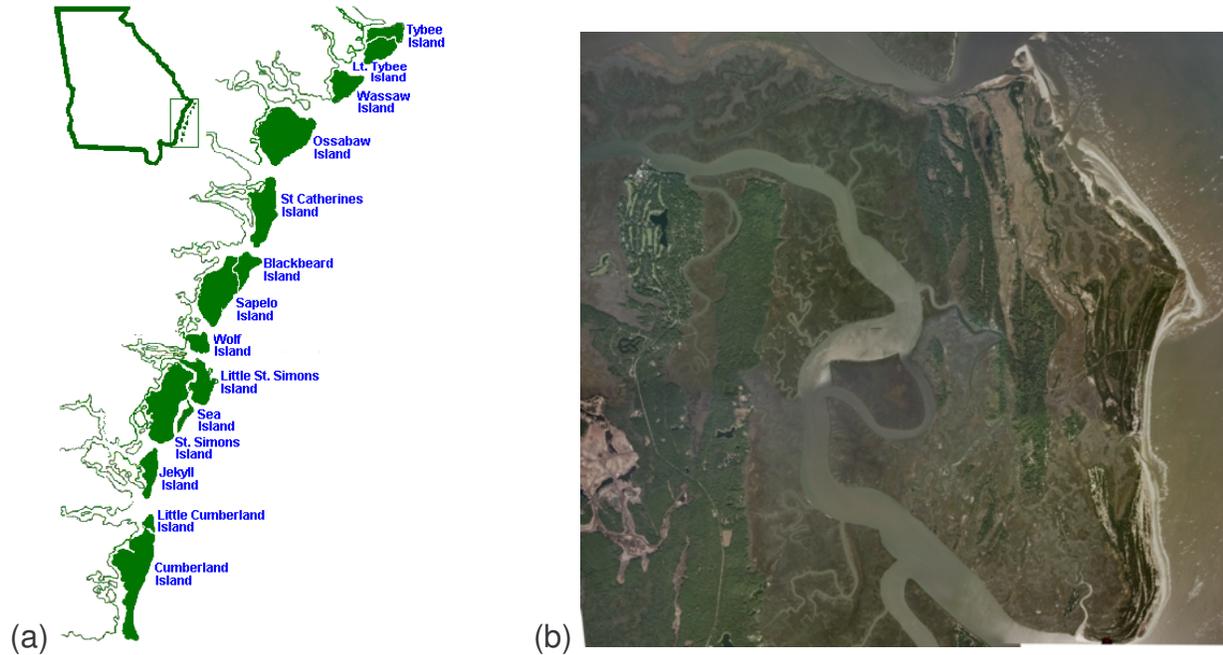
Table 7. Mean linear distance of recognizable color marked wintering individuals by breeding population and all recognizable marked plovers during each study year, and for individually recognizable individuals that wintered both study years. Site fidelity and detection rates are included as reference. The mean linear distance was calculated from each individual's northernmost location to the southernmost location in our study area.

	n	Mean Linear Distance (km)	% Site Faithful	% Detected
<i>2003-2004</i>				
Great Lakes	13	2.9	88.3	58.3
Great Plains	3	3.7	72.4	66.4
Atlantic Coast	1 ^a	3.7	96.3	64.3
All marked plovers	17	3.1	85.2	60.2
<i>2004-2005</i>				
Great Lakes	13	3.8 ^b	82.2	74.3
Great Plains	2	3.5	67.4	71.2
All marked plovers	15	3.8	80.9	74.1
<i>2003-2005</i>				
Great Lakes	7	4.7	82.6	71.1
Great Plains	2	3.6	72.2	67.7
All marked plovers	9	4.5	80.5	70.4

^a 1 individual, so data are not representative of a true mean

^b 1 individual was documented on Egg Island B

Figure 1. Location of Piping Plover study area during the 2003-2004 and 2004-2005 migrating and wintering study years. (a) Georgia coastline, and (b) 2004 aerial of Little St. Simons Island, and (c) critical wintering habitat designations, including LSSI as GA-13, and Egg Island Bar as GA-12 (United States Fish and Wildlife Service 2001).



(c) Some locations have been slightly enlarged for display purposes only.

Figure 2. Piping Plover abundance on Little St. Simons Island from Jul 2003 to May 2005. The figure includes the mean number of plovers detected per survey per month, the mean number of marked plovers detected per survey per month, and the mean number of Great Lakes plovers detected per survey per month.

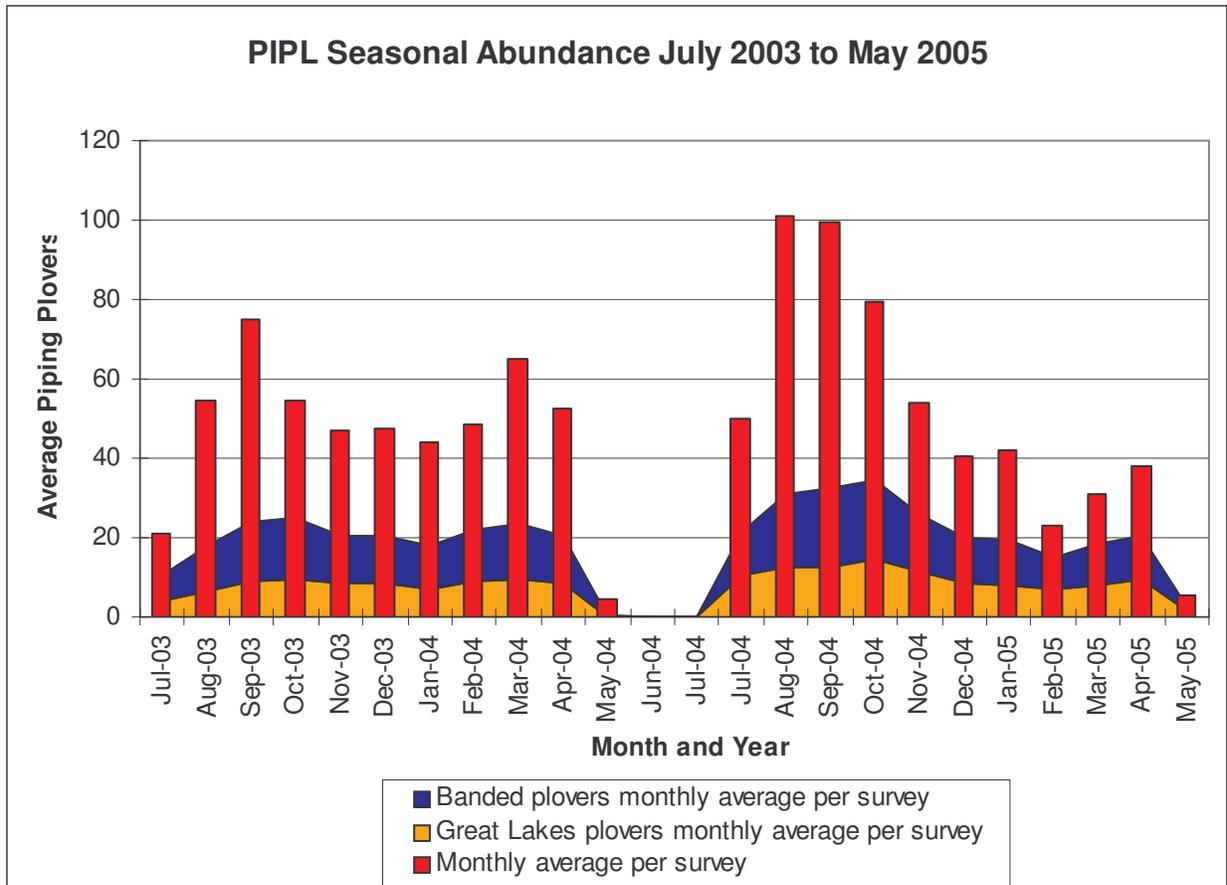


Figure 3. Four sections of beach delineated to map spatial distribution throughout Little St. Simons Island during the 2003-2004 and 2004 –2005 migrating and wintering study years. Section 1 (Sancho Panza Beach), Section 2 (Bass Creek), Section 3 (Middle Bar), and Section 4 (Rainbow Beach).



Figure 4. Piping Plover abundance on Sancho Panza Beach from Jul 2003 to May 2005. The figure includes the mean number of plovers detected per survey per month at low and high tide.

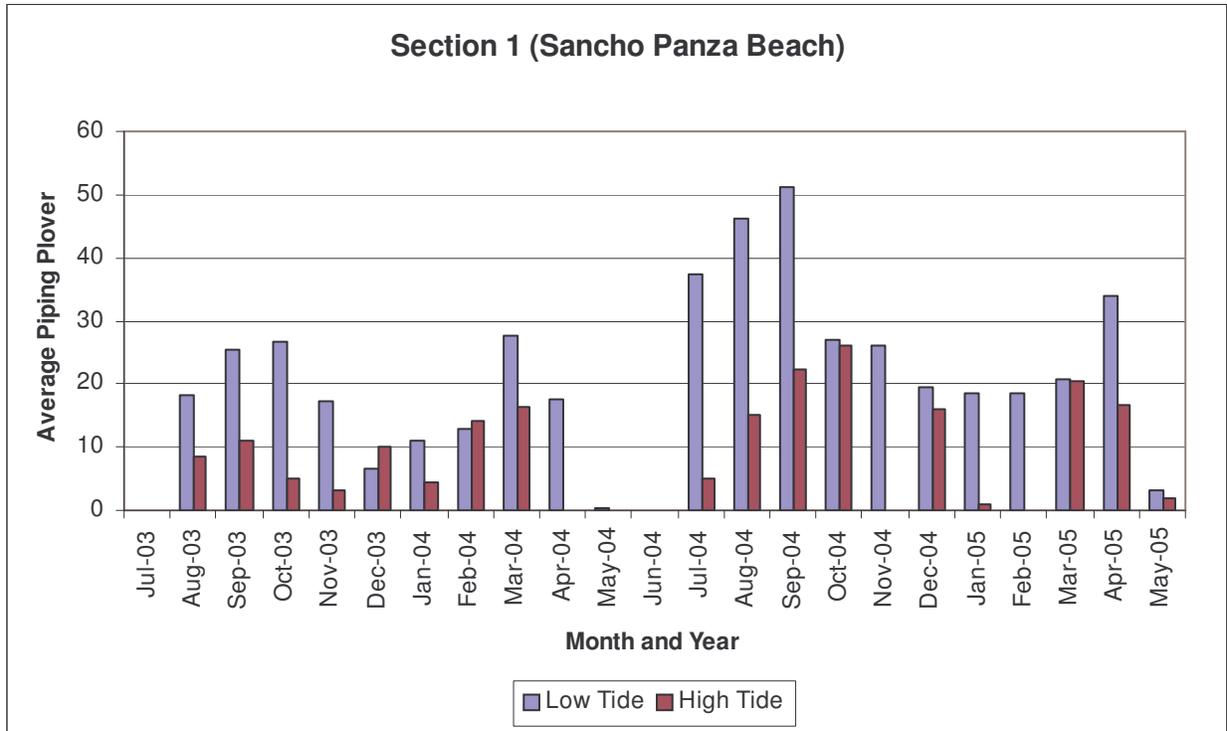


Figure 5. Piping Plover abundance at Bass Creek from Jul 2003 to May 2005. The figure includes the mean number of plovers detected per survey per month at low and high tide.

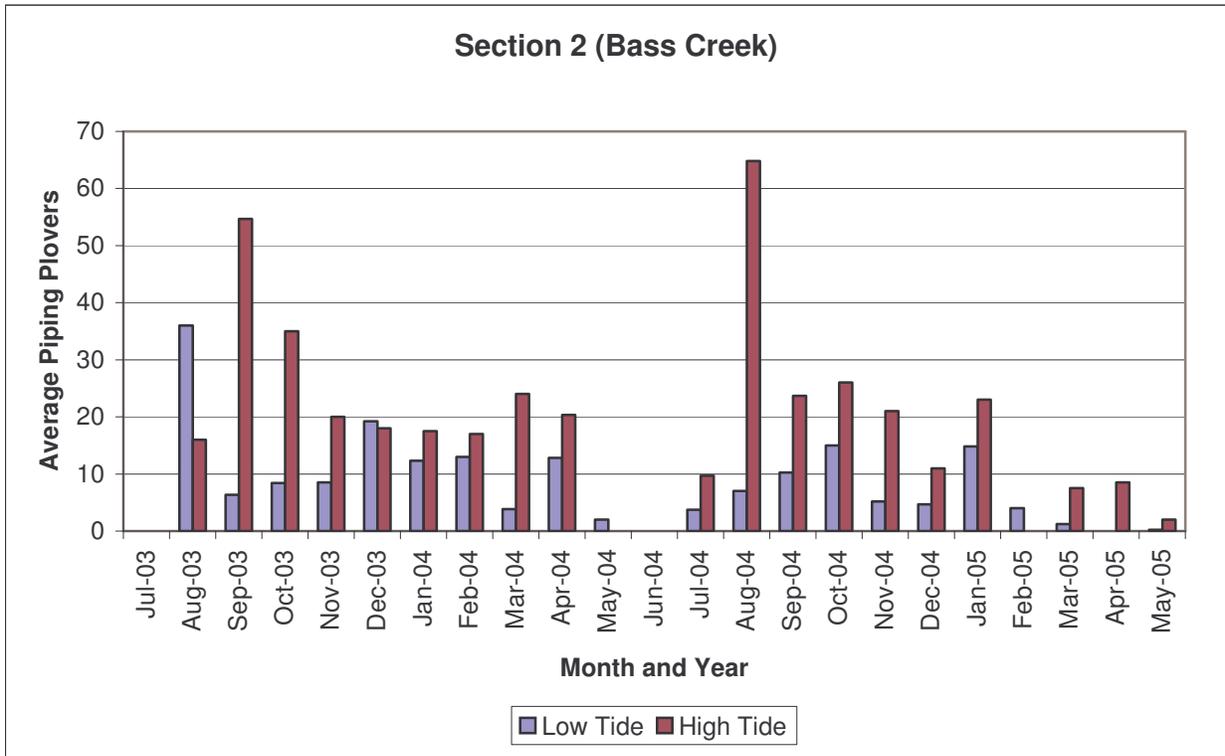


Figure 6. Piping Plover abundance at Middle Bar from Jul 2003 to May 2005. The figure includes the mean number of plovers detected per survey per month at low and high tide.

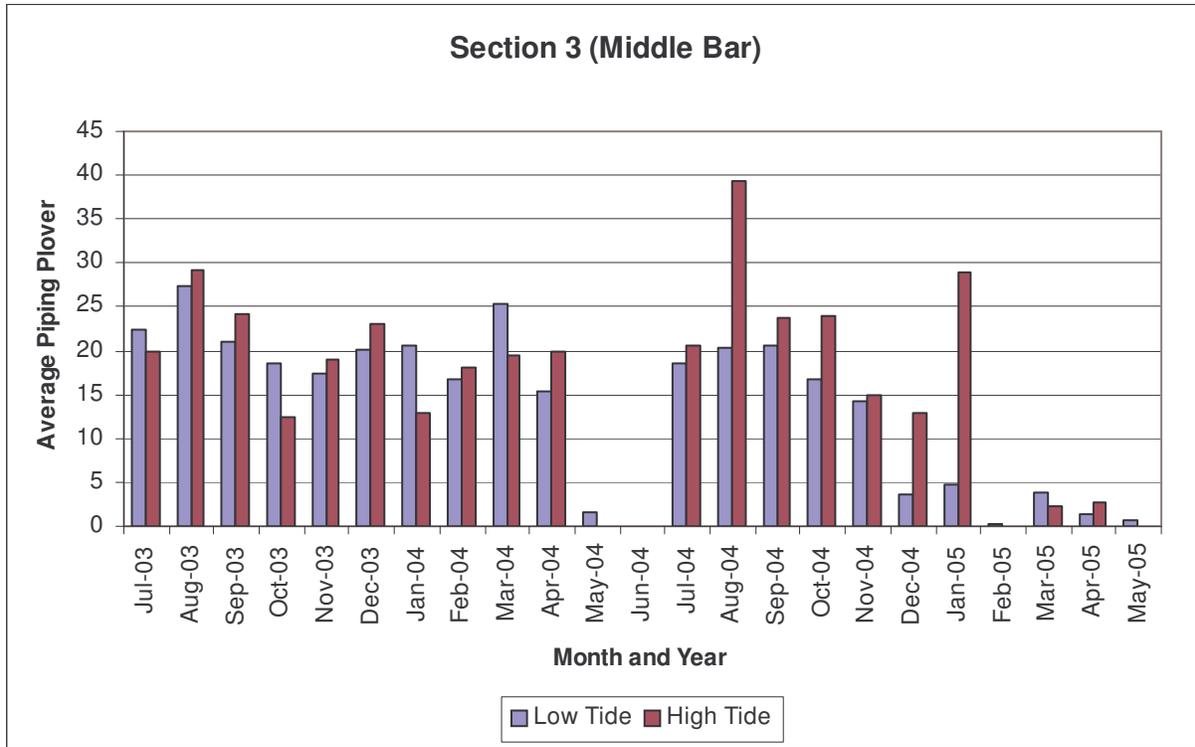


Figure 7. Piping Plover abundance on Rainbow Beach from Jul 2003 to May 2005. The figure includes the mean number of plovers detected per survey per month at low and high tide.

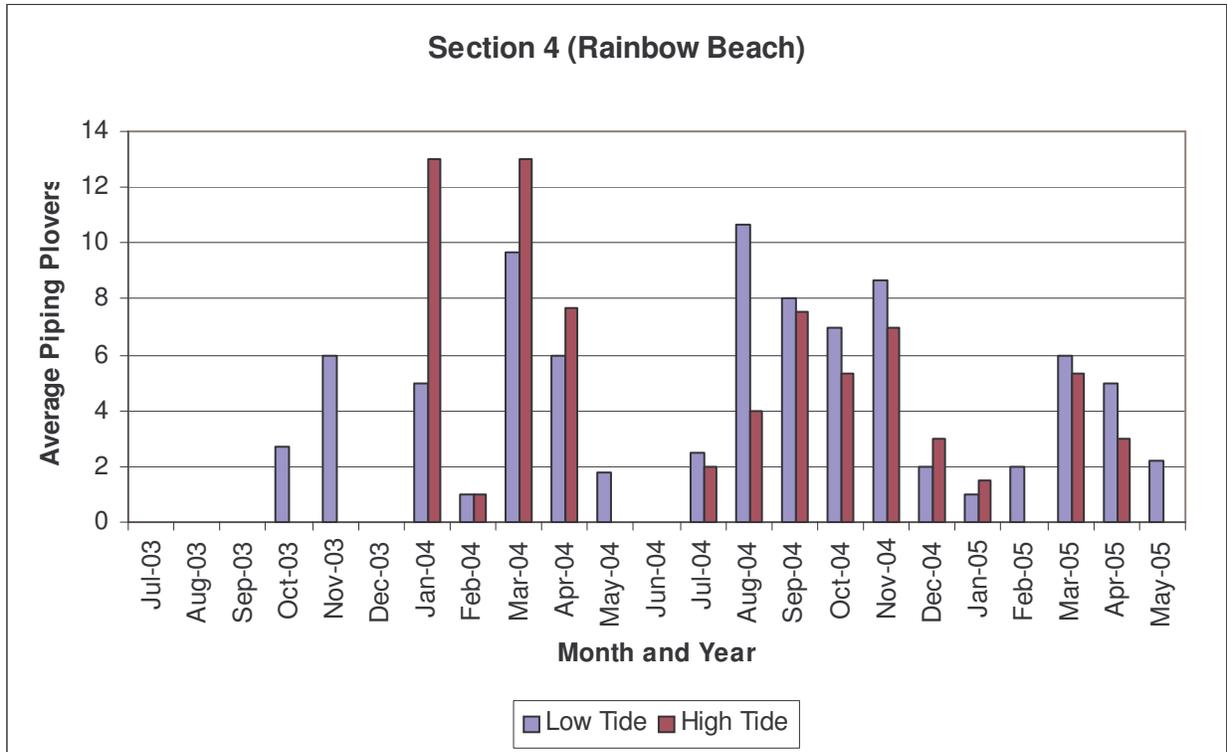


Figure 8. Sancho Panza Beach on LSSI at high tide in the Altamaha River looking north to south. Photo taken 7 Jun 2005.



Figure 9. The north end of Sancho Panza Beach on LSSI at low tide. Notice the large pond (red circle) in Fig.8 compared to this figure. Photo taken Jun 2005.



Figure 10. The southern tip of Sancho Panza Beach on LSSI at high tide. Photo taken 7 Jun 2005.



Figure 11. The southern tip of Sancho Panza Beach on LSSI at low tide, looking north to south, bordering Bass Creek. Photo taken Jun 2005.



Figure 12. Sancho Panza Beach and Bass Creek of LSSI bordering one another at high tide. The small creek is Sancho Panza Creek (Hole # 1), and the larger creek is Sancho Panza Creek (Hole #2) and Bass Creek together. These creeks converge to empty out into the Atlantic Ocean and physically separate these sections of beaches. Photo taken 7 Jun 2005.



Figure 13. The north end of Bass Creek on LSSI at high tide depicting the large washover zone (red circle), primarily used for roosting by plovers. The creek on the left side of the larger green area is Sancho Panza Creek (Hole # 2) and the creek on the right side is Bass Creek. Photo taken 7 Jun 2005.



Figure 14. Bass Creek on LSSI looking north to south at low tide. This photo depicts the large washover zone (red circle) that runs parallel to Bass Creek. It also depicts the lack of vegetation and dunes above the mean high tide mark. Photo taken Jun 2005.



Figure 15. The old mouth of Bass Creek on LSSI (red circle), which emptied into the Atlantic Ocean prior to 2001. Plovers were not consistently using this area, but were detected in this area throughout both study years, especially at the beginning of fall migration. Photo taken 7 Jun 2005.



Figure 16. The northern end of Middle Bar on LSSI at low tide at the point. This photo depicts the northern edge of this section of beach with large flats off the point and the tidal pool inside the point. Photo taken Jun 2005.



Figure 17. The southern edge of the point at Middle Bar on LSSI at high tide. This photo depicts a large tidal pool with a washover zone being used by terns, pelicans, and gulls. Photo taken 7 Jun 2005.



Figure 18. Near high tide looking at south Main Beach. This photo depicts a section of beach used infrequently by plovers with the northern edge of the photo being the southern tip of Middle Bar at the primary beach access point. Photo taken 7 Jun 2005.



Figure 19. Near low tide looking at south Main Beach. This photo depicts a section of beach used infrequently by plovers with the northern edge of the photo being the southern tip of Middle Bar at the beach access point. Photo taken Jun 2005.



Figure 19. The northern border (Mosquito Creek) of Rainbow Beach on LSSI at high tide. Plovers were inconsistently documented using this area on the southern side of the mouth of Mosquito Creek (red circle). Photo taken 7 Jun 2005.



Figure 20. The northern edge of Rainbow Beach on LSSI at high tide looking south towards the washed ashore tugboat (red circle). This photo depicts a primary dune line with upland vegetation behind the dunes. Photo taken Jun 2005.



Figure 21. The northern edge of Rainbow Beach on LSSI at low tide looking south towards the washed ashore tugboat (red circle). Note the tidal flats adjacent to the tugboat. Photo taken Jun 2005.



Figure 22. Pelican Spit (red circle) and south of the tugboat on Rainbow Beach of LSSI at high tide. Plovers were inconsistently observed using these beaches, especially when recreational boaters were present on Pelican Spit. Photo taken 7 Jun 2005.



Figure 23. Rainbow Beach at low tide looking east to southeast at Pelican Spit (red circle) and surrounding emergent sandbars. These emergent sandbars continue running parallel to the beach to the north and house foraging habitat for other species and could provide more habitat for Piping Plovers. Photo taken Jun 2005.



Figure 24. The southern tip of Rainbow Beach on LSSI at high tide. Bungalow Creek empties into the Hampton River, which empties into the Atlantic Ocean. This spot is the physical border of the southern tip of LSSI and Rainbow Beach. Photo taken 7 Jun 2005.



Figure 25. The southern tip of Rainbow Beach on LSSI at low tide. Bungalow Creek empties into the Hampton River, which empties into the Atlantic Ocean. This spot is the physical border of the southern tip of LSSI and Rainbow Beach. Photo taken Jun 2005.

