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Engineer Research and
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Dredging Operations and Environmental Research Program

Distribution and Abundance of Piping Plovers (*Charadrius melodus*) and Snowy Plovers (*Charadrius alexandrinus*) on the West Coast of Florida Before and After the 2004/2005 Hurricane Seasons

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September 2009



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Final report

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Abstract: In 2004 and 2005 several large hurricanes (category 3 or greater) made landfall along Florida's barrier island shorelines. Where shorelines were developed, storms did millions of dollars in structural damage. Where previous shoreline protection had occurred in the form of beach nourishment or dune restoration, much of this sand was removed. On public lands, overwash from storms removed beach and dune vegetation, redistributed sand, created new inlets, and in some cases, caused damage to park roads and facilities. Large federal and state appropriations for post-storm shoreline protection ushered in the busiest period of sand placement in Florida history. Florida's Panhandle and Southwest Gulf Coast host large proportions of continental non-breeding populations for both federally-listed Piping Plovers (*Charadrius melodus*) and state-threatened Snowy Plovers (*Charadrius alexandrinus*). These two regions also contain the majority of Snowy Plover pairs nesting along the eastern Gulf of Mexico. This report compares the distribution of plovers and engineering projects before and after the 2004/2005 hurricane seasons. Counts were similar between pre- and post-storm surveys and bird distribution did not change appreciably between the two periods. However, this investigation illustrated a strong negative correlation between sand placement and the presence of both plover species. Future research should clarify if the negative correlation between sand placement and plovers is the result of habitat degradation that can be directly attributed to sand placement, and perhaps mitigated, or the tendency for sand placement projects to occur in areas of high population density where human disturbance may limit the distribution of plovers.

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Contents

Figures and Tables.....	iv
Preface.....	vi
Executive Summary.....	vii
Unit Conversion Factors.....	ix
1 Introduction.....	1
2 Methods.....	4
3 Results.....	6
Overall Results.....	6
Panhandle.....	9
<i>Engineering projects from 1993-2000.....</i>	<i>9</i>
<i>Engineering projects from 1998-2005.....</i>	<i>10</i>
<i>Wintering Snowy Plovers.....</i>	<i>17</i>
<i>Nesting Snowy Plovers.....</i>	<i>20</i>
<i>Panhandle summary.....</i>	<i>23</i>
Southwest Florida engineering project and bird survey summaries	24
<i>Engineering projects from 1993-2000.....</i>	<i>24</i>
<i>Engineering projects from 1998-2005.....</i>	<i>27</i>
<i>Wintering Piping Plovers</i>	<i>27</i>
<i>Nesting Snowy Plovers.....</i>	<i>29</i>
<i>Southwest Gulf Coast Summary.....</i>	<i>29</i>
4 Discussion	31
References.....	35
Report Documentation Page	

Figures and Tables

Figures

Figure 1. IPPC counts for wintering Piping Plovers in Florida, 2001 and 2006. Symbols from 2001 have been slightly displaced so that counts at the same site can be seen for both surveys.....	8
Figure 2. IPPC counts for wintering Snowy Plovers in Florida, 2001 and 2006. Symbols from 2001 have been slightly displaced so that counts at the same site can be seen for both surveys.....	8
Figure 3. FWC Snowy Plover breeding pair estimates for Florida, 2002 and 2006. Symbols from 2002 have been slightly displaced so that counts at the same site can be seen for both surveys.....	9
Figure 4. 2001 IPPC counts for wintering Piping Plovers and sand placement projects from 1993 to 2000 in the Florida Panhandle.....	11
Figure 5. 2006 IPPC counts for wintering Piping Plovers and sand placement projects from 1998 to 2005 in the Florida Panhandle.....	11
Figure 6. 2001 IPPC counts for wintering Snowy Plovers and sand placement projects from 1993 to 2000 in the Florida Panhandle.....	12
Figure 7. 2006 IPPC counts for wintering Snowy Plovers and sand placement projects from 1998 to 2005 in the Florida Panhandle.....	12
Figure 8. 2002 FWC Snowy Plover breeding pair estimates and sand placement projects from 1993 to 2000 in the Florida Panhandle.....	13
Figure 9. 2006 FWC Snowy Plover breeding pair estimates and sand placement projects from 1998 to 2005 in the Florida Panhandle.....	13
Figure 10. 2001 IPPC counts for wintering Piping Plovers and sand placement projects from 1993 to 2000 in Southwest Florida.....	24
Figure 11. 2006 IPPC counts for wintering Piping Plovers and sand placement projects from 1998 to 2005 in Southwest Florida.....	25
Figure 12. 2001 IPPC counts for wintering Snowy Plovers and sand placement projects from 1993 to 2000 in Southwest Florida.....	25
Figure 13. 2006 IPPC counts for wintering Snowy Plovers and sand placement projects from 1998 to 2005 in Southwest Florida.....	26
Figure 14. 2002 FWC Snowy Plover breeding pair estimates and sand placement projects from 1993 to 2000 in Southwest Florida.....	26
Figure 15. 2006 FWC Snowy Plover breeding pair estimates and sand placement projects from 1998 to 2005 in Southwest Florida.....	27

Tables

Table 1. State-wide count totals for wintering Piping Plovers and Snowy Plovers from the 2001 and 2006 IPPC and state-wide estimates for Snowy Plover pairs in 2002 and 2006 from FWC.....	6
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Table 2. 2001 and 2006 IPPC Piping Plover counts (and percentage of state-wide counts) by region.....	7
Table 3. 2001 and 2006 FWC Snowy Plover pair estimates (and percentage of state-wide pair estimates) by region.	7
Table 4. 2001 and 2006 IPPC Snowy Plover counts (and percentage of state-wide counts) by region.....	7
Table 5. 2001 and 2006 IPPC Piping Plover counts by county (with percentages of state-wide and regional count totals).....	14
Table 6. 2001 and 2006 IPPC Piping Plover counts summarized by property and land management agency (with percentages of state-wide and regional count totals).	15
Table 7. 2001 and 2006 IPPC Snowy Plover counts by county (with percentages of state-wide and regional count totals).....	18
Table 8. 2001 and 2006 IPPC Snowy Plover counts summarized by property and land management agency (with percentages of state-wide and regional count totals).	19
Table 9. 2001 and 2006 FWC Snowy Plover pair estimates by county (with percentages of state-wide and regional pair estimates).....	21
Table 10. 2001 and 2006 FWC Snowy Plover pair estimates summarized by property and land management agency (with percentages of state-wide and regional pair estimates).	22

Preface

Research conducted for this report was funded by the Shore Protection Assessment Program. The Technical Director of the program at the time of publication was Dr. Jack E. Davis and the Program Manager was William R. Curtis. The work was performed under the direction of Dr. William Martin, Director of the Coastal and Hydraulics Laboratory (CHL), U.S. Army Engineer Research and Development Center (ERDC). The authors would like to thank the following for their support regarding this project: Roxane Dow of DEP, Ann-Marie Lauritsen of USFWS, and Ken Dugger of the U.S. Army Corps of Engineers (Corps) for compiling or reviewing data that were eventually incorporated into this GIS; John Himes, Jeff Gore, and Nance Douglass of FWC for providing bird survey data that were incorporated into the GIS; and Dr. Richard Fischer of the Corps, and Patty Kelly and Anne Hecht of USFWS, for encouraging this look at the interaction between coastal engineering and bird distribution in Florida. ERDC technical review was provided by Drs. Richard A. Fischer and Michael P. Guilfoyle.

At the time of publication, Director of EL was Dr. Beth Fleming. Dr. James R. Houston was Director of ERDC, and COL Gary E. Johnston was Commander.

Executive Summary

In 2004 and 2005 an unprecedented number of large hurricanes (category 3 or greater) made landfall along Florida's barrier island shorelines. Where barrier islands developed, storms did millions of dollars in structural damage. Where developed barrier islands had received previous shoreline protection, in the form of beach nourishment or dune restoration, much of this sand was removed. On public parklands and undeveloped military properties, overwash from storms removed beach and dune vegetation, redistributed sands, created new inlets, and in some cases, caused damage to park infrastructure (e.g., roads and facilities).

In response to these storms, US Congress sent over 200 million dollars in emergency appropriations for the US Army Corps of Engineers to manage the re-nourishment of developed beaches with previous nourishment histories that had lost sand to the storms, and to accelerate the initial nourishment or planned re-nourishment of previously authorized projects in areas that were now considered vulnerable to subsequent storm damage. Similarly, the Florida State legislature sent tens of millions of dollars in emergency appropriations to the Department of Environmental Protection's Bureau of Beaches and Coastal Systems to conduct beach or dune restoration projects on developed beaches that were not covered by federally authorized projects.

These large appropriations resulted in the busiest period of sand placement in Florida history. Florida's barrier islands, particularly in the Panhandle and Southwest Gulf Coast regions, also host large proportions of continental non-breeding populations for both federally listed Piping Plovers (*Charadrius melodus*) and state-threatened Snowy Plovers (*Charadrius alexandrinus*). These two regions of Florida also contain the vast majority of Snowy Plover pairs that nest along the eastern Gulf of Mexico. State-wide mid-winter surveys of both plover species were conducted prior to the storms in 2001 and after the storms (and the subsequent engineering response) in 2006 as part of the International Piping Plover Census. Similarly, pre- and post-storm surveys for nesting Snowy Plovers were conducted in 2002 and 2006 by the Florida Fish and Wildlife Conservation Commission. This provided the opportunity to investigate the effects of 2004/2005 storms, and the sand placement projects that

followed, on plover distribution. Plover counts were similar between pre- and post-storm surveys and bird distribution did not change appreciably between the two periods. However, this investigation illustrated a strong negative correlation between sand placement projects and the presence of both plover species. This distributional pattern was already present prior to the 2004/2005 hurricane seasons and persisted after the storms, since most post-storm sand placement occurred in areas that had received sand in the past.

Future research should clarify if the negative correlation between sand placement and plovers is the result of habitat degradation that can be directly attributed to sand placement projects, and perhaps mitigated, or the tendency for sand placement projects to occur in areas of high population density where human disturbance may limit the distribution of plovers. Now that most of Florida's private shorelines have been developed and protected through beach nourishment, the distribution of both plover species has been mostly restricted to public lands. Engineering or restoration projects that are designed to protect public land infrastructure, such as rebuilding roads with hard structures after storms, or massive planting of dune vegetation, which restricts the storm overwash that maintains plover habitat, could have strongly negative effects on Florida's plovers.

Unit Conversion Factors

Multiply	By	To Obtain
miles (nautical)	1,852	meters
miles (U.S. statute)	1,609.347	meters

1 Introduction

Although Snowy Plovers (*Charadrius alexandrinus*) have an extensive breeding distribution across North America, the Florida breeding population (which is contiguous with small breeding populations in Alabama and Mississippi) is geographically isolated from other breeding populations in coastal Texas, the Caribbean, or the interior of the western United States (Lott, in press). An estimated 213-222 pairs of Snowy Plovers nest on barrier island beaches on Florida's west coast; primarily in the Panhandle (as far east as Alligator Point) and secondarily along the southwestern Gulf Coast from Pasco County to Marco Island (Chase and Gore 1989, Lamonte et al. 2006, Himes et al. 2006). The Florida Fish and Wildlife Conservation Commission (FWC) lists Snowy Plovers as threatened, the US Shorebird Conservation Plan lists them as Extremely High Priority for conservation (Brown et al. 2001), and an unresolved petition has been filed to add Gulf Coast Snowy Plovers as a candidate to the US Fish and Wildlife Service's (USFWS) list of threatened and endangered wildlife. In addition to nesting in Florida, Snowy Plovers are also relatively common during the non-breeding season (fall migration, winter, and spring migration), and winter counts have tallied between 312 and 332 individual Snowy Plovers (Ferland and Haig 2002, USFWS unpublished data for 2006). Mid-winter counts of Snowy Plovers in Florida during the 2001 International Piping Plover Census (IPPC) comprised 28.7 percent of all Snowy Plover counts (Ferland and Haig 2002). This was second only to Texas, which comprised 63.7 percent of all mid-winter Snowy Plover counts. Aside from Texas and Florida, no other state had >3.3 percent of all Snowy Plovers counted during the 2001 census.

In addition to Snowy Plovers, federally listed Piping Plovers (*Charadrius melodus*) occur in high numbers (relative to the rest of their non-breeding range) on Florida's barrier islands during the non-breeding season. Mid-winter counts of Piping Plovers in 2001 comprised 17.4 percent of all counts in an attempted census of this species' entire non-breeding range in the United States (Ferland and Haig 2002). Florida had the third highest counts of wintering Piping Plover in 2001, after Texas (43.6 percent) and Louisiana (21.4 percent). No other states had >4.6 percent of all Piping Plovers counted during the 2001 census. Piping Plovers occur in relatively high numbers at sites in the same Panhandle and Southwest Gulf Coast

regions where Snowy Plovers are present; however, they also occur in relatively high abundance at several sites on the Northeast Atlantic Coast, a small number of inlets on the Central Atlantic Coast, and a small number of sites in the Florida Keys (Ferland and Haig 2002). Piping Plovers are listed by the USFWS as three separate sub-populations: the Great Plains and Atlantic Coast populations are listed as threatened and the Great Lakes population is listed as endangered (USFWS 1996, 2003). Color-banded individuals from all three populations have been observed during fall migration and winter in Florida (Stucker and Cuthbert 2006, USFWS, Panama City field office, unpublished data).

The non-breeding distributions of both plover species and the breeding distribution of Snowy Plovers are highly fragmented within the state of Florida (Ferland and Haig 2002, Himes et al. 2006). The cause of this fragmentation is unclear, although widespread disturbance due to human recreation has been suggested previously as a potential limiting factor for nesting Snowy Plovers (Chase and Gore 1989, Lamonte et al. 2006). An alternative, but not mutually exclusive, hypothesis to explain the absence of both plover species at sites within regions where they may otherwise be common is that some sites lack suitable habitat. Few data exist to address this hypothesis. Although critical habitat units have been delineated for Piping Plover at sites with a history of use (USFWS 2001), Florida-specific data are not available to describe explicit habitat needs. Similarly, although habitat has been previously described for Snowy Plover nest locations (e.g., the actual sites of nest placement), no studies have addressed landscape level habitat selection during the breeding season, which would likely need to include a description of brood foraging habitat (Page et al. 1995). Finally, detailed descriptions of non-breeding habitat use are not available for Snowy Plovers in Florida.

This report presents data from two independent state-wide bird surveys: 1) the International Piping Plover Census (IPPC), a mid-winter survey that includes counts for both Piping Plovers and Snowy Plovers; and 2) FWC's state-wide surveys for nesting Snowy Plovers. Both surveys have been conducted twice in recent years, using the identical survey protocol: the IPPC in 2001 and 2006 (Ferland and Haig 2002) and FWC's Snowy Plover nesting survey in 2002 and 2006 (Himes et al. 2006). The intervening years between both survey efforts included two of the most active hurricane seasons in Florida's history: 2004 and 2005 (Florida Department of Environmental Protection 2004, 2005 and

<http://www.dep.state.fl.us/beaches/#HotTopics/>). In addition to causing tremendous damage to structures, hurricanes also re-shape barrier island habitats used by birds (Godfrey and Godfrey 1976, Leatherman 1988). When hurricane-induced changes to barrier islands are allowed to persist, the result can be very beneficial to early-successional birds. For example, the new inlet/flood shoal system created on North Captiva Island during Hurricane Charley, now known as Charley Pass, created many acres of mudflats used for foraging and roosting by shoreline-dependent birds (Lott et al., in press a). Similarly, washovers during storm surges on narrow barrier islands can create new unvegetated mud and sand flats that are extensively used by both nesting Snowy Plovers and non-breeding birds of both plover species.¹

In addition to damaging structures and re-shaping bird habitats, hurricanes often result in large losses of sand on nourished beaches. Consequently, emergency appropriations after hurricanes can result in large-scale efforts by coastal engineers to replace sands lost during storms (Florida Department of Environmental Protection 2004). A recent summary of historic data on sand placement events in Florida showed that twice as many sand placement events were completed in the three years after the recent storms (2004-2006) than the three years prior to the storms from 2000-2003 (Lott et al. in press b). The consolidation of bird survey data and engineering project data into a single GIS with bird observations from surveys before and after major hurricanes affords the opportunity to see if either the hurricanes of 2004/2005, or the subsequent engineering response, had an effect on the distribution of Snowy Plovers and Piping Plovers.

¹ Unpublished data. 2009. Mark Nicholas, Biologist, Gulf Island National Seashore, Florida.

2 Methods

Lott et al. (in press) describe methods used to consolidate bird and engineering data into a single GIS. This report summarizes information from the aforementioned GIS to present a series of maps and tables exploring plover distribution and abundance during two different survey periods: 1) pre-hurricane, and 2) post-hurricane. Pre-hurricane maps include bird survey data from January 2001 (for non-breeding Piping Plovers and Snowy Plovers) or February-August 2002 (nesting Snowy Plovers). Post-hurricane maps include bird survey data from January 2006 (for non-breeding Piping Plovers and Snowy Plovers) or February-August 2006 (nesting Snowy Plovers).

Most large-scale beach nourishment projects in Florida expect a renourishment cycle of 6-10 years (US Army Corps of Engineers 2006). In other words, enough of the sand placed in 1990 is expected to be lost by 1998 that renourishment would be necessary. In reality, renourishment frequencies vary from more to less frequent than this due to differences in erosion rates among sites. Using an average re-nourishment period for Florida of 8 years, pre-hurricane maps included sand placement events completed between 1993 and 2000 (reflecting the extent of sand placement activity 8 years before the 2001 IPPC or the 2002 FWC Snowy Plover nesting survey). Similarly, post-hurricane maps included sand placement projects from 1998 to 2005 (reflecting the extent of sand placement activity for 8 years prior to the 2006 IPPC or the 2006 nesting Snowy Plover survey).

During each time period (pre- or post- hurricane); bird observations for each species/survey combination (e.g., IPPC for Piping Plovers, IPPC for Snowy Plovers) are summarized by region, county, land management agency, or property. Regions defined by the Department of Environmental Protection's (DEP) Bureau of Beaches and Coastal Systems (BBCS) were used since these boundaries are designed to reflect regional differences in littoral transport (http://www.dep.state.fl.us/beaches/publications/gen-pub.htm#Strategic_Management_Plan). This tends to result in regional differences in the availability of beaches and mudflats used by roosting or foraging birds. DEP regions closely match regional divisions of the west coast of Florida

that have been used in previous large-scale bird surveys (Sprandel et al. 1997, Douglass 2006, Gore et al. 2007, Himes et al. 2006).

Observations of non-breeding birds, both Snowy Plovers and Piping Plovers, were assigned to individual properties using a GIS layer prepared by the Florida Natural Areas Inventory showing property boundaries for all state- or federally-managed areas in Florida (<http://www.fnai.org/gisdata.cfm>). In cases where points for bird observations occurred just outside of property boundaries for properties with large numbers of birds, these observations were lumped with the observations within that property if observations were within 2 km of a property boundary, since wintering home ranges for both plover species are $>2 \text{ km}^2$ (Drake et al. 2001, Page et al. 1995). Major private landowners were specified if they have an active role in shorebird management (e.g., St. Joe Paper Company, The Nature Conservancy).

GIS layers for 2001 and 2006 International Piping Plover Census (IPPC) counts were acquired directly from the USFWS Panama City Field Office, which coordinated the collection of these data in Florida. Counts from the 2001 IPPC surveys have been summarized previously in Ferland and Haig (2002). Discrepancies in summarized counts between this report and Ferland and Haig (2002) are a result of counts being summarized at different spatial scales between the two reports and additional proofing of Florida data by USFWS that occurred after Ferland and Haig (2002) was published. Ferland and Haig (2002) summarized counts by survey reaches that in some cases spanned property boundaries and in other cases split properties into more than one reach. This report summarizes counts by individual properties, following the protocol described above for assigning birds near property boundaries.

Points on maps in this report for non-breeding Snowy Plovers and Piping Plovers display counts of groups of birds sighted within relatively small areas (e.g., a single mudflat, a roosting group on a beach). Points on maps in Ferland and Haig (2002) present counts summarized with less specificity, by survey reach, with the point occurring in the center of each reach. For nesting Snowy Plovers, points on maps indicate FWC pair estimates summarized by property (from tables in Himes et al. 2006) rather than observations of individual nests or pairs. Pair estimates are displayed using points located at the center of each property.

3 Results

Overall Results

Despite major increases in coastal engineering activity in response to the hurricane seasons of 2004 and 2005, the state-wide distribution and abundance of non-breeding Piping Plovers, non-breeding Snowy Plovers, and breeding pairs of Snowy Plovers did not change tremendously between pre-hurricane and post-hurricane surveys (Table 1, Figures 1-3). For Piping Plovers, regional counts varied between surveys, with increased counts in the Panhandle and Northeast Florida and decreased counts in Southwestern Florida between 2001 and 2006 (Table 2). Similarly, Snowy Plover pair counts increased slightly in the Panhandle and decreased in Southwest Florida between 2001 and 2006 (Table 3). Conversely, non-breeding Snowy Plover counts increased in Southwest Florida and decreased in the Panhandle between 2001 and 2006 (Table 4). A majority of all Piping Plovers and Snowy Plovers were counted on public lands in all surveys (between 77.5 percent and 93.1 percent of state-wide totals depending on survey-species combination). Changes in coastal engineering activity between the two bird-survey periods and local-scale variation in counts among counties and properties are described in greater detail in the regional results sections below.

Table 1. State-wide count totals for wintering Piping Plovers and Snowy Plovers from the 2001 and 2006 IPPC and state-wide estimates for Snowy Plover pairs in 2002 and 2006 from FWC.

Survey	2006	2001/2002
Wintering Piping Plover (IPPC)	426	434
Wintering Snowy Plover (IPPC)	312	332
Snowy Plover Pairs (FWC)	222	213

Table 2. 2001 and 2006 IPPC Piping Plover counts (and percentage of state-wide counts) by region.

	Piping Plover 2006		Piping Plover 2001	
Region	Count	% total	Count	% total
Panhandle Gulf Coast	111	26.1	65	15.0
Big Bend Gulf Coast	7	1.6	0	0.0
Southwest Gulf Coast	163	38.3	240	55.3
Northeast Atlantic Coast	101	23.7	62	14.3
Central Atlantic Coast	0	0.0	12	2.8
Florida Keys	44	10.3	55	12.7
Total	426		434	

Table 3. 2001 and 2006 FWC Snowy Plover pair estimates (and percentage of state-wide pair estimates) by region.

	Snowy Plover Pairs 2006		Snowy Plover Pairs 2001	
Region	SNPL pairs 06	% total	SNPL pairs 02	% total
Panhandle Gulf Coast	177	79.7	153	71.8
Big Bend Gulf Coast	0	0.0	0	0.0
Southwest Gulf Coast	45	20.3	60	28.2
Northeast Atlantic Coast	0	0.0	0	0.0
Central Atlantic Coast	0	0.0	0	0.0
Florida Keys	0	0.0	0	0.0
Total	222		213	

Table 4. 2001 and 2006 IPPC Snowy Plover counts (and percentage of state-wide counts) by region.

	Snowy Plover 2006		Snowy Plover 2001	
Region	SNPL 06	% total	SNPL 01	% total
Panhandle Gulf Coast	175	56.1	228	68.7
Big Bend Gulf Coast	0	0.0	0	0.0
Southwest Gulf Coast	137	43.9	103	31.0
Northeast Atlantic Coast	0	0.0	0	0.0
Central Atlantic Coast	0	0.0	1	0.3
Florida Keys	0	0.0	0	0.0
Total	312		332	

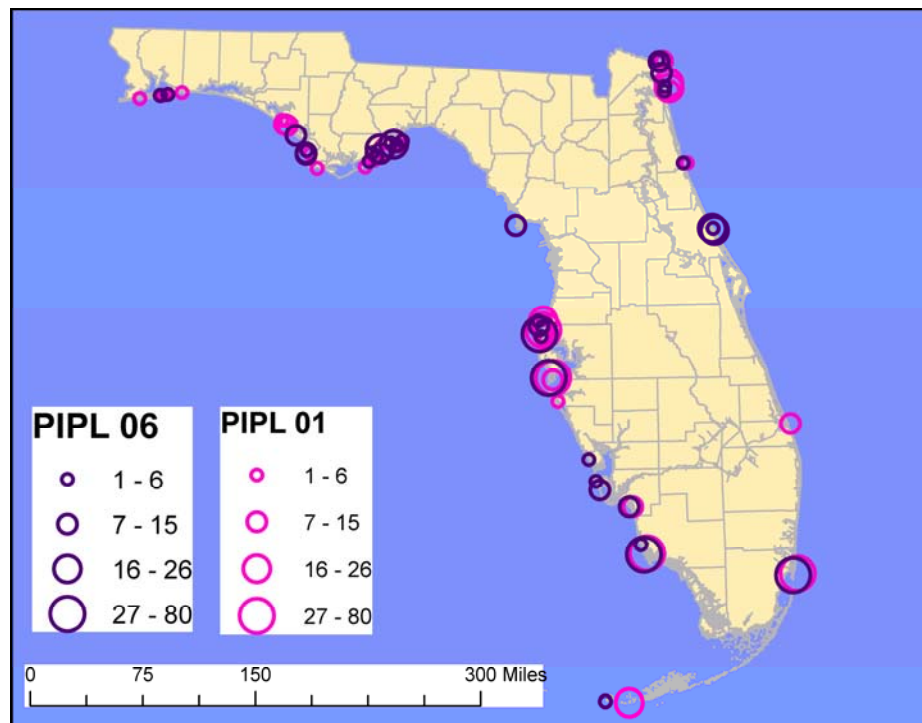


Figure 1. IPPC counts for wintering Piping Plovers in Florida, 2001 and 2006. Symbols from 2001 have been slightly displaced so that counts at the same site can be seen for both surveys.

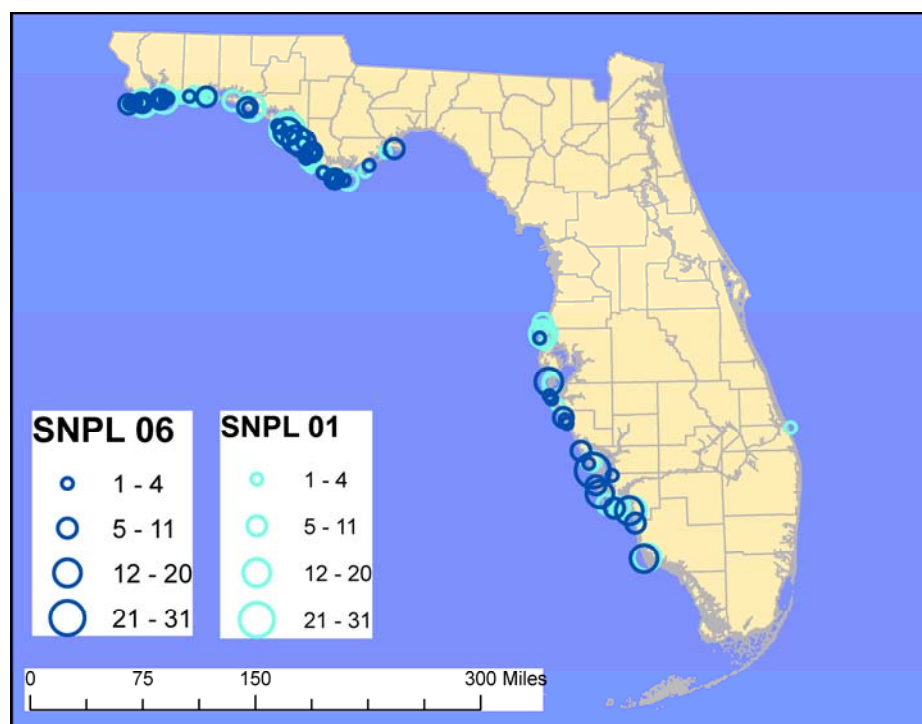


Figure 2. IPPC counts for wintering Snowy Plovers in Florida, 2001 and 2006. Symbols from 2001 have been slightly displaced so that counts at the same site can be seen for both surveys.

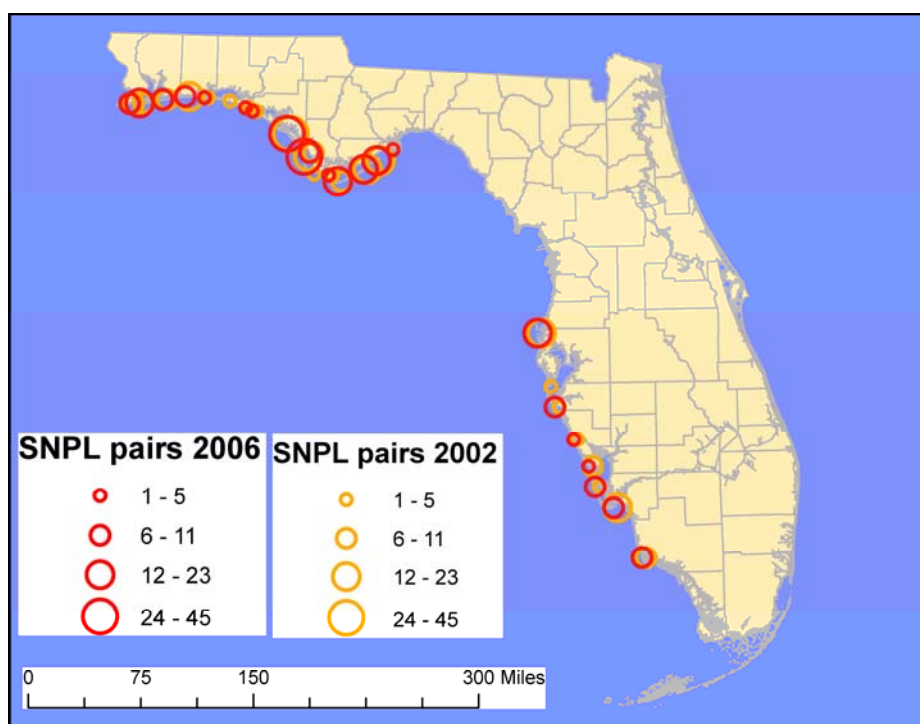


Figure 3. FWC Snowy Plover breeding pair estimates for Florida, 2002 and 2006. Symbols from 2002 have been slightly displaced so that counts at the same site can be seen for both surveys.

Panhandle

Engineering projects from 1993-2000

The Panhandle had no history of sand placement projects prior to 1995. During the eight years prior to the 2001/2002 bird surveys, coastal engineering in the Florida Panhandle was limited to “assisted recovery” projects in response to Hurricanes Opal in 1995 (whole Panhandle), Kate in 1995 (eastern Panhandle), Georges in 1998 (western Panhandle), and Earl in 1998 (eastern Panhandle). Assisted recovery projects were “conducted where upland developed property was left vulnerable to storms. Sand was trucked from upland borrow sites, placed in an alongshore berm configuration, and stabilized with wood slat sand fence and plantings of sea oats” (Florida Department of Environmental Protection 2007). Assisted recovery projects are similar to what has also been called “dune restoration” in recent years; however, some dune restoration projects have been designed proactively, rather than occurring explicitly in response to storms, and some of the more recent dune restoration projects have been executed at larger scales than assisted recovery projects, involving the placement of greater volumes of sand from a variety of borrow sources. In addition to the assisted recovery projects that occurred across the

Panhandle between 1995 and 1998, the low-impact access road to St. George Island State Park was rebuilt in 1995 in response to Hurricane Kate. The Panhandle's first major Federal Civil Works project occurred in 1999, with the large-scale nourishment of Panama City Beach. Figures 4-9 display maps of Panhandle engineering projects relative to bird survey data for both pre- and post-hurricane time periods.

Engineering projects from 1998-2005

In addition to the assisted recovery projects in response to Hurricane Georges and Earl in 1998, and the Panama City beach nourishment project mentioned above, the volume and scale of coastal engineering activity has increased considerably in the Panhandle in recent years. Most projects have taken place in the same locations as assisted recovery projects that had occurred starting with Hurricanes Kate and Opal in 1995. In 2003, the second major Federal Civil Works project was completed in the Panhandle with the nourishment of Pensacola Beach. Subsequently, the Panhandle received major hurricane impacts during Hurricane Ivan in 2004 (from Perdido Key to Cape San Blas), and Hurricanes Dennis (whole Panhandle) and Katrina (Perdido Key to Cape San Blas) in 2005 (Florida Department of Environmental Protection 2004, 2005). These storms touched off an unprecedented era of shoreline engineering projects in the Panhandle. In most locations where there had been damage to structures, FEMA emergency berms were followed by dune restoration projects, mostly funded by DEP. Then, in many locations, large-scale beach nourishment or beach restoration projects followed dune restoration projects. This included FEMA-funded emergency renourishment of both federal projects (Panama City and Pensacola Beach) as well as new, large-scale beach restoration projects, funded by DEP's Bureau of Beaches and Coastal Systems, at Perdido Key, Navarre Beach, Fort Walton Beach, Destin, much of Walton County, Mexico Beach, the St. Joseph Peninsula, and Alligator Point. Figures 4-9 display maps of Panhandle engineering projects relative to bird survey data for both pre- and post-hurricane time periods.

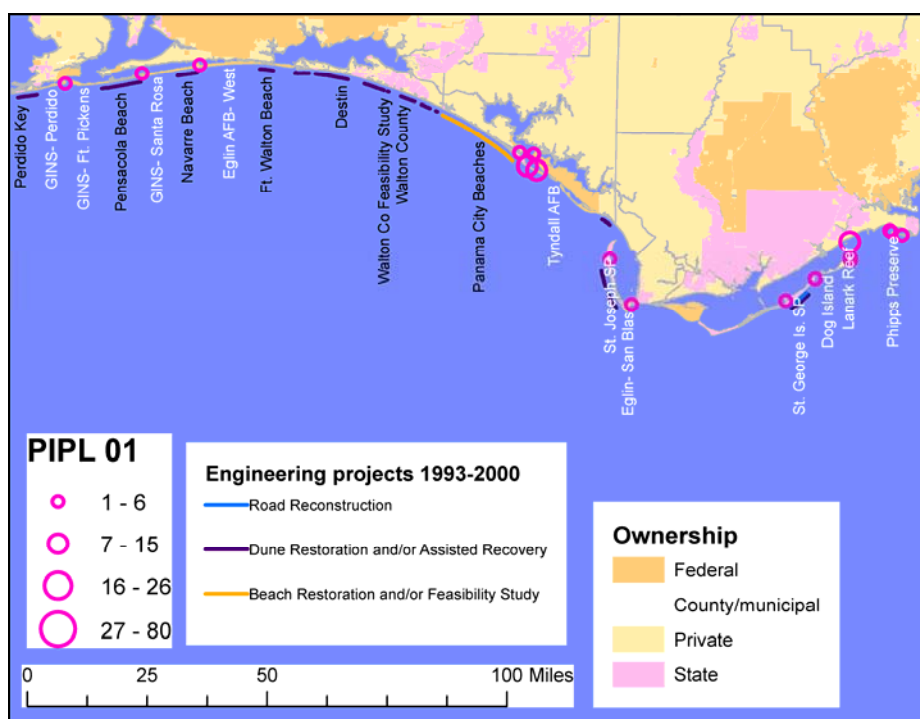


Figure 4. 2001 IPPC counts for wintering Piping Plovers and sand placement projects from 1993 to 2000 in the Florida Panhandle.

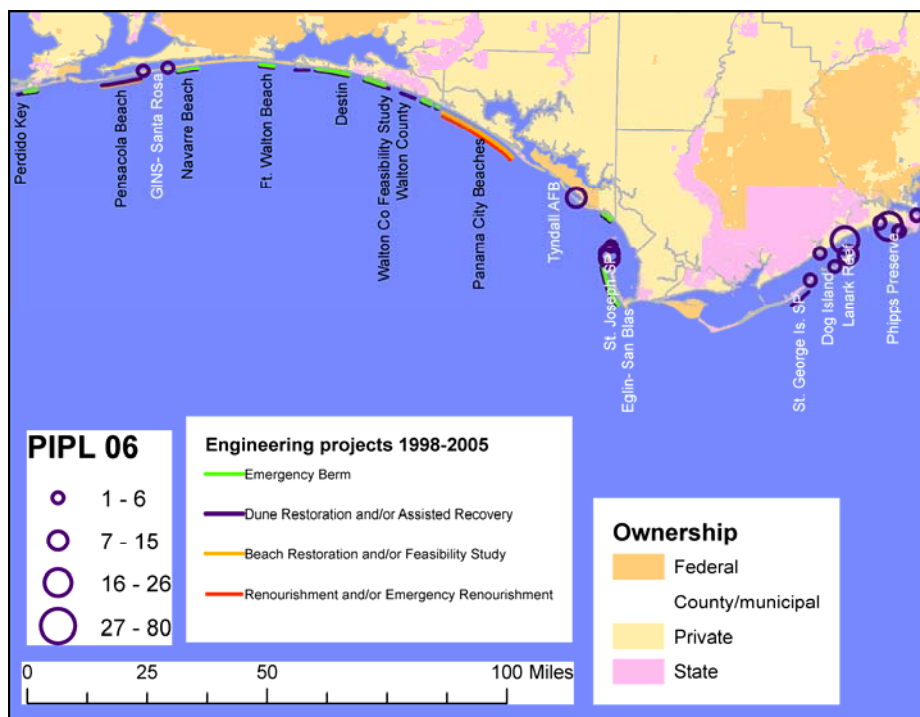


Figure 5. 2006 IPPC counts for wintering Piping Plovers and sand placement projects from 1998 to 2005 in the Florida Panhandle.

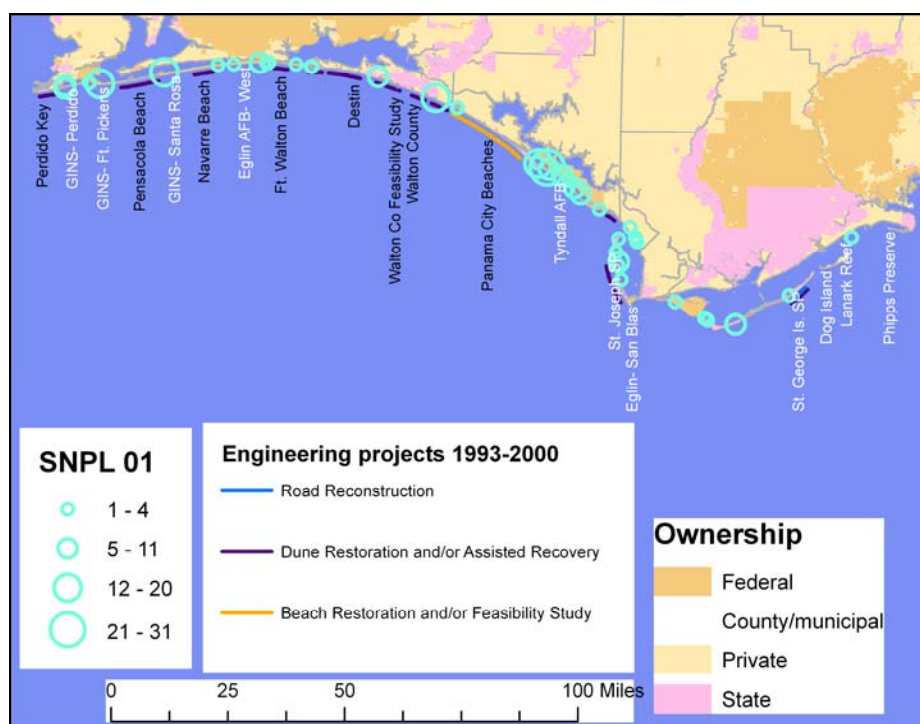


Figure 6. 2001 IPPC counts for wintering Snowy Plovers and sand placement projects from 1993 to 2000 in the Florida Panhandle.

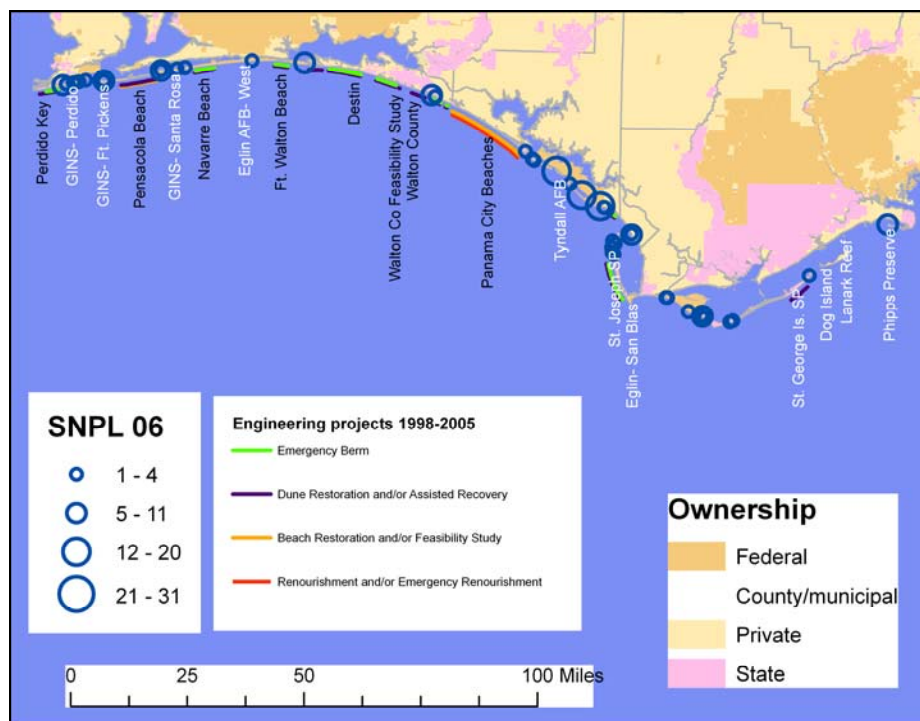


Figure 7. 2006 IPPC counts for wintering Snowy Plovers and sand placement projects from 1998 to 2005 in the Florida Panhandle.

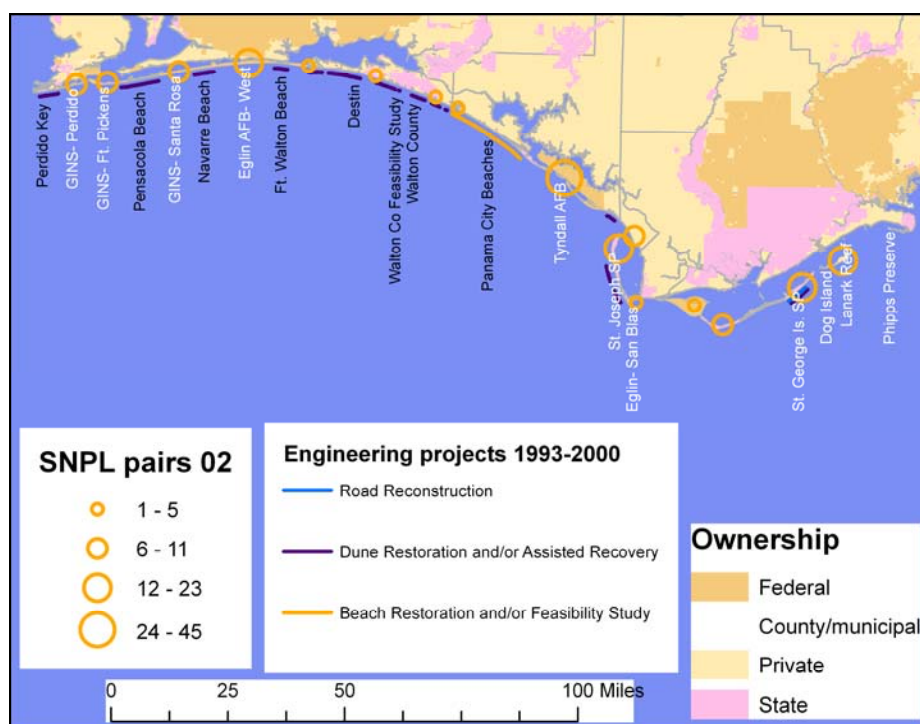


Figure 8. 2002 FWC Snowy Plover breeding pair estimates and sand placement projects from 1993 to 2000 in the Florida Panhandle.

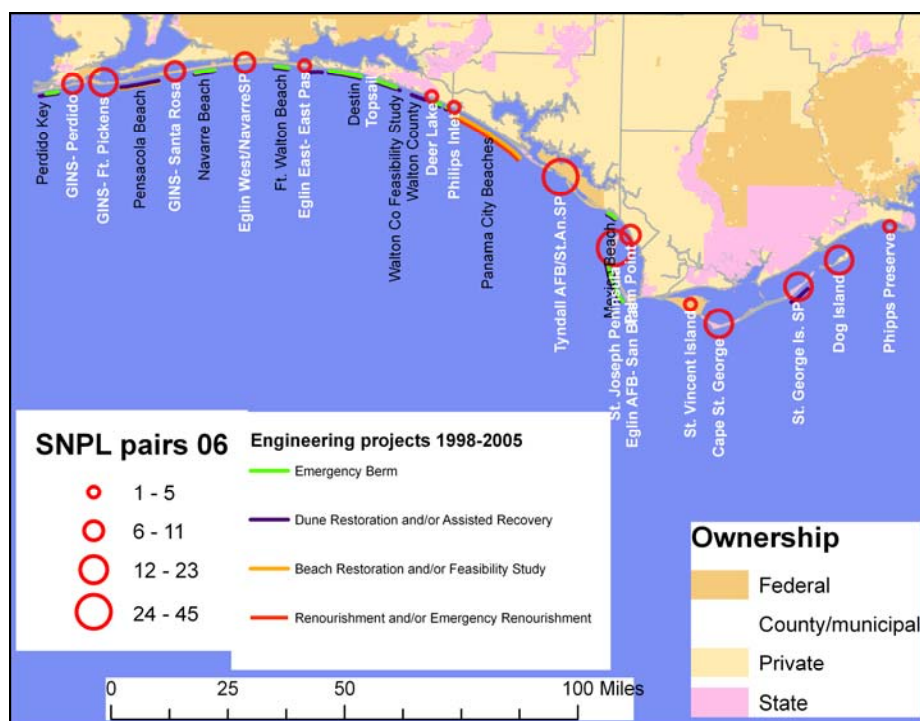


Figure 9. 2006 FWC Snowy Plover breeding pair estimates and sand placement projects from 1998 to 2005 in the Florida Panhandle.

Wintering Piping Plovers

During both surveys, Piping Plovers were most abundant in the eastern half of the Panhandle (Table 5). Counts increased between 2001 and 2006 at three important private property sites in Franklin County, from 11 to 23 birds at Phipps Preserve, 15 to 22 birds at Lanark Reef, and from 3 to 14 birds at Dog Island. Similarly, counts increased from 2 to 26 Piping Plovers at St. Joseph Peninsula State between 2001 and 2006. Counts decreased from 19 to 8 Piping Plovers at Tyndall Air Force Base. Small numbers of Piping Plovers were also observed in the Western Panhandle, at Gulf Islands National Seashore (GINS), during both surveys. Recent NPS surveys, after Hurricane Dennis washed over Santa Rosa Island and created new sand flats, have resulted in increased counts of Piping Plovers at GINS,¹ although high counts for Piping Plovers were not documented during the 2006 IPPC at this site. Within the Panhandle, the majority of Piping Plovers occurred on private property in Franklin County, with other important sites being managed by DEP-State Parks, the Department of Defense, and NPS (Table 6).

Table 5. 2001 and 2006 IPPC Piping Plover counts by county
(with percentages of state-wide and regional count totals).

Location	Piping Plover 2006			Piping Plover 2001		
	Count	% state	% region	Count	% state	% region
Panhandle Gulf Coast						
Escambia	5	1.2%	4.5%	5	1.2%	7.7%
Santa Rosa	0	0.0%	0.0%	2	0.5%	3.1%
Okaloosa	0	0.0%	0.0%	0	0.0%	0.0%
Bay	8	1.9%	7.2%	19	4.4%	29.2%
Gulf	26	6.1%	23.4%	3	0.7%	4.6%
Franklin	72	16.9%	64.9%	36	8.3%	55.4%
Panhandle subtotal	111	26.1%		65	15.0%	
Big Bend Gulf Coast						
Levy	7	1.6%	100.0%	0	0.0%	0.0%
Big Bend subtotal	7	1.6%		0	0.0%	
Southwest Gulf Coast						
Pasco	13	3.1%	8.0%	26	6.0%	10.8%
Pinellas	76	17.8%	46.6%	163	37.6%	67.9%
Manatee	0	0.0%	0.0%	1	0.2%	0.4%
Charlotte	3	0.7%	1.8%	0	0.0%	0.0%

¹ Unpublished Data. 2009. Mark Nicholas, Biologist, Gulf Islands National Seashore, Florida.

Location	Piping Plover 2006			Piping Plover 2001		
	Count	% state	% region	Count	% state	% region
Lee	21	4.9%	12.9%	9	2.1%	3.8%
Collier	50	11.7%	30.7%	41	9.4%	17.1%
Southwest subtotal	163	38.3%		240	55.3%	
Northeast Atlantic Coast						
Nassau	31	7.3%	30.7%	9	2.1%	14.5%
Duval	26	6.1%	25.7%	52	12.0%	83.9%
St. Johns	1	0.2%	1.0%	1	0.2%	1.6%
Volusia	43	10.1%	42.6%	0	0.0%	0.0%
Northeast subtotal	101	23.7%		62	14.3%	
Central Atlantic Coast						
Martin	0	0.0%	0.0%	12	2.8%	100.0%
Central Atlantic subtotal	0	0.0%		12	2.8%	
Florida Keys						
Miami-Dade	38	8.9%	86.4%	31	7.1%	56.4%
Monroe	6	1.4%	13.6%	24	5.5%	43.6%
Florida Keys subtotal	44	10.3%		55	12.7%	
State-wide survey total	426			434		

Table 6. 2001 and 2006 IPPC Piping Plover counts summarized by property and land management agency (with percentages of state-wide and regional count totals).

Location	Piping Plover 2006			Piping Plover 2001		
	Count	% state	% region	Count	% state	% region
Panhandle Gulf Coast	111	26.1%		65	15.0%	
<i>Private</i>	64	15.0%	57.7%	29	6.7%	44.6%
<i>TNC Phipps Preserve</i>	23			11		
<i>Lanark Reef</i>	22			15		
<i>TNC Dog Island</i>	14			3		
<i>Turkey Point</i>	4			0		
<i>Carabelle Beach</i>	1			0		
DEP- State Parks	34	8.0%	30.6%	9	2.1%	13.8%
<i>St. Joseph Peninsula State Park</i>	26			2		
<i>St. George Island State Park</i>	4			7		
<i>Bald Point State Park</i>	4			0		
DOD	8	1.9%	7.2%	22	5.1%	33.8%
<i>Tyndall Air Force Base</i>	8			19		
<i>Eglin Air Force Base</i>	0			3		

Location	Piping Plover 2006			Piping Plover 2001		
	Count	% state	% region	Count	% state	% region
NPS	5	1.2%	4.5%	5	1.2%	7.7%
<i>Gulf Islands National Seashore</i>	5			5		
Big Bend Gulf Coast	7	1.6%		0	0.0%	
FWS	7	1.6%	100.0%	0	0.0%	0.0%
<i>Cedar Keys National Wildlife Refuge</i>	7			0		
Southwest Gulf Coast	163	38.3%		240	55.3%	
DEP- State Parks	55	12.9%	33.7%	139	32.0%	57.9%
<i>Honeymoon Island State Park</i>	38			19		
<i>Anclote Key Preserve State Park</i>	13			119		
<i>Don Pedro Island State Park</i>	3			0		
<i>Cayo Costa State Park</i>	1			0		
<i>Caladesi Island State Park</i>	0			1		
Collier County	49	11.5%	30.1%	41	9.4%	17.1%
<i>Tigertail Beach County Park</i>	49			41		
DEP- Coastal and Aquatic Managed Areas	35	8.2%	21.5%	41	9.4%	17.1%
<i>Shell Key Preserve</i>	34			41		
<i>Rookery Bay National Estuarine Research Reserve</i>	1			0		
Unknown	10	2.3%	6.1%	0	0.0%	0.0%
<i>Charley Pass</i>	10			0		
DEP- Division of State Lands	10	2.3%	6.1%	9	2.1%	3.8%
<i>Little Estero Lagoon</i>	10			9		
Pinellas County	4	0.9%	2.5%	9	2.1%	3.8%
<i>Howard County Park</i>	4			0		
<i>Fort Desoto Park</i>	0			9		
Private	0	0.0%	0.0%	1	0.2%	0.4%
<i>Longboat Key ?</i>	0			1		
Northeast Atlantic Coast	101	23.7%		62	14.3%	
DEP- State Parks	36	8.5%	35.6%	53	12.2%	85.5%
<i>Fort Clinch State Park</i>	31			9		
<i>Little Talbot Island State Park</i>	5			44		
Private	32	7.5%	31.7%	0	0.0%	0.0%
<i>South of Ponce de Leon Inlet</i>	17			0		
<i>North Nassau Sound ?</i>	15			0		

Location	Piping Plover 2006			Piping Plover 2001		
	Count	% state	% region	Count	% state	% region
Volusia County	26	6.1%	25.7%	0	0.0%	0.0%
<i>Lighthouse Point Park</i>	25			0		
<i>Smyrna Dunes Park</i>	1			0		
City of Jacksonville	6	1.4%	5.9%	8	1.8%	12.9%
<i>Hugenot Memorial Park</i>	6			8		
DEP- Coastal and Aquatic Managed Areas	1	0.2%	1.0%	0	0.0%	0.0%
<i>Guana Tolomato Matanzas National Estuarine</i>	1			0		
NPS	0	0.0%	0.0%	1	0.2%	1.6%
<i>Fort Matanzas National Monument</i>	0			1		
Central Atlantic Coast	0	0.0%		12	2.8%	
DEP- State Parks	0	0.0%	0.0%	12	2.8%	100.0%
<i>St. Lucie Inlet Preserve State Park</i>	0			12		
Florida Keys	44	10.3%		55	12.7%	
Miami-Dade County	38	8.9%	86.4%	31	7.1%	56.4%
<i>Crandon Park</i>	38			31		
FWS	6	1.4%	13.6%	24	5.5%	43.6%
<i>Key West National Wildlife Refuge</i>	6			24		
State-wide survey total	426			434		

Wintering Snowy Plovers

During both surveys, non-breeding Snowy Plovers had a broader distribution within the Panhandle than Piping Plovers (Tables 7 and 8, Figures 1 and 2) with high counts in the western Panhandle (mostly at Gulf Islands National Seashore and Eglin Air Force Base), the central Panhandle (primarily Deer Lake State Park), and the eastern Panhandle (with high counts occurring at Tyndall Air Force Base, St. Joseph Peninsula State Park, and Cape St. George State Reserve). The percentage of counts occurring among the different counties of the Panhandle did not vary considerably between 2001 and 2006 (Table 7). Counts decreased at both Department of Defense properties between 2001 and 2006 (from 81 to 56 birds at Tyndall and from 20 to 11 birds at Eglin), although Tyndall AFB still had the highest counts for wintering Snowy Plovers anywhere in the

state. Wintering Snowy Plovers were not observed at several sites in 2006 where they had been present (albeit in small numbers) in 2001: Big Lagoon State Park in Escambia County; Navarre Beach State Park in Santa Rosa County; Topsail Hill Preserve and Camp Helen State Parks in the HWY 30 Lakes region in Walton County; and Lanark Reef in Franklin County. In contrast, wintering Snowy Plovers were observed in small numbers at two locations in 2006 where they were not counted in 2001: St. Andrews State Park and TNC's Phipps Preserve. The two DoD properties, DEP-State Parks and NPS-GINS, accounted for 86.4 percent and 76.3 percent of all wintering Snowy Plover counts in the Panhandle during 2001 and 2006, respectively (Table 8). Only 8.6 percent (2001) and 6.6 percent (2006) of all Snowy Plover counts in the Panhandle occurred on private property and these were divided between three properties: St. Joe Paper Company properties near Palm Point, TNC's Phipps Preserve, and Lanark Reef.

**Table 7. 2001 and 2006 IPPC Snowy Plover counts by county
(with percentages of state-wide and regional count totals).**

Location	Snowy Plover 2006			Snowy Plover 2001		
	Count	% state	% region	Count	% state	% region
Panhandle Gulf Coast						
Escambia	39	12.5%	22.3%	48	14.5%	21.1%
Santa Rosa	1	0.3%	0.6%	1	0.3%	0.4%
Okaloosa	10	3.2%	5.7%	20	6.0%	8.8%
Walton	12	3.8%	6.9%	23	6.9%	10.1%
Bay	59	18.9%	33.7%	84	25.3%	36.8%
Gulf	22	7.1%	12.6%	32	9.6%	14.0%
Franklin	32	10.3%	18.3%	20	6.0%	8.8%
Panhandle subtotal	175	56.1%		228	68.7%	
Southwest Gulf Coast						
Pasco	0	0.0%	0.0%	6	1.8%	5.8%
Pinellas	15	4.8%	10.9%	39	11.7%	37.9%
Manatee	5	1.6%	3.6%	2	0.6%	1.9%
Sarasota	18	5.8%	13.1%	0	0.0%	0.0%
Charlotte	30	9.6%	21.9%	7	2.1%	6.8%
Lee	44	14.1%	32.1%	32	9.6%	31.1%
Collier	25	8.0%	18.2%	17	5.1%	16.5%
Southwest subtotal	137	43.9%		103	31.0%	
West Coast subtotal	312			331		

Table 8. 2001 and 2006 IPPC Snowy Plover counts summarized by property and land management agency (with percentages of state-wide and regional count totals).

Location	Snowy Plover 2006			Snowy Plover 2001		
	Count	% state	% region	Count	% state	% region
Panhandle Gulf Coast	175	56.1%		228	69.9%	
DoD	67	21.5%	38.3%	101	31.0%	44.3%
<i>Tyndall Air Force Base</i>	56			81		
<i>Eglin Air Force Base</i>	11			20		
NPS	39	12.5%	22.3%	41	12.6%	18.0%
<i>Gulf Islands National Seashore</i>	39			41		
DEP- State Parks	31	9.9%	17.7%	55	16.9%	24.1%
<i>St. Joseph Peninsula State Park</i>	14			19		
<i>Deer Lake State Park</i>	12			14		
<i>St. Andrews State Park</i>	3			0		
<i>St. George Island State Park</i>	2			2		
<i>Big Lagoon State Park</i>	0			7		
<i>Navarre Beach State Park</i>	0			1		
<i>Topsail Hill Preserve State Park</i>	0			9		
<i>Camp Helen State Park</i>	0			3		
Private	15	4.8%	8.6%	15	4.6%	6.6%
<i>St. Joe Company</i>	8			13		
<i>TNC Phipps Preserve</i>	7			0		
<i>Lanark Reef</i>	0			2		
DEP- Coastal and Aquatic Managed Areas	14	4.5%	8.0%	12	3.7%	5.3%
<i>Cape St. George State Reserve</i>	14			12		
FWS	9	2.9%	5.1%	4	1.2%	1.8%
<i>St. Vincent National Wildlife Refuge</i>	9			4		
Southwest Gulf Coast	137	43.9%		103	31.6%	
Private	46	14.7%	33.6%	19	5.8%	18.4%
<i>Gasparilla Island ?</i>	24			0		
<i>Sanibel Captiva Conservation Foundation</i>	8			10		
<i>Anna Maria Island ?</i>	5			0		
<i>Manasota Key ?</i>	5			0		
<i>Siesta Key ?</i>	4			0		
<i>Longboat Key ?</i>	0			2		
<i>South of Stump Pass Beach State Park</i>	0			7		
Collier County	20	6.4%	14.6%	17	5.2%	16.5%
<i>Tigertail Beach County Park</i>	20			17		

Location	Snowy Plover 2006			Snowy Plover 2001		
	Count	% state	% region	Count	% state	% region
DEP- State Parks	19	6.1%	13.9%	35	10.7%	34.0%
<i>Cayo Costa State Park</i>	6			0		
<i>Delnor-Wiggins Pass State Park</i>	5			0		
<i>Charlotte Harbor Preserve State Park</i>	4			0		
<i>Honeymoon Island State Park</i>	2			7		
<i>Don Pedro Island State Park</i>	2			0		
<i>Anclote Key Preserve State Park</i>	0			24		
<i>Caladesi Island State Park</i>	0			4		
DEP- Division of State Lands	16	5.1%	11.7%	15	4.6%	14.6%
<i>Little Estero Lagoon</i>	16			15		
Unknown	14	4.5%	10.2%	0	0.0%	0.0%
<i>Charley Pass</i>	14			0		
DEP- Coastal and Aquatic Managed Areas	13	4.2%	9.5%	5	1.5%	4.9%
<i>Shell Key Preserve</i>	13			5		
Sarasota County	9	2.9%	6.6%	0	0.0%	0.0%
<i>North Lido Public Beach</i>	7			0		
<i>South Lido County Park</i>	2			0		
City of Sanibel	0	0.0%	0.0%	7	2.1%	6.8%
<i>Bowman's Beach Regional Park</i>	0			7		
Pinellas County	0	0.0%	0.0%	5	1.5%	4.9%
<i>Fort Desoto Park</i>	0			5		
Central Atlantic Coast	0	0.0%		1	0.3%	
DEP- State Parks	0	0.0%	0.0%	1	0.3%	100.0%
<i>St. Lucie Inlet Preserve State Park</i>	0			1		
State-wide survey total	312			326		

Nesting Snowy Plovers

Although nesting Snowy Plovers occur across the entire Panhandle, and there is considerable overlap in the properties used by non-breeding and nesting Snowy Plovers, the distribution of nests is broader than the distribution of non-breeding birds. Several sites in the Panhandle (e.g., St. George Island State Park and Dog Island) are used much more extensively for nesting than they are during the non-breeding season. Three counties in the eastern Panhandle (Bay, Gulf, and Franklin) contained 69.3 percent (2001) and 73.4 percent (2006) of the Panhandle's estimated nesting pairs

(Table 9). Snowy Plover pair estimates were very similar between 2001 and 2006 and the estimated proportion of Snowy Plovers nesting on different properties within the Panhandle did not change considerably between the two surveys. Pair estimates increased slightly at Tyndall Air Force Base (from 36 to 43) and considerably at both St. Vincent National Wildlife Refuge (from 3 to 11) and at Cape St. George State Reserve (from 8 to 16 pairs). The two DoD properties, DEP-State Parks, and NPS-GINS, accounted for 81.7 percent and 75.7 percent of all estimated nesting Snowy Plover pairs in the Panhandle during 2001 and 2006, respectively (Table 10). Only 11.1 percent (2001) and 9.0 percent (2006) of all estimated Snowy Plover pairs in the Panhandle occurred on private property and these were divided between three properties: St. Joe Paper Company properties near Palm Point, and TNC properties on Dog Island and Phipps Preserve.

Table 9. 2001 and 2006 FWC Snowy Plover pair estimates by county (with percentages of state-wide and regional pair estimates).

Location	Snowy Plover pairs 2006			Snowy Plover pairs 2001		
	Count	% state	% region	Count	% state	% region
Panhandle Gulf Coast						
Escambia	29	13.1%	16.4%	23	10.8%	15.0%
Santa Rosa	0	0.0%	0.0%	2	0.9%	1.3%
Okaloosa	16	7.2%	9.0%	17	8.0%	11.1%
Walton	2	0.9%	1.1%	5	2.3%	3.3%
Bay	47	21.2%	26.6%	39	18.3%	25.5%
Gulf	35	15.8%	19.8%	29	13.6%	19.0%
Franklin	48	21.6%	27.1%	38	17.8%	24.8%
Panhandle subtotal	177	79.7%		153	71.8%	
Southwest Gulf Coast						
Pasco	4	1.8%	8.9%	5	2.3%	8.3%
Pinellas	9	4.1%	20.0%	12	5.6%	20.0%
Hillsborough	0	0.0%	0.0%	0	0.0%	0.0%
Manatee	2	0.9%	4.4%	1	0.5%	1.7%
Sarasota	5	2.3%	11.1%	3	1.4%	5.0%
Charlotte	5	2.3%	11.1%	9	4.2%	15.0%
Lee	13	5.9%	28.9%	22	10.3%	36.7%
Collier	7	3.2%	15.6%	8	3.8%	13.3%
Southwest subtotal	45	20.3%		60	28.2%	
State-wide survey total	222			213		

Table 10. 2001 and 2006 FWC Snowy Plover pair estimates summarized by property and land management agency (with percentages of state-wide and regional pair estimates).

	Snowy Plover pairs 2006			Snowy Plover pairs 2001		
	Count	% state	% region	Count	% state	% region
Panhandle Gulf Coast	177	79.7%		153	71.8%	
DOD	59	26.6%	33.3%	53	24.9%	34.6%
<i>Tyndall Air Force Base</i>	43			36		
<i>Eglin Air Force Base</i>	16			17		
DEP- State Parks	47	21.2%	26.6%	49	23.0%	32.0%
<i>St. Joseph Peninsula State Park</i>	28			23		
<i>St. George Island State Park</i>	13			16		
<i>Deer Lake State Park</i>	2			2		
<i>St. Andrews State Park</i>	2			0		
<i>Camp Helen State Park</i>	2			3		
<i>Navarre Beach State Park</i>	0			2		
<i>Topsail Hill Preserve State Park</i>	0			3		
NPS	28	12.6%	15.8%	23	10.8%	15.0%
<i>Gulf Islands National Seashore</i>	28			23		
DEP- Coastal and Aquatic Managed Areas	16	7.2%	9.0%	8	3.8%	5.2%
<i>Cape St. George State Reserve</i>	16			8		
Private	16	7.2%	9.0%	17	8.0%	11.1%
<i>St. Joe Company</i>	7			6		
<i>TNC Dog Island</i>	7			11		
<i>TNC Phipps Preserve</i>	1			0		
<i>Perdido Key West</i>	1					
FWS	11	5.0%	6.2%	3	1.4%	2.0%
<i>St. Vincent National Wildlife Refuge</i>	11			3		
Southwest Gulf Coast	45	20.3%		60	28.2%	
DEP- State Parks	17	7.7%	37.8%	15	7.0%	25.0%
<i>Caladesi Island State Park</i>	6			6		
<i>Cayo Costa State Park</i>	4			2		
<i>Anclote Key Preserve State Park</i>	4			5		
<i>Honeymoon Island State Park</i>	3			2		
Private	13	5.9%	28.9%	30	14.1%	50.0%
<i>Sanibel Captiva Conservation Foundation</i>	5			19		
<i>South of Stump Pass Beach State Park</i>	3			6		
<i>Gasparilla Island</i>	2			3		

	Snowy Plover pairs 2006			Snowy Plover pairs 2001		
	Count	% state	% region	Count	% state	% region
<i>Anna Maria Island?</i>	1			0		
<i>Siesta Key</i>	1			1		
<i>Longboat Key</i>	1			1		
Collier County	4	1.8%	8.9%	5	2.3%	8.3%
<i>Tigertail Beach County Park</i>	4			5		
Sarasota County	4	1.8%	8.9%	2	0.9%	3.3%
<i>North Lido Public Beach</i>	3			2		
<i>South Lido County Park</i>	1			0		
DEP- Coastal and Aquatic Managed Areas	3	1.4%	6.7%	4	1.9%	6.7%
<i>Rookery Bay National Estuarine Research Reserve</i>	3			3		
<i>Shell Key Preserve</i>	0			1		
Unknown	3	1.4%	6.7%	0	0.0%	0.0%
<i>Charley Pass</i>	3			0		
DEP- Division of State Lands	1	0.5%	2.2%	1	0.5%	1.7%
<i>Little Estero Lagoon</i>	1			1		
Pinellas County	0	0.0%	0.0%	3	1.4%	5.0%
<i>Fort Desoto Park</i>	0			3		
State-wide survey total	222			213		

Panhandle summary

The spatial extent of sand placement projects did not increase considerably between the 8 years prior to 2001/2002 bird surveys and the 8 years prior to 2006 bird surveys. However, the volume of sand placed on beaches, and the prevalence of large-scale beach nourishment/beach restoration projects, increased dramatically between the two periods. Two new areas will receive sand placement in the near future with projects proposed at Alligator Point (an area with few birds) and a proposed large-scale dredged-material disposal project at Gulf Islands National Seashore (an important area for Snowy Plovers, with smaller numbers of Piping Plovers). With some relatively minor exceptions, as mentioned above, the distribution and abundance of plovers did not change dramatically between the two survey periods within the Panhandle. In all cases, engineering projects did not directly overlap with the distribution of Snowy

Plovers or Piping Plovers; however, projects have occurred near the boundaries of properties where both species are present.

Southwest Florida engineering project and bird survey summaries

Engineering projects from 1993-2000

Unlike the Panhandle, which did not have its first large-scale beach nourishment project completed until 1999, several large-scale Federal Civil Works projects had already been completed in Southwest Florida prior to 1993, including beach nourishment projects on Sand Key and Treasure Island north of Tampa Bay; Anna Maria Island, Longboat Key, and Lido Key to the south of Tampa Bay; Captiva Island fronting Port Charlotte Harbor; and Marco Island. During the 8 years before the 2001/2002 bird surveys, renourishment events occurred in all of these areas and new federal beach nourishment projects were completed at Mullet Key, Venice Beach, Knight Island, Gasparilla Island, Naples, and Marco Island. Figures 10-15 display maps of Southwest Florida engineering projects relative to bird survey data for both pre- and post-hurricane time periods.

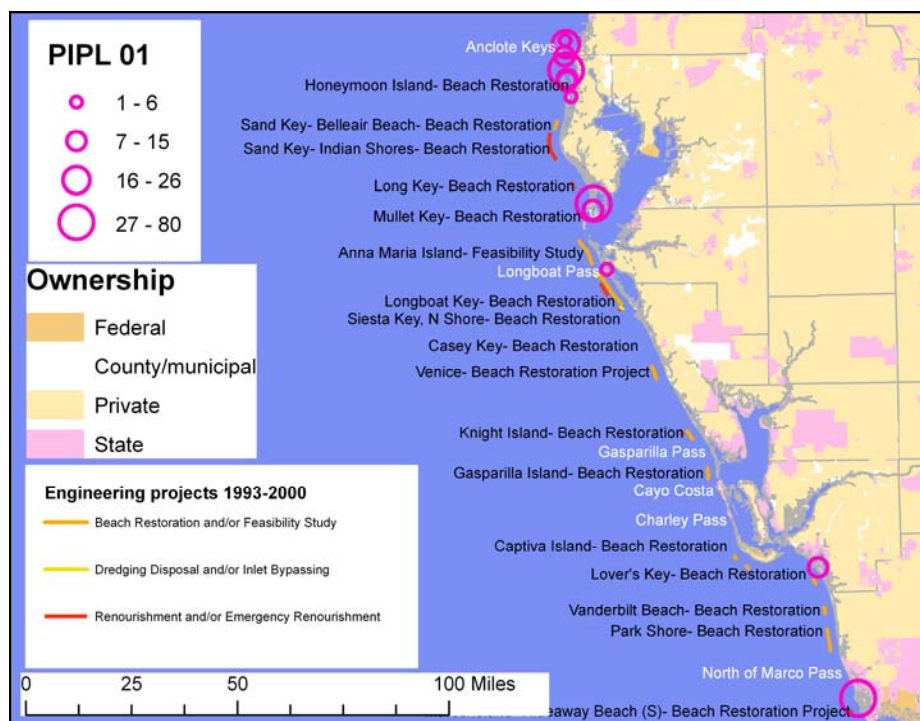


Figure 10. 2001 IPPC counts for wintering Piping Plovers and sand placement projects from 1993 to 2000 in Southwest Florida.

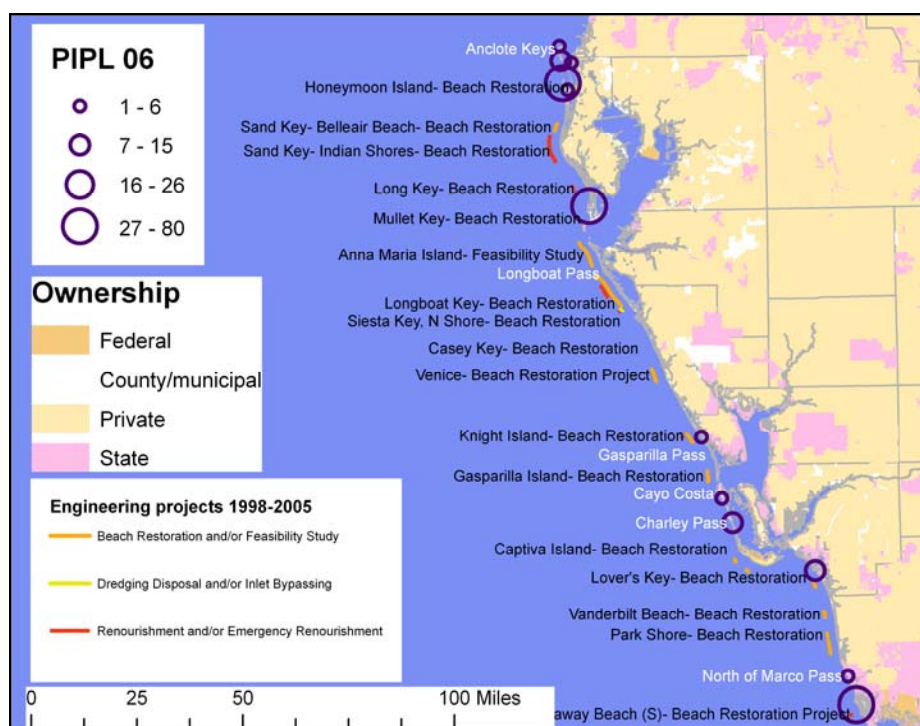


Figure 11. 2006 IPPC counts for wintering Piping Plovers and sand placement projects from 1998 to 2005 in Southwest Florida.

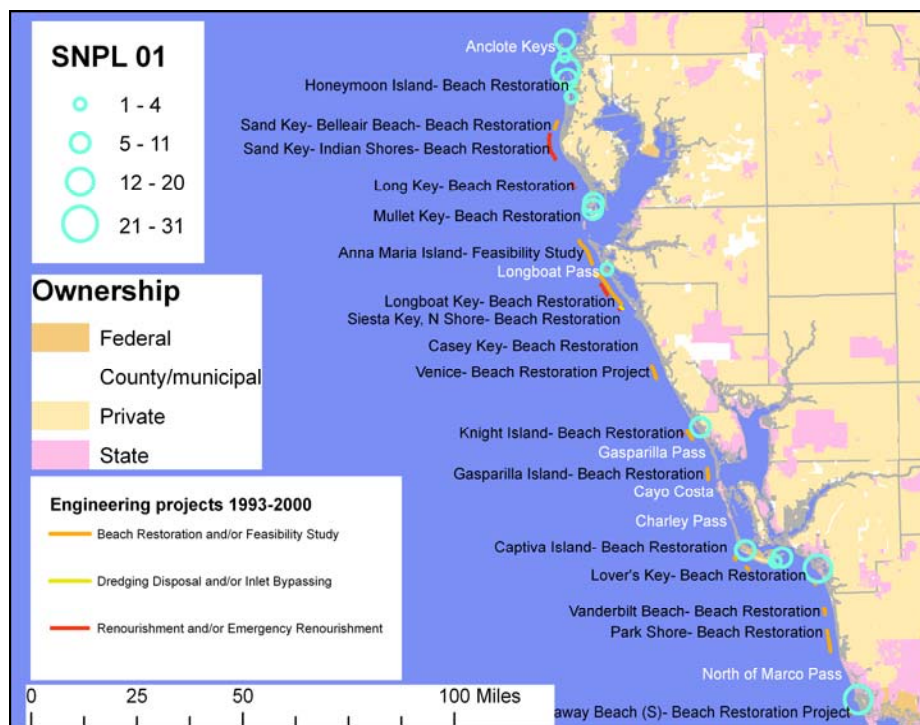


Figure 12. 2001 IPPC counts for wintering Snowy Plovers and sand placement projects from 1993 to 2000 in Southwest Florida.

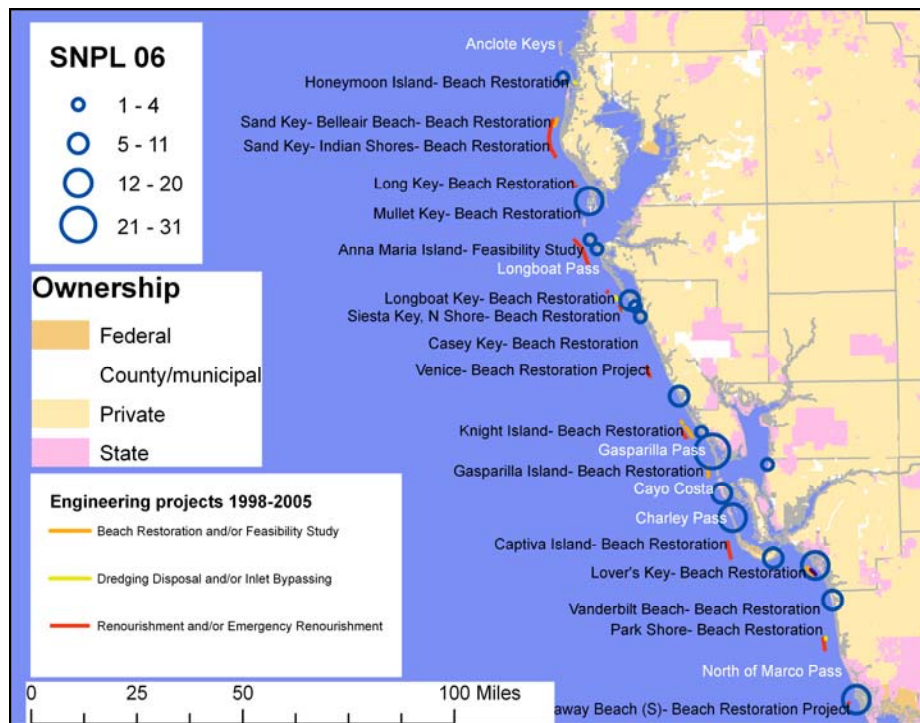


Figure 13. 2006 IPPC counts for wintering Snowy Plovers and sand placement projects from 1998 to 2005 in Southwest Florida.

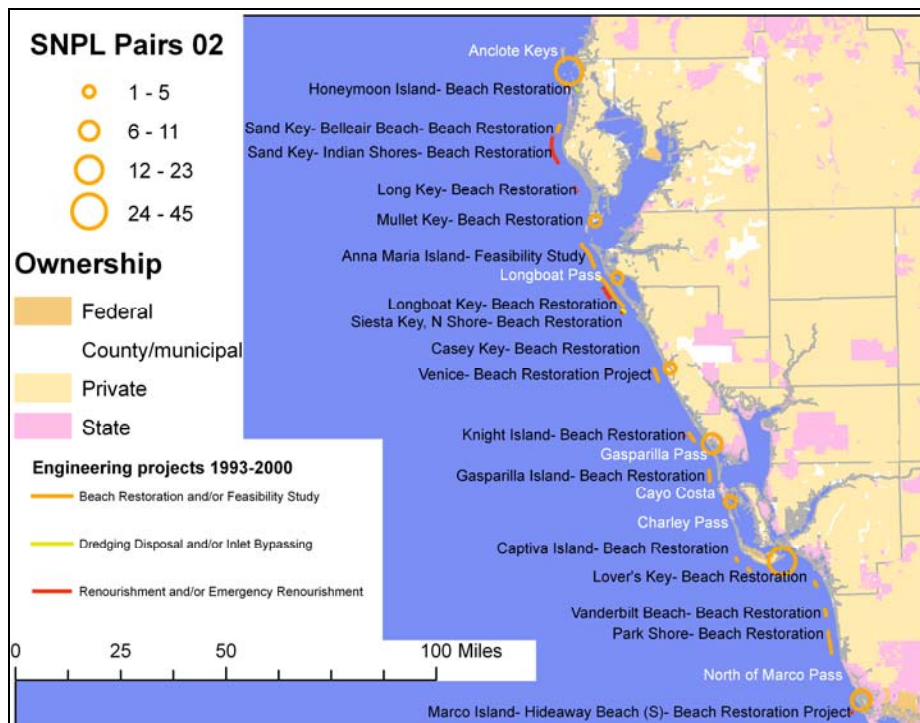


Figure 14. 2002 FWC Snowy Plover breeding pair estimates and sand placement projects from 1993 to 2000 in Southwest Florida.

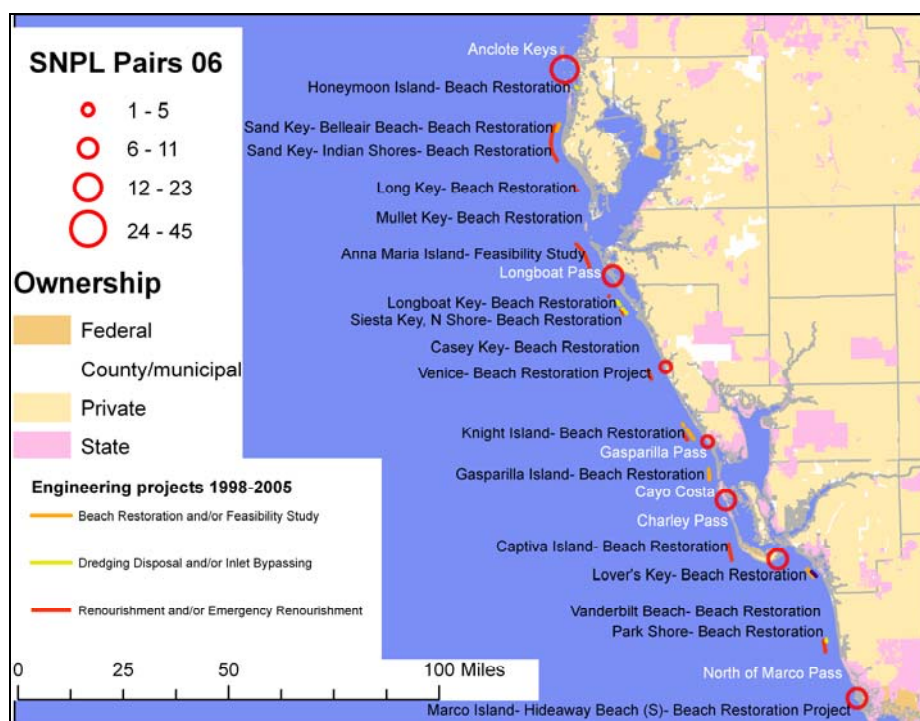


Figure 15. 2006 FWC Snowy Plover breeding pair estimates and sand placement projects from 1998 to 2005 in Southwest Florida.

Engineering projects from 1998-2005

In the 8 years prior to 2006 bird surveys, renourishment events occurred on all of the project areas listed above and a new beach and dune restoration project was completed at Lover's Key State Park. Since the 2006 surveys, new beach restoration projects have been proposed or initiated for Casey Key (an area with few birds) and Fort Myers Beach on Estero Island (the northern and southern portions of which, Bowditch Point and Little Estero Lagoon, are heavily used by birds). Figures 10-15 display maps of Southwest Florida engineering projects relative to bird survey data for both pre- and post-hurricane time periods.

Wintering Piping Plovers

Piping Plovers occur at a small number of sites in Southwest Florida (Table 6). The total count of wintering Piping Plovers on the Southwest Gulf Coast decreased from 240 in 2001 to 163 in 2006 (Table 2). This was entirely due to a very large decrease at a single site, Anclote Key Preserve State Park, which straddles the Pasco/Pinellas County line, where counts decreased from 119 (which had been the highest count in the state in 2001) to 13 birds in 2006 (Table 6). In the two other counties where more than 5 Piping Plovers were counted, counts increased from 2001 to 2006, with

increases from 9 to 21 birds in Lee County, and 41 to 50 birds in Collier County. Counts increased between 2001 and 2006 at Honeymoon Island State Park (from 19 to 38) and Tigertail Beach County Park at Marco Island (41 to 49), decreased at Shell Key Preserve (from 41 to 34) and Fort DeSoto State Park (9 to 0), and were similar at Little Estero Lagoon (9 and 10). Ten Piping Plovers were counted in 2006 at a new inlet in Lee County, called Charley Pass, which was created during Hurricane Charley in 2004. This site was not present in 2001. All other sites in Southwest Florida had counts of less than 5 birds in both surveys. Less than 0.3 percent of all Piping Plovers were counted on private property in Southwest Florida in both surveys. An overwhelming majority of wintering Piping Plovers in Southwest Florida (91.2 percent in 2001 and 85.3 percent in 2006) were counted on lands managed by Collier County, DEP's State Parks, or DEP's Office of Coastal and Aquatic managed areas.

Wintering Snowy Plovers

The total count of wintering Snowy Plovers in Southwest Florida was relatively similar between 2001 and 2006 surveys (332 and 312, respectively). However, counts varied considerably between the two surveys when summarized by county and property (Tables 7 and 8). For example, counts decreased from 6 to 0 in Pasco County (all at one site, Anclote Key State Preserve) and from 39 to 15 in Pinellas County. By contrast, counts increased from 0 to 18 in Sarasota County, 7 to 30 in Charlotte County, 32 to 44 in Lee County, and 17 to 25 in Collier County. Contrary to the Panhandle where Snowy Plover counts often occurred on the same properties between 2001 and 2006, only 4 sites in Southwest Florida had counts of wintering Snowy Plovers in both 2001 and 2006. Counts increased from 5 to 13 birds at Shell Key Preserve and were relatively similar at Tigertail Beach County Park (17 and 20 birds in 2001 and 2006, respectively), Sanibel Island (10 and 8 birds), and Little Estero Lagoon (15 and 16 birds). Charley Pass, the new inlet created in Lee County during Hurricane Charley in 2004, had 14 Snowy Plovers. Six sites where Snowy Plovers were counted in 2001 had no Snowy Plovers observed in 2006; from north to south, these were: Anclote Key (24 birds in 2001), Caladesi State Park (4), Fort DeSoto State Park (5), Longboat Key (2), Stump Pass (7), and Bowman's Beach Regional Park (7). On the other hand, 10 sites that had 0 Snowy Plovers in 2001 had Snowy Plover sightings in 2006; from north to south, these were: Anna Maria Island (5 birds in 2006), North Lido Public Beach (7), South Lido County Park (2), Siesta Key (4), Manasota Key (5), Don Pedro Island State Park (2),

Gasparilla Island (24), Cayo Costa State Park (6), Charlotte Harbor State Preserve (4), and Delnor-Wiggins Pass State Park (5). The proportion of wintering Snowy Plovers counted on private property in Southwest Florida increased from 18.4 percent in 2001 to 33.6 percent in 2006.

Nesting Snowy Plovers

In contrast to the Panhandle, not all properties used by non-breeding Snowy Plovers are also used for nesting in Southwest Florida. Since the number of estimated Snowy Plover pairs is small (less than 6 pairs) at all sites on the Southwest Coast, the distribution of nests is not broader than the distribution of non-breeding birds at most sites, unlike the Panhandle where areas used for nesting are often larger than non-breeding areas. Snowy Plover pair estimates decreased between 2002 and 2006 from 19 to 5 pairs on Sanibel Island, from 6 to 3 pairs south of Stump Pass, and from 3 to 0 pairs at Fort DeSoto State Park. Three pairs were estimated at Charley Pass in 2006, a site that was not present in 2002. In 2002, 50 percent of Southwest Florida's estimated Snowy Plover pairs were nesting on Private Property, in part due to the relatively large number of estimated pairs at Sanibel Island. With the decrease in estimated pairs at Sanibel Island, 38.9 percent of Southwest Florida's Snowy Plovers were estimated to be nesting on private property in 2006. A relatively large proportion of Southwest Florida's estimated Snowy Plover pairs nest in State Parks (25 percent in 2001, 37.8 percent in 2006), including three adjacent parks in the northern part of the Southwest Gulf Coast: Anclote Key Preserve, Honeymoon Island, and Caladesi Island State Park.

Southwest Gulf Coast Summary

A much greater proportion of the Southwest Gulf Coast has experienced many years of high-volume coastal engineering than the Panhandle. The spatial extent of beach nourishment projects has been steadily expanding along the Southwest coast over time and most projects have received regular renourishment, either as part of a federally authorized maintenance schedule or through emergency appropriations related to recent hurricanes (Frances and Jeanne affected the northern part of the region in 2004 and Charley and Wilma affected the southern half in 2004 and 2005). The distribution of plovers is fragmented within this region, with most plovers occurring on public lands (with some exceptions, see above). Most plovers do not occur within engineering project areas, with the exception of the three barrier islands south of Tampa Bay: Anna Maria,

Longboat, and Lido Key, which have minor use by birds. Sand placement projects have occurred within the range of littoral drift of emplaced sediments from several important areas for plovers in Southwest Florida: Fort DeSoto and Shell Key, Stump Pass, Sanibel Island, Fort Myers Beach (Estero Island), and Marco Island. Decreased counts of wintering Piping Plovers, wintering Snowy Plovers, and estimated Snowy Plover pairs between 2001 and 2006 at Fort DeSoto State Park, Shell Key Preserve, Stump Pass, and Sanibel Island were coincident with sand placement projects in adjacent areas between the two survey periods. Large decreases in regional counts of wintering Piping Plovers and Snowy Plovers between 2001 and 2006 were driven nearly entirely by lower counts at Anclote Key State Park in 2006. Charley Pass, a new inlet in Lee County created during Hurricane Charley in 2004, is now being used by both plover species during the non-breeding season and by nesting Snowy Plovers.

4 Discussion

This report summarizes bird distribution and abundance data from two large-scale survey efforts (the IPPC and FWC's nesting Snowy Plover surveys) that were conducted twice between 2001/2002 and 2006, before and after the major hurricane seasons of 2004/2005. Although the magnitude of coastal engineering activities increased tremendously between the two survey periods, changes in bird distribution and abundance were minor between the two surveys, with some exceptions. However, observed changes in counts of non-breeding birds (from IPPC survey data) and estimated nesting Snowy Plover pair numbers (from FWC surveys) should be interpreted cautiously, due to methodological limitations of both survey efforts listed below. Despite these caveats, there was a strong negative correlation between sand placement projects and plover presence for both nesting Snowy Plovers and non-breeding Piping Plovers and Snowy Plovers. This distributional pattern was observed during both pre-hurricane surveys and post-hurricane surveys. This distributional pattern could use confirmation from more intensive surveys, with multiple visits to each site, that are designed to address issues of detectability and reduce the potential for "false absences" (site visits where birds were not counted when they were actually present), which is high for IPPC counts in particular (MacKenzie et al. 2005).

IPPC counts represent a single visit to each site within a narrow 2-3 week survey window (Ferland and Haig 2002). No attempt is made to control the timing of this visit relative to tide height, which can strongly affect the distribution of shoreline-dependent birds (Sprandel et al. 1997, Rehfish et al. 2003). The lack of replicate counts and lack of control for the timing of counts relative to tide height most likely biases IPPC survey results. The direction and magnitude of this bias is unknown and has never been estimated through double sampling with more intensive survey protocols (Bart and Ernst 2002). The potential for 0 counts to occur when birds were actually present but were not detected is high for any single-visit survey, but it is even more so when major factors that affect presence (e.g., tide height) are not controlled for. For these reasons, IPPC counts are best considered as indices to abundance and site use. Cumulative counts from different sites should not be treated as accurate population estimates, but rather an index to population size that is probably biased low due to areas

of incomplete survey coverage and non-detection of birds that may have been present in the survey area, but were not detected when sites were only visited once. Changes in counts between two IPPC surveys should be interpreted cautiously since it is not known whether changes in counts reflect differences in detectability between the surveys or true changes in numbers.

FWC surveys for nesting Snowy Plovers include multiple site visits within the breeding season when the presence or distribution of pairs is not as strongly driven by tide height as it is during the non-breeding season, since adults are often attending nests and young on the dry beach (Himes et al. 2006). This tends to focus pairs within a more narrow survey area than is the case during non-breeding surveys when plovers may be dispersed across large intertidal foraging areas. However, FWC pair estimates are based on a number of assumptions regarding the behavior of observed birds (Chase and Gore 1989, Lamonte et al. 2006, Himes et al. 2006). These assumptions have not been verified by studies with marked individuals. Similarly, the annual count metric for comparison among years is the maximum number of estimated pairs at each site (see Himes et al. (2006) for a detailed description of how this is determined). This estimate is sensitive to differences in breeding phenology between years. For these reasons, changes in estimated pair numbers for sites, regions, and the entire state between FWC's various Snowy Plover nesting surveys should also be interpreted cautiously.

Given the limitation of these bird survey data, changes in counts of birds between the two survey periods are difficult to interpret at any scale (site, region, or state). However, nearly all of the bird sightings, and thus, variation in counts between the two survey periods, occurred in areas that DID NOT have sand placement projects. If these counts were unbiased estimates of occurrence or abundance, one hypothesis to explain changes in counts might be that birds are responding to hurricane-related alterations of habitat in non-nourished areas. Of course, this would require information regarding changes to habitat between the two survey periods, before and after storms. However, such information is not available at any scale to facilitate such interpretation. Therefore, interpretation of the factors driving variation in counts in the subset of areas that have not received sand placement, where most birds occur, seems inadvisable and would probably be so even if count data were less biased given the absence of pre- and post-storm habitat data. A time series of observations from

more intensive sampling of the habitat and disturbance factors that affect bird abundance in areas where they are present, that takes place concurrently with bird surveys, would be necessary for such interpretations.

Since birds were mostly absent from the same areas before and after the hurricanes (and since the majority of the high-magnitude engineering response to storms occurred in developed areas where birds were not originally present) it seems as if the large-scale engineering response to the 2004/2005 hurricane seasons did not strongly alter the distribution or abundance of plovers in Florida. This is not to say that sand placement does not affect plover distribution, only that the fragmented distribution of plovers along Florida's shorelines, and the negative correlation between plover presence and sand placement projects, was observable prior to the 2004/2005 hurricane season and the subsequent engineering response.

Perhaps it is best to view these two sets of surveys as temporal replicates of index counts that suggest a strong distributional pattern of bird presence in areas without sand placement and bird absence in areas with sand placement. Insufficient data currently exist to address the specific causes of this distributional pattern. However, the pattern is strong enough to necessitate the exploration of a series of a priori hypotheses that may discriminate among potential underlying causes of this negative correlation, based on known or suspected correlates of plover habitat use, which could be tested through intensive data collection at sites with and without sand placement projects. These hypotheses could address the relative importance of habitat or human-use factors in determining plover presence or abundance during either the breeding or non-breeding seasons. These hypotheses need not be mutually exclusive and a large number of biologically plausible hypotheses incorporating various interactions of habitat and human-use factors, at multiple scales, could be tested using model selection and multi-model inference (Burnham and Anderson 2002). Given the difficulty of drawing inferences from index counts, future studies should be designed to provide more robust estimates of either of these two state variables (occupancy or abundance) that incorporate methods to adjust estimates by detection probabilities (MacKenzie et al. 2005).

Most of Florida's barrier island shorelines have been developed for many years, although the magnitude and pace of this development is accelerating in the Panhandle. This has led to widespread shoreline protection

activities in most developed areas. This contrasts strongly with management practices on the large public properties that are interspersed with developed shorelines, which have mostly allowed natural coastal processes to occur. The combination of development and shoreline protection seems to limit the distribution of both non-breeding Piping Plovers and Snowy Plovers in all seasons in Florida. If mitigation or habitat restoration efforts on barrier islands fronting private property are not sufficient to allow plover use of some of these areas, the burden for plover conservation will fall almost entirely on public land managers. Given the large proportion of all plover sightings on public lands in Florida, it is critical that public land management agencies continue to take stewardship responsibility for plovers and the bare ground habitats that they prefer. In many cases this will involve upholding agency policies that support natural resource and wildlife stewardship in the face of increasing pressures to develop public lands to facilitate recreational use by residents and tourists. Projects that increase infrastructure investment on public lands on barrier islands (e.g., campgrounds, day use areas, visitor centers, and their associated roads) will lead to future proposals to protect this investment with the same shoreline protection activities that may have resulted in plover absence on private lands. Any sand placement or hard-structural engineering proposals that may increase recreational use and/or alter the natural function of barrier islands on the limited number of public properties where plovers occur should be subjected to high levels of scrutiny, since these projects could have major impacts to Florida's statewide plover populations.

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1. REPORT DATE (DD-MM-YYYY) September 2009		2. REPORT TYPE Final report		3. DATES COVERED (From - To)	
4. TITLE AND SUBTITLE Distribution and Abundance of Piping Plovers (<i>Charadrius melodus</i>) and Snowy Plovers (<i>Charadrius alexandrinus</i>) on the West Coast of Florida Before and After the 2004/2005 Hurricane Seasons				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Casey A. Lott				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) The American Bird Conservancy The Plains, VA 20198				8. PERFORMING ORGANIZATION REPORT NUMBER ERDC/EL TR-09-13	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Corps of Engineers Washington, DC 20314-1000				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT In 2004 and 2005 several large hurricanes (category 3 or greater) made landfall along Florida's barrier island shorelines. Where shorelines were developed, storms did millions of dollars in structural damage. Where previous shoreline protection had occurred in the form of beach nourishment or dune restoration, much of this sand was removed. On public lands, overwash from storms removed beach and dune vegetation, redistributed sand, created new inlets, and in some cases, caused damage to park roads and facilities. Large federal and state appropriations for post-storm shoreline protection ushered in the busiest period of sand placement in Florida history. Florida's Panhandle and Southwest Gulf Coast host large proportions of continental non-breeding populations for both federally-listed Piping Plovers (<i>Charadrius melodus</i>) and state-threatened Snowy Plovers (<i>Charadrius alexandrinus</i>). These two regions also contain the majority of Snowy Plover pairs nesting along the eastern Gulf of Mexico. This report compares the distribution of plovers and engineering projects before and after the 2004/2005 hurricane seasons. Counts were similar between pre- and post-storm surveys and bird distribution did not change appreciably between the two periods. However, this investigation illustrated a strong negative correlation between sand placement and the presence of both plover species. Future research should clarify if the negative correlation between sand placement and plovers is the result of habitat degradation that can be directly attributed to sand placement, and perhaps mitigated, or the tendency for sand placement projects to occur in areas of high population density where human disturbance may limit the distribution of plovers.					
15. SUBJECT TERMS Beach nourishment Dune restoration Hurricanes Coastal engineering Florida barrier islands Plovers					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES 47	19a. NAME OF RESPONSIBLE PERSON
a. REPORT UNCLASSIFIED	b. ABSTRACT UNCLASSIFIED	c. THIS PAGE UNCLASSIFIED			19b. TELEPHONE NUMBER (include area code)