Supplemental Information for the Snowy Plover

Biological Status Review Report

The following pages contain peer reviews received from selected peer reviewers, comments received during the public comment period, and the draft report that was reviewed before the final report was completed

March 31, 2011

Table of Contents

Peer review #1 from Jim Watkins 3
Peer review #2 from Brad Smith 7
Peer review #3 from Stefani Melvin 9
Peer review #4 from Raya Pruner 11
Letters and emails received during the solicitation of information from the public period of September 17, 2010 through November 1, 2010 15
Email from Dana Hartley 15
Email from Ann Hodgson 174
Copy of the Snowy plover BSR draft report that was sent out for peer review 38

Peer review #1 from Jim Watkins

From: Jim_H_Watkins@fws.gov
To: Imperiled
Cc: Douglass, Nancy
Subject: Florida snowy plover
Date: Friday, January 14, 2011 6:32:14 PM
Attachments: FL listing review 2011.docx

Dr. Haubold:

Please find attached my review and comments on the Florida snowy plover Biological Status Review. Please feel free to contact me if you require clarification or additional detail.

Thank you for the opportunity.
(See attached file: FL listing review 2011.docx)

Jim Watkins
U.S. Fish & Wildlife Service
1655 Heindon Road
Arcata, California 95521

January 14, 2011

Elsa M. Haubold, Ph.D.
Section Leader, Species Conservation Planning
Florida Fish and Wildlife Conservation Commission

Subject: Biological Status Review for the Snowy Plover (*Charadrius alexandrinus*)

Dr. Haubold:
Thank you for the opportunity to review and comment on the State of Florida's listing of the snowy plover (*Charadrius alexandrinus*). I appreciate the background information provided on the listing process and State-specific background data relative to the snowy plover.

General Comments:

1. Using a widely accepted listing process assists managing agencies support their findings. Such is the case with the use of International Union for Conservation of Nature's (IUCN) listing criteria. Use of IUCN's listing criteria also helps the general public understand a process and criteria that are applied more broadly, and puts perspective on State listings relative to international conservation.
2. However, the use of IUCN's process/criteria typically applies to a population of organisms, and may best be applied to endemics. The State of Florida is a geographic, or "political", boundary that does not necessarily correlate to a species', or listable entities', range. This may be the situation with the snowy plover in Florida. Treating snowy plovers in Florida as a separate entity may not be appropriate unless there is evidence that they are biologically distinct from snowy plovers in adjacent States. The amount of interstate and international movements may help determine if the IUCN criteria are being applied appropriately. Genetic work indicates that there is significant interchange between snowy plovers in Florida and elsewhere in North America and Caribbean (Gorman and Haig 2002; Funk, et al. 2007; Kupper, et al. 2009). At question is the distinctness of the Florida snowy plover population. I do not believe that question can be addressed with the information provided in your review package. In addition, I am not aware of literature that addresses snowy plover movements in the southeastern United States. Consequently, I encourage researchers to study snowy plover movements to determine the amount and frequency of interchange with nearby States and Nations. These data can be used to determine the "distinctness" of the Florida snowy plover population.

Specific Comments:

1. Criterion (B)b(iii) addresses habitat degradation; however, in the snowy plover Biological Status Review (BSR), habitat loss is discussed without specifics to habitat degradation. None-native vegetation, dune and shoreline stabilization, and human-related activities all degrade habitat. I suggest addressing this issue in greater detail.
2. Data regarding snowy plover distribution and basic reproductive success are up to date. The figures relating to the Pacific Coast snowy plover population's reproductive measures may or may not be applicable to the Florida situation. The Pacific Coast population requires 1.0 chicks to be fledged per adult male annually to maintain a stable

population, and 1.2 chicks per adult male fledged to moderately grow and recover the population (Nur, et al. 1999). The Population Viability Analysis (PVA) for the Pacific Coast population is somewhat outdated. We now have better data regarding adult and juvenile survivorship, and dispersal. Consequently, the figures used to sustain and increase a population may need adjustment. Researchers should consider similar studies to model the Florida population. There needs to be data regarding the level of polyandry in the Florida snowy plovers, and the composition of the population – specifically; the ratio of non-breeding males in the population, and the frequency at which females breed within a season. The current State-wide surveys (i.e. counting pairs) do not address these data.

3. Snowy plovers generally exhibit high site fidelity (Stenzel, et al. 1994). If true in Florida, this fact could assist in determining the "distinctness" of the Florida population, and assist in establishing the population as a separate, listable entity.
4. Snowy plover distribution and management appears to be restricted to public lands. If there is data supporting rationale why this distribution occurs, I think it should be included in the BSR. Private lands might be important to recovery, and require special management and regulation.
5. There is no discussion of "coastal squeeze" that may occur as a result of a rise in sea level due to climate change. The long-term loss of habitat should be considered in the evaluation of threats to a coastal-nesting shorebird, such as the snowy plover.

Conclusion:

I believe the use of the IUCN criteria is a good decision as it is a widely accepted model. It works well with endemics, but may not be suitable for a wider-ranging species, such as the snowy plover, that may have movements beyond the political boundaries of the State of Florida. In general, the data presented are current, and represent the best available. Similarly, reference is made to the Pacific Coast population that is similar to the Florida situation in many ways. Use of the Pacific Coast data and models (PVA) is appropriate, but should be used with caution as they are somewhat out dated. Portions of the species' threat evaluation should be bolstered to include coastal squeeze and climate change, and habitat degradation.

I concur with staff findings that the snowy plover should be listed as a Threatened species due to its limited geographic range, population declines, limited population size, and vulnerability to stochastic events. However, additional work is needed, in my opinion, to determine if the Florida snowy plover is distinct, or is a smaller portion of a larger population that includes individuals outside of the State of Florida.

If you have questions regarding my review or comments, please feel free to contact me at (707) 825-5124.

Jim Watkins
Recovery Coordinator - Pacific Coast western snowy plover
U.S. Fish and Wildlife Service
1655 Heindon Road
Arcata, CA 95521
Jim_h_watkins@fws.gov

Literature Reference

Funk, C.W., T.D. Mullens, and S.M. Haig. 2007. Conservation genetics of snowy plovers (*Charadrius alexandrinus*) in the Western Hemisphere: population genetic structure and delineation of subspecies. USGS Forest and Rangeland Ecosystem Science Center, Corvallis, OR

Gorman LR (2000) Population differentiation among snowy plovers (*Charadrius alexandrinus*) in North America. Masters thesis, Oregon State University, Corvallis, OR

Küpper, C., J. Augustin, A. Kosztolányi, J. Figuerola, T. Burke, and T. Székely. 2009. Kentish versus Snowy Plover: Phenotypic and genetic analyses of *Charadrius alexandrinus* reveal divergence of Eurasian and American subspecies. Auk 126:839−852.

Nur, N., G.W. Page, L.E. Stenzel. 1999. Population Viability Analysis for Pacific Coast Western Snowy Plovers. Point Reyes Bird Observatory, Stinson Beach, CA

Peer review #2 from Brad Smith

From: Bradley Smith
To: Imperiled
Subject: SNPL BSR comments
Date: Wednesday, January 12, 2011 9:09:42 PM
Attachments: SNPL_Bio_Stat_Review_BWS.doc

Please find attached my comments on the BSR for the SNPL. Please let me know if there are any questions or clarifications needed.

Best of luck in your efforts,

Brad

The data presented here in the BSR appear to be complete and well presented. Given these data the conclusion to list as threatened is justified under the IUCN Red List Criteria.

I will add some additional thoughts/comments that I think further support the case for listing as threatened.

It should be emphasized that, as noted in the BSR, the distribution of nesting by the species on only a few beaches in the Panhandle make it particularly vulnerable to stochastic events. Also while such a stochastic event in the Southwest would not be as devastating to the overall State population (all of these sites contain fewer than 5 pairs (Himes et al 2006), the years 2002-2005 on Sanibel being the only exception (Brad Smith 2003-2010), and most consisting of fewer than three pairs (Himes et al 2006)) most of these sites appear to be sinks and overall the Southwest subpopulation is in decline.

The Southwest subpopulation is also facing a very real new threat from invasive Nile monitor lizards. These lizards are established and spreading from the Cape Coral area since 1990 (Campbell, T. [S.] 2003. Species profile: Nile monitors (*Varanus niloticus*) in Florida. Iguana 10(4):119-120.). According to the USGS (http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=1085), sightings have since come from areas all along the Lee County coast including Sanibel Island, Gasperella, and Cayo Costa. On Sanibel sightings have been confirmed several times in the last three years along with suspected tracks seen on the beach (pers obs). These predators are spreading rapidly in the heart of the Southwest subpopulation breeding area (Cayo Costa and Sanibel Island are the two largest single breeding areas in the SW (Himes et al 2006)) and pose a significant future threat to all beach nesting birds.

Ghost crabs were not mentioned as predators despite the observations of Pruner and Johnson (2010) Our experience at Cayo Costa (very high densities of ghost crabs and little to no survival of chicks) as well as numerous physical foot injuries of adults observed on Sanibel suggests they can play a major role as a predator of not only eggs but chicks and possibly seriously limit

productivity. This is particularly critical to consider for the Southwest population since Cayo Costa is one of the largest single nesting locations with ~5 pairs each year and has fledged only two chicks out of 28 hatched in three years of observation (a serious sink for such a small population)(Brad Smith 2010). The implications here also are that even on a pristine, relatively undisturbed site such as Cayo Costa, the species faces serious threats despite a lack of human disturbance.

It should also be pointed out that; a bird banded in the Panhandle by Raya Pruner was cited in the Southwest in 2010 (these records should be held at either SCCF or with Raya Pruner). This suggests that the Southwest subpopulation may be supported by dispersal from the more productive Panhandle.

One last comment: Although I agree that human disturbance can have serious negative consequences on breeding success of Snowy Plovers and should be treated as one of the most serious threats to the species if not the greatest threat, I caution against a blanket assumption that human beach use and successful Snowy Plover nesting are mutually exclusive. Data from Sanibel, particularly years 2006-2010 when nearly all nesting on the Island was in high beach traffic areas, suggest that at the very least human disturbance can be mitigated through proper management. During those five seasons, the ratio of fledged chicks to pairs needed to sustain the population (cited in the BSR as 1.0 fledge/pair) was exceeded three of the five seasons (Brad Smith 2010 on SharePoint site). Cara Faillace (2010) demonstrated one mechanism whereby the birds themselves can mitigate for the disturbance through greater tolerance of human presence both near a nest and around a brood, though the research also showed a decrease in forage activity with increased human presence. A better understanding of these dynamics is critical to any efforts to recover the species since pressures for development and recreational use of beaches will only increase going forward.

Peer review #3 from Stefani Melvin

From: Stefani Melvin
To: Imperiled
Subject: review of Snowy Plover BSR
Date: Monday, January 10, 2011 9:55:47 AM
Attachments: Independent Review by Stefani Melvin.docx

Thank you for the opportunity to review the BSR for snowy plover. Attached are my comments.

Stefani Melvin
Ecosystem Staff Officer
Salmon-Challis National Forest
1206 S. Challis St.
Salmon, ID 83467

Independent Review by Stefani Melvin, U.S. Forest Service of
Biological Status Review for the Snowy Plover (*Charadrius alexandrinus*)

I have reviewed the report and the documentation supporting the recommendation to retain the threatened status of the Snowy Plover in Florida. The information used to make the determination is recent and complete. The authors have done a very good job of summarizing existing information from the literature and the statewide survey efforts. The state of Florida has done a very good job of thoroughly and consistently surveying breeding Snowy Plovers for a number of years. Even though the survey methods differed between past surveys, the more recent surveys have used similar methodology and if continued, will provide adequate information to determine actual population size. Given the protracted distribution and the potential for stochastic events such as hurricanes, I believe this population is very vulnerable. In addition, the constant struggle between shoreline development and the needs of wildlife in Florida only highlights this vulnerability.

The majority of Snowy Plovers in Florida nest on public lands because there is little other high quality habitat available. With such a large proportion of the population restricted to only a few nesting sites, the potential for severe and sudden loss is high. A very recent and obvious example is the Deepwater Horizon Oil Spill which could easily have eliminated reproduction for the year as well as caused the death of a large number of adults. Maintaining the current population status and allowing for recruitment into the breeding population requires a huge effort, coordinated across federal and state agencies, universities, and volunteers. This population is currently in a stable condition due to those efforts to protect habitat and birds during the nesting season. Without that investment, it is doubtful that the breeding numbers would have remained relatively stable over the past 10 years. Even with this focused attention, the data suggests that productivity is decreasing. The effect of decreased productivity takes years to show up in populations of long-lived adults. The Florida population is in danger of a sudden decline due to the low survival of chicks and the lost opportunity for their recruitment into the population to offset adult mortality.

Retaining the threatened status of this species in Florida is prudent and justifiable. As a threatened species, it is highlighted for focused conservation efforts which are necessary for the persistence of this species in the state. Additional efforts will be required to address increasing human disturbance and its affect on productivity in the future.

Peer review #4 from Raya Pruner

From: raya.pruner@gmail.com on behalf of Raya Pruner
To: Imperiled
Subject: Re: Deadline reminder for peer reviews of BSR reports
Date: Sunday, January 16, 2011 11:52:42 AM
Attachments: Pruner BSR SNPL Review.docx
Pruner BSR AMOY Review.docx

Elsa,

Final copies of independent reviews!!!!!!!!!!!!!!

Sorry to keep sending edits. But, I wanted to ensure these were as complete as possible and I thought of a few more comments that I wanted to add. Also, sorry for the tardiness on the American Oystercatcher review. As I mention previously, I had assumed these 2 reviews were due on the same day. The 18th of January is when the Snowy plover review is due. I do hope you accept both of these reviews!

Cheers!!!

Raya

After conducting an independent literature review, the biological information presented in this review is complete and accurate given the available data on American Oystercatchers in Florida and throughout their range. Additionally, it is evident that the reviewers' interpretations of the data are accurate and justified. Consequently, it is apparent that American Oystercatchers meet the status of *Threatened* by FWC guidelines and *Vulnerable* under IUCN regional guidelines by meeting three requirements under both guidelines: 1) small geographic range, 2) low population size and trend, and 3) population very small or restricted. See below for an independent review of the available data on American Oystercatchers as it pertains to the listing guidelines.

A) Population Size Reduction: Data does not support. Agree with review panel.

B) Geographic Range: Meets Requirements (see below)

B1) Geographic range, the extent of occurrence is <20,000km^2 (7,722mi^2): Because American Oystercatchers are restricted to coastal habitats for foraging and breeding (Nol and Humphrey 1994), Fernald and Purdum (1992) estimated the Oystercatchers range to be 2,276mi^2. Findings of the review panel are in accordance with available data and interpretations are straight forward based on the availability of coastal habitat along both the Atlantic and Gulf coasts, including unsuitable habitat.

OR

B2) Geographic range, area of 0ccupancy <2,000km^2: American Oystercatchers are restricted to the beach/surf zone and coastal strand habitats, as defined by the Florida's Wildlife Legacy Initiative (FWLI) (FWC 2005). Based on FWLI the combined about of these 2 habitat types along Florida's coast line is approximately 73.7 mi^2. However, this value represents all potential habitat in the state. The actual area of occupancy is much less. In addition, similar results can be obtained by matching nesting locations from Burney 2009 and beach miles by county from DEP 1993 (DP FL Shoreline Length) with occurrence of nesting, the estimated area of occurrence is in agreement with that listed by the review panel.
AND at least 2 of the following:

B2a) Geographic range, severely fragmented or exist in <10 locations: Based on data from the state-wide beach nesting bird database, Burney (2009) identified 7 disjunct aggregations of nesting. Douglass (2004) observed similar aggregations, documenting 6 such aggregations. Findings of the review panel are in agreement with the available data. Based on mapped nesting distribution (Burney 2009), the nesting aggregations are apparent by areas of continuous nesting separated by coastal habitat with lack of nesting. Although nesting locations throughout the state can be interpreted in many ways, the findings of the review panel are justified given the reality of impact to each of these nesting regions in entirety. For example, the likelihood of one hurricane destroying an entire nesting aggregation during a breeding season is high.

B2b) Continuing decline, observed, inferred, or projected: Review panel found this area to not fit the data stating only suspected declines in Florida (Douglass and Clayton 2004, Hodgson et al. 2008, Brush 2010, Shulte et al. 2008). However, it is my interpretation that that data does support this in estimation of decline in quality of habitat due to increased recreational pressures

(American Bird Conservancy 2007 Threatened Habitats) and in the observed/inferred/projected number of mature individuals through productivity data that are below the rates required for stability (e.g., Douglass and Clayton 2004, Zimmerman 2009, Brush 2010, Pruner 2010). For example, Pruner (2010) documented a 0.0% productivity rates for American Oystercatcher breeding at coastal state parks in the panhandle during the past 5 years. These low rates are due to both incompatible recreation pressures and continued depredation of nests by coyotes. These rates are far below those required for stability. As a result, Pruner (2010) projects the number of mature individuals in the panhandle to decline based on the presented productivity rates. Similarly, Forys (2010) ran simulations on the population of mature indviduals for American Oystercatchers (values obtained from Nols and Humphries 1994) and concluded that current ground and rooftop productivities are not sufficient to produce a stable population . In fact, she stated a required fledge rates of 1 per breeding pair for obtained population stability. Although productivty rates are variable from year to year and site to site, this level of productivity was not observed in any of the available literature.

B2c) Extreme fluctuations: no data to support.

C) <u>Population Size and Structure:</u> Meets Requirements

Population size estimate to number < 10,000 mature individuals: population estimated to be < 500 breeding adults. The most comprehensive state-wide assessment documented 391 breeding pairs (782 individuals) (Douglass and Clayton 2004). However, Douglass and Clayton (2004) only confirmed breeding for 213 pairs (426 individuals). Based on these estimates, the breeding population is likely between 426-782 mature breeding individuals. The conclusions of the review panel are reasonable given the available data sets estimating the adult American Oystercatcher population in Florida.

AND EITHER

C1) estimated continuing decline of at least 10%: Review panel could not determine from current data. Because of data gaps and the long-lived nature of the American Oystercatcher, it is evident that the available data does not support this trend.

C2) A continuing decline in number of mature individuals: see B2b above. There is ample data on American Oystercatcher current productivity rates, and continuous decline in mature individuals is projected. The interpretation of the review panel is reasonable given the available data for American Oystercatchers in Florida.

AND AT LEAST 1 OF THE FOLLOWING

C2ai) No subpopulation estimated to contain more than 1000 mature individuals: Because there is movement during at least 1 part of the year between breeding locations, the American Oystercatcher breeding population in Florida is part of one subpopulation. For example, American Oystercatchers from the panhandle move to the southwest region of Florida during the winter months (pers. Obs). Therefore, based on the range of estimates documented by Douglass

and Clayton (2004) of 426-782 mature breeding individuals American Oystercatchers in Florida, the findings of the review panel are in agreement with the available data.

EITHER

C2aii) all mature individuals are in one subpopulation: Douglass and Clayton (2004) reported the Florida American Oystercatcher population to be part of 1 subpopulation, with movement between regions during at least 1 part of the year. Due this movement of individuals, all mature individuals are within 1 breeding subpopulation. The interpretation of the review panel is justified given the available data.

OR

C2b) Extreme fluctuations in number of mature individuals: based on the available data fluctuations have not been observed, likely due the long lived nature of American Oystercatchers. However, the review panels interpretations are accurate given the available data. 'No data to support'.

D) <u>Populations very small or restricted:</u> Meets requirements

D1) Population estimated to fewer than 1,000 mature individuals: Based on the range of estimates documented by Douglass and Clayton (2004) of 426-782 mature breeding individuals American Oystercatchers in Florida, the findings of the review panel are in agreement with the available data.

OR

D2) Population with very restricted area of occurrence (< 20km^2): Based on findings under B2, American Oystercatchers are restricted to an area <2000km, but > than 20km. For example, the nesting occurrence at only one breeding location, the panhandle for example, is greater than this value. Interpretations of the review panel are reasonable and straightforward.

E) Quantitative Analysis: Insufficient data on American Oystercatchers to do quantitative modeling.

Letters and emails received during the solicitation of information from the public period of September 17, 2010 through November 1, 2010

Email from Dana Hartley

From: Dana_Hartley@fws.gov
To: Imperiled; Douglass, Nancy
Cc: Paula_Halupa@fws.gov; Marilyn_Knight@fws.gov
Subject: snowy plover
Date: Wednesday, November 03, 2010 11:56:51 AM
Attachments: Lott et al. 09 shorebird habitat associations FL.pdf
Lott et al. 09 plovers and engineering in FL.pdf

Dear Dr. Douglass (and whoever is checking the "Imperiled" email): Marilyn Knight of my staff reviewed our records and discovered the attached literature for snowy plovers. These did not appear to be on the FWC's sharepoint site. We are hopeful that these will arrive in time to be useful in your review.

Thanks,
Dana

Dana Hartley
Endangered Species Supervisor
U.S. Fish & Wildlife Service
South Florida Ecological Services Office
1339 20th Street
Vero Beach, FL 32960

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
September 2009	Final report	

4. TITLE AND SUBTITLE

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

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 (*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.

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	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER *(include area code)*
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		47	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. 239.18

ERDC/EL TR-09-13

Environmental Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

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

Casey A. Lott

September 2009

Dredging Operations and Environmental Research Program

ERDC/EL TR-09-13
September 2009

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

Casey A. Lott

The American Bird Conservancy
The Plains, VA 20198

Final report

Approved for public release; distribution is unlimited.

Prepared for U.S. Army Corps of Engineers
Washington, DC 20314-1000

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.

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

Engineering projects from 1993-2000 9

Engineering projects from 1998-2005 10

Wintering Snowy Plovers 17

Nesting Snowy Plovers 20

Panhandle summary 23

Southwest Florida engineering project and bird survey summaries 24

Engineering projects from 1993-2000 24

Engineering projects from 1998-2005 27

Wintering Piping Plovers 27

Nesting Snowy Plovers 29

Southwest Gulf Coast Summary 29

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

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 fo 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 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	

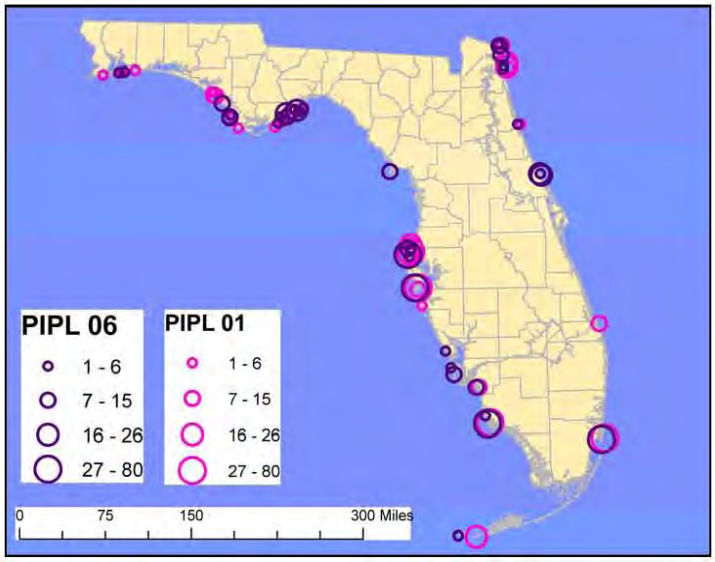


Figure 1. IPPC counts for wintering Piping Plovers in Florida, 2001 and 2006. Symbols from 2001 have been slightly displaced so that counts at the same site can be seen for both surveys.

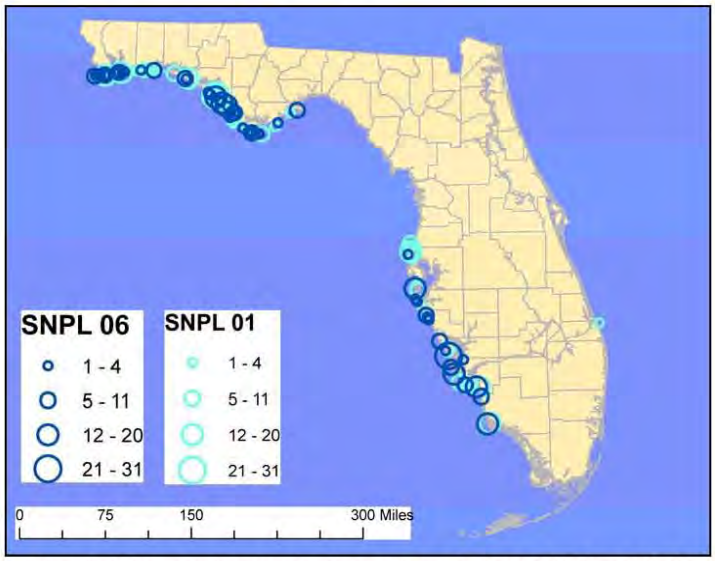


Figure 2. IPPC counts for wintering Snowy Plovers in Florida, 2001 and 2006. Symbols from 2001 have been slightly displaced so that counts at the same site can be seen for both surveys.

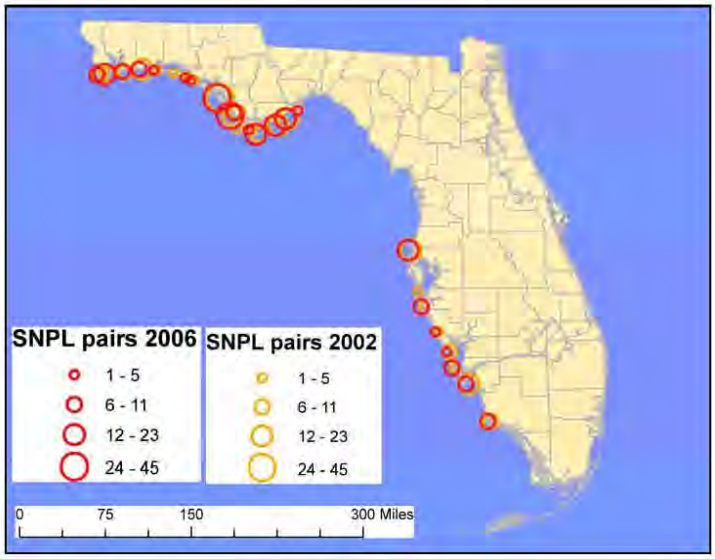


Figure 3. FWC Snowy Plover breeding pair estimates for Florida, 2002 and 2006. Symbols from 2002 have been slightly displaced so that counts at the same site can be seen for both surveys.

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.

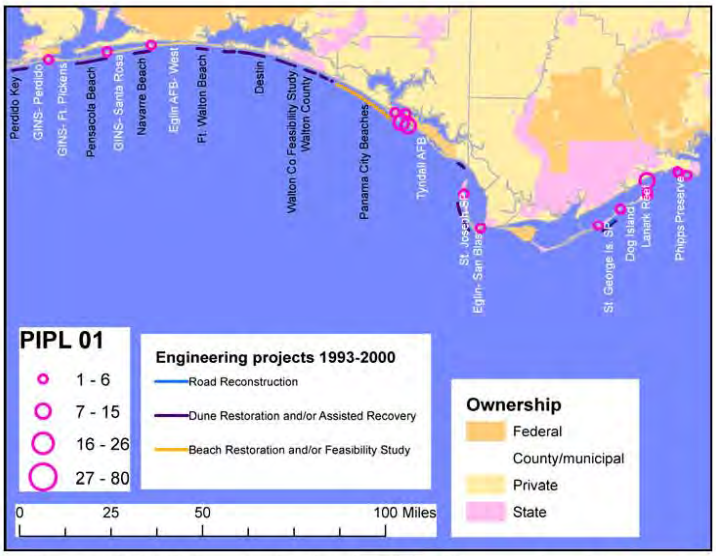


Figure 4. 2001 IPPC counts for wintering Piping Plovers and sand placement projects from 1993 to 2000 in the Florida Panhandle.

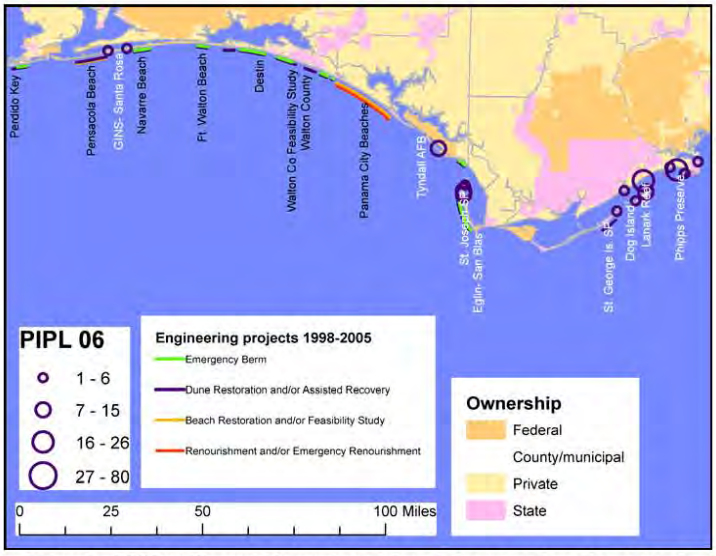


Figure 5. 2006 IPPC counts for wintering Piping Plovers and sand placement projects from 1998 to 2005 in the Florida Panhandle.

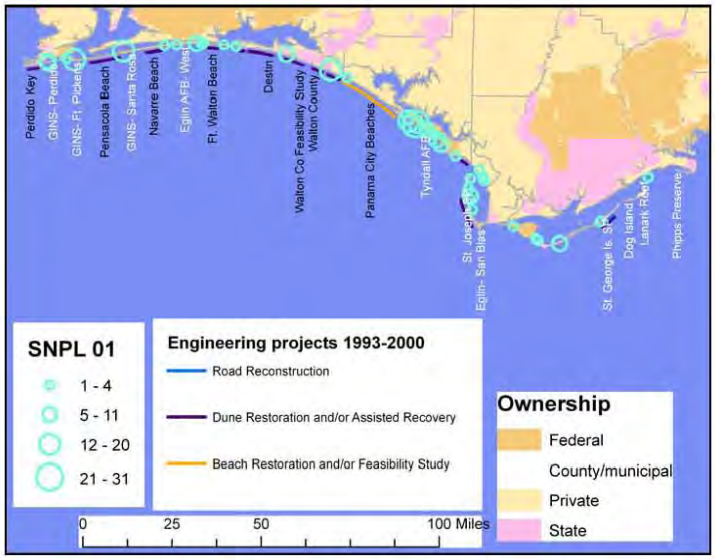


Figure 6. 2001 IPPC counts for wintering Snowy Plovers and sand placement projects from 1993 to 2000 in the Florida Panhandle.

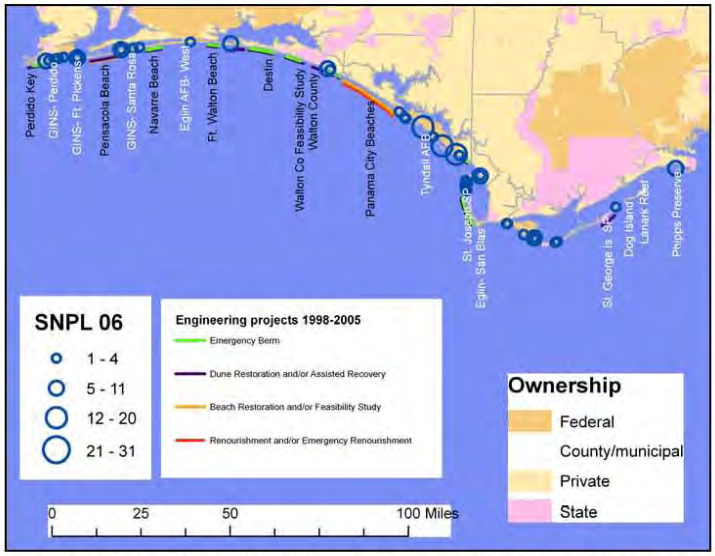


Figure 7. 2006 IPPC counts for wintering Snowy Plovers and sand placement projects from 1998 to 2005 in the Florida Panhandle.

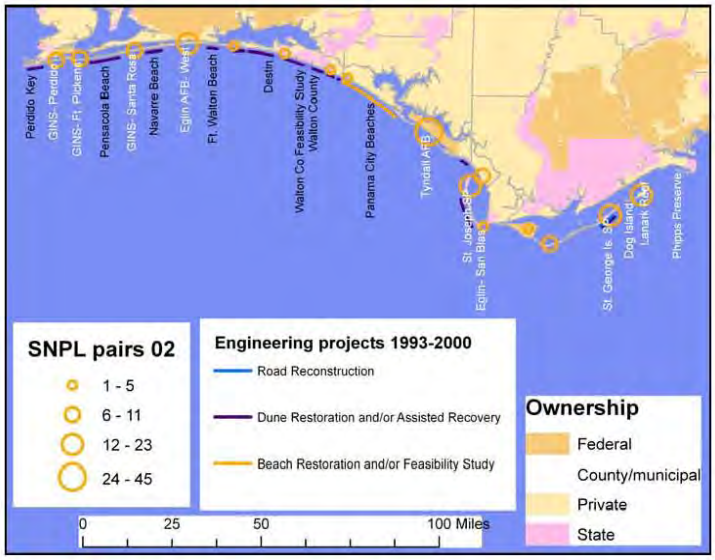


Figure 8. 2002 FWC Snowy Plover breeding pair estimates and sand placement projects from 1993 to 2000 in the Florida Panhandle.

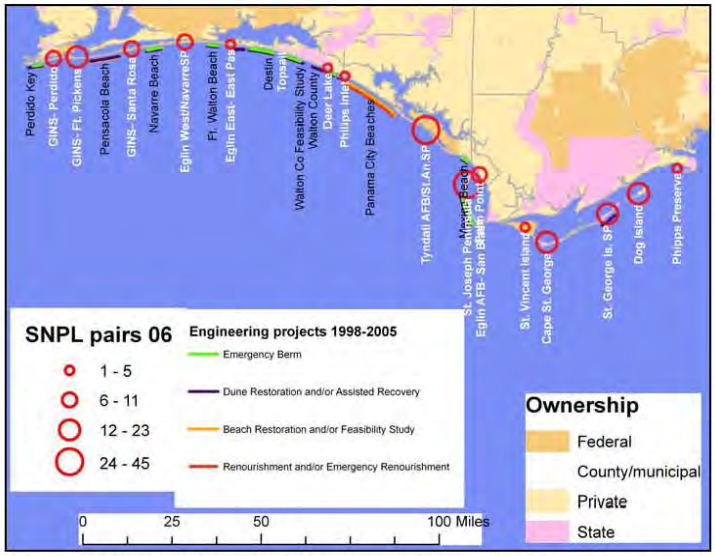


Figure 9. 2006 FWC Snowy Plover breeding pair estimates and sand placement projects from 1998 to 2005 in the Florida Panhandle.

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).

	Piping Plover 2006			Piping Plover 2001		
Location	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%**	
Private	**64**	**15.0%**	**57.7%**	**29**	**6.7%**	**44.6%**
TNC Phipps Preserve	23			11		
Lanark Reef	22			15		
TNC Dog Island	14			3		
Turkey Point	4			0		
Carabelle Beach	1			0		
DEP- State Parks	**34**	**8.0%**	**30.6%**	**9**	**2.1%**	**13.8%**
St. Joseph Peninsula State Park	26			2		
St. George Island State Park	4			7		
Bald Point State Park	4			0		
DOD	**8**	**1.9%**	**7.2%**	**22**	**5.1%**	**33.8%**
Tyndall Air Force Base	8			19		
Eglin Air Force Base	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%**
Gulf Islands National Seashore	5			5		
Big Bend Gulf Coast	**7**	**1.6%**		**0**	**0.0%**	
FWS	**7**	**1.6%**	**100.0%**	**0**	**0.0%**	**0.0%**
Cedar Keys National Wildlife Refuge	7			0		
Southwest Gulf Coast	**163**	**38.3%**		**240**	**55.3%**	
DEP- State Parks	**55**	**12.9%**	**33.7%**	**139**	**32.0%**	**57.9%**
Honeymoon Island State Park	38			19		
Anclote Key Preserve State Park	13			119		
Don Pedro Island State Park	3			0		
Cayo Costa State Park	1			0		
Caladesi Island State Park	0			1		
Collier County	**49**	**11.5%**	**30.1%**	**41**	**9.4%**	**17.1%**
Tigertail Beach County Park	49			41		
DEP- Coastal and Aquatic Managed Areas	**35**	**8.2%**	**21.5%**	**41**	**9.4%**	**17.1%**
Shell Key Preserve	34			41		
Rookery Bay National Estuarine Research Reserve	1			0		
Unknown	**10**	**2.3%**	**6.1%**	**0**	**0.0%**	**0.0%**
Charley Pass	10			0		
DEP- Division of State Lands	**10**	**2.3%**	**6.1%**	**9**	**2.1%**	**3.8%**
Little Estero Lagoon	10			9		
Pinellas County	**4**	**0.9%**	**2.5%**	**9**	**2.1%**	**3.8%**
Howard County Park	4			0		
Fort Desoto Park	0			9		
Private	**0**	**0.0%**	**0.0%**	**1**	**0.2%**	**0.4%**
Longboat Key ?	0			1		
Northeast Atlantic Coast	**101**	**23.7%**		**62**	**14.3%**	
DEP- State Parks	**36**	**8.5%**	**35.6%**	**53**	**12.2%**	**85.5%**
Fort Clinch State Park	31			9		
Little Talbot Island State Park	5			44		
Private	**32**	**7.5%**	**31.7%**	**0**	**0.0%**	**0.0%**
South of Ponce de Leon Inlet	17			0		
North Nassau Sound ?	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%***
Lighthouse Point Park	25			0		
Smyrna Dunes Park	1			0		
City of Jacksonville	***6***	***1.4%***	***5.9%***	***8***	***1.8%***	***12.9%***
Hugenot Memorial Park	6			8		
DEP- Coastal and Aquatic Managed Areas	***1***	***0.2%***	***1.0%***	***0***	***0.0%***	***0.0%***
Guana Tolomato Matanzas National Estuarine	1			0		
NPS	***0***	***0.0%***	***0.0%***	***1***	***0.2%***	***1.6%***
Fort Matanzas National Monument	0			1		
Central Atlantic Coast	**0**	**0.0%**		**12**	**2.8%**	
DEP- State Parks	***0***	***0.0%***	***0.0%***	***12***	***2.8%***	***100.0%***
St. Lucie Inlet Preserve State Park	0			12		
Florida Keys	**44**	**10.3%**		**55**	**12.7%**	
Miami-Dade County	***38***	***8.9%***	***86.4%***	***31***	***7.1%***	***56.4%***
Crandon Park	38			31		
FWS	***6***	***1.4%***	***13.6%***	***24***	***5.5%***	***43.6%***
Key West National Wildlife Refuge	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).

	Snowy Plover 2006			Snowy Plover 2001		
Location	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%***
Tyndall Air Force Base	56			81		
Eglin Air Force Base	11			20		
NPS	***39***	***12.5%***	***22.3%***	***41***	***12.6%***	***18.0%***
Gulf Islands National Seashore	39			41		
DEP- State Parks	***31***	***9.9%***	***17.7%***	***55***	***16.9%***	***24.1%***
St. Joseph Peninsula State Park	14			19		
Deer Lake State Park	12			14		
St. Andrews State Park	3			0		
St. George Island State Park	2			2		
Big Lagoon State Park	0			7		
Navarre Beach State Park	0			1		
Topsail Hill Preserve State Park	0			9		
Camp Helen State Park	0			3		
Private	***15***	***4.8%***	***8.6%***	***15***	***4.6%***	***6.6%***
St. Joe Company	8			13		
TNC Phipps Preserve	7			0		
Lanark Reef	0			2		
DEP- Coastal and Aquatic Managed Areas	***14***	***4.5%***	***8.0%***	***12***	***3.7%***	***5.3%***
Cape St. George State Reserve	14			12		
FWS	***9***	***2.9%***	***5.1%***	***4***	***1.2%***	***1.8%***
St. Vincent National Wildlife Refuge	9			4		
Southwest Gulf Coast	**137**	**43.9%**		**103**	**31.6%**	
Private	***46***	***14.7%***	***33.6%***	***19***	***5.8%***	***18.4%***
Gasparilla Island ?	24			0		
Sanibel Captiva Conservation Foundation	8			10		
Anna Maria Island ?	5			0		
Manasota Key ?	5			0		
Siesta Key ?	4			0		
Longboat Key ?	0			2		
South of Stump Pass Beach State Park	0			7		
Collier County	***20***	***6.4%***	***14.6%***	***17***	***5.2%***	***16.5%***
Tigertail Beach County Park	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%***
Cayo Costa State Park	6			0		
Delnor-Wiggins Pass State Park	5			0		
Charlotte Harbor Preserve State Park	4			0		
Honeymoon Island State Park	2			7		
Don Pedro Island State Park	2			0		
Anclote Key Preserve State Park	0			24		
Caladesi Island State Park	0			4		
DEP- Division of State Lands	***16***	***5.1%***	***11.7%***	***15***	***4.6%***	***14.6%***
Little Estero Lagoon	16			15		
Unknown	***14***	***4.5%***	***10.2%***	***0***	***0.0%***	***0.0%***
Charley Pass	14			0		
DEP- Coastal and Aquatic Managed Areas	***13***	***4.2%***	***9.5%***	***5***	***1.5%***	***4.9%***
Shell Key Preserve	13			5		
Sarasota County	***9***	***2.9%***	***6.6%***	***0***	***0.0%***	***0.0%***
North Lido Public Beach	7			0		
South Lido County Park	2			0		
City of Sanibel	***0***	***0.0%***	***0.0%***	***7***	***2.1%***	***6.8%***
Bowman's Beach Regional Park	0			7		
Pinellas County	***0***	***0.0%***	***0.0%***	***5***	***1.5%***	***4.9%***
Fort Desoto Park	0			5		
Central Atlantic Coast	0	**0.0%**		1	**0.3%**	
DEP- State Parks	***0***	***0.0%***	***0.0%***	***1***	***0.3%***	***100.0%***
St. Lucie Inlet Preserve State Park	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).

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

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

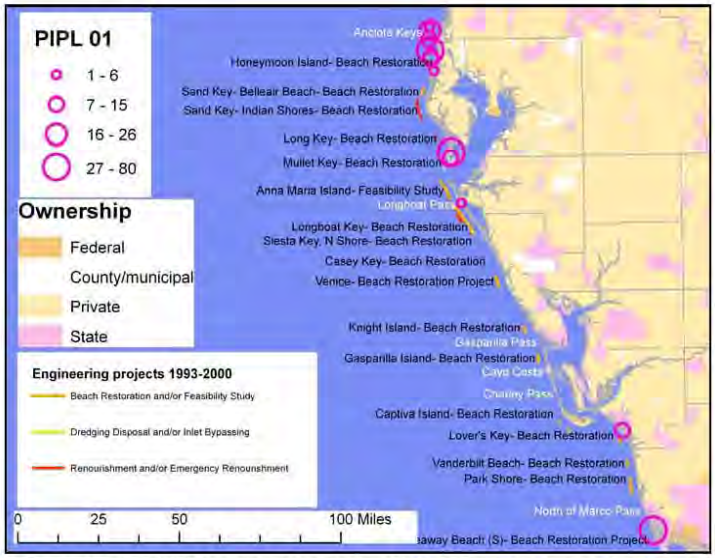


Figure 10. 2001 IPPC counts for wintering Piping Plovers and sand placement projects from 1993 to 2000 in Southwest Florida.

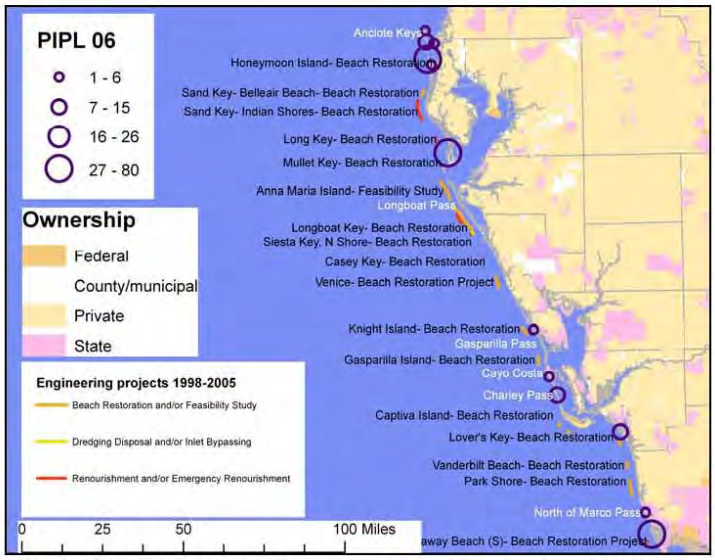


Figure 11. 2006 IPPC counts for wintering Piping Plovers and sand placement projects from 1998 to 2005 in Southwest Florida.

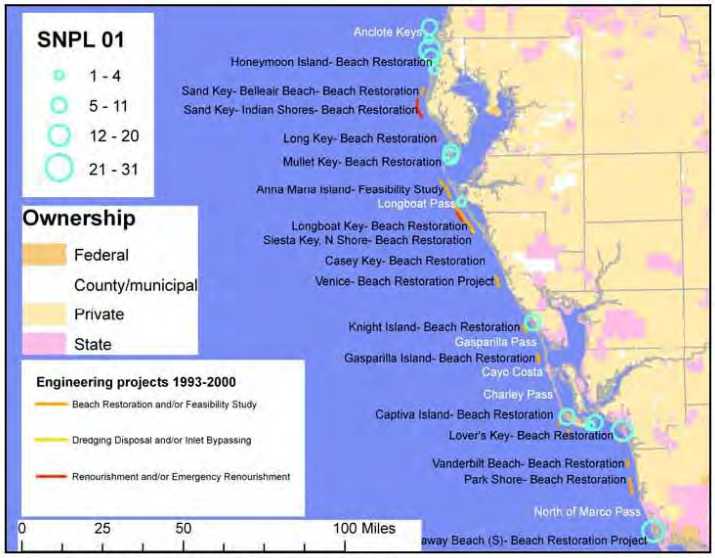


Figure 12. 2001 IPPC counts for wintering Snowy Plovers and sand placement projects from 1993 to 2000 in Southwest Florida.

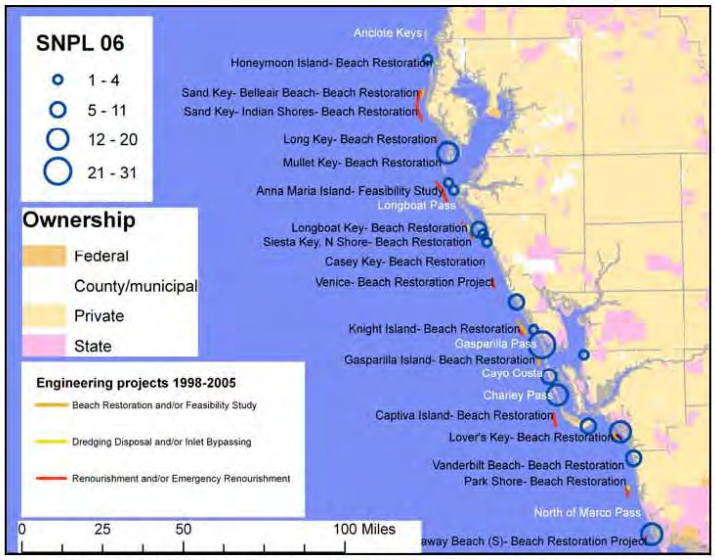


Figure 13. 2006 IPPC counts for wintering Snowy Plovers and sand placement projects from 1998 to 2005 in Southwest Florida.

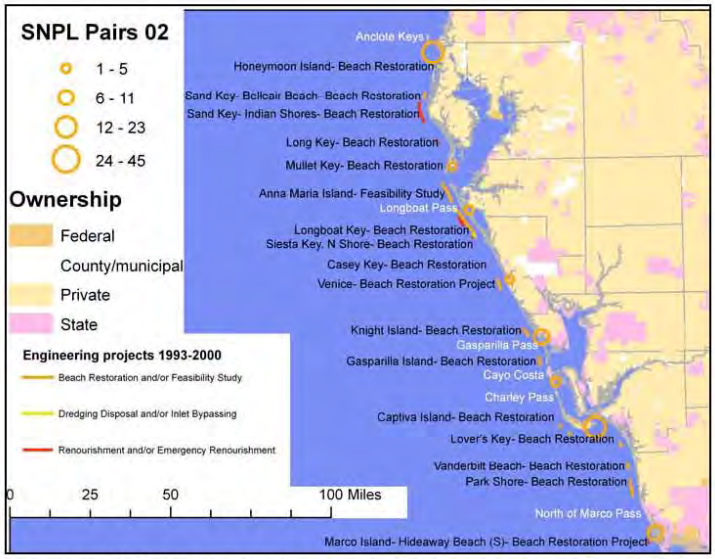


Figure 14. 2002 FWC Snowy Plover breeding pair estimates and sand placement projects from 1993 to 2000 in Southwest Florida.

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, Rehfisch 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 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.

References

Bart, J., and S. L. Ernst. 2002 Double sampling to estimate density and population trends in birds. *AUK* 119:36-45.

Brown, S., C. Hickey, B. Harrington, and R. Gill. 2001. *United States Shorebird Conservation Plan, 2nd edition.* Manomet Center for Conservation Sciences.

Burnham, K. P., and D. R. Anderson. 2002. *Model selection and multimodel inference: A practical information-theoretic approach.* 2nd ed. New York: Springer-Verlag.

Chase, C.A., III, and J.A. Gore. 1989. *Snowy Plover breeding distribution.* Tallahassee, Fl: Florida Game and Fresh Water Fish Commission.

Douglass, N.J. 2006. *Survey of breeding American Oystercatcher (Haematopus palliatus) populations in Florida.* 2002 study final report. Tallahassee, Fl: Florida Fish and Wildlife Conservation Commission.

Drake, K.R., J.E. Thompson, K.L. Drake, and C. Zonick. 2001. Movements, habitat use, and survival of non-breeding Piping Plovers. *Condor* 103: 259-267.

Ferland, C.L., and S.M. Haig. 2002. 2001 *International Piping Plover Census.* Corvallis, OR: U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center.

Florida Department of Environmental Protection. 2004. *2004 Hurricane Recovery Plan for Florida's Beach and Dune System.*

Florida Department of Environmental Protection. 2005. *Hurricane Dennis: Beach and dune erosion and structural damage assessment and post-storm recovery recommendations for the Panhandle coast of Florida.*

Florida Department of Environmental Protection. 2007. *Strategic beach management plan.* Document regularly revised at: http://www.dep.state.fl.us/beaches/publications/gen-pub.htm#Strategic_Management_Plan

Godfrey, P.J., and M.M. Godfrey. 1976. *Barrier Island ecology of Cape Lookout National Seashore and vicinity, North Carolina.* National Park Service Scientific Monograph Series, Number 9.

Gore, J. A., J. A. Hovis, G. L. Sprandel, and N. J. Douglass. 2007. *Distribution and abundance of breeding seabirds along the coast of Florida, 1998 – 2000.* Final Performance Report. Tallahassee, FL: Florida Fish and Wildlife Conservation Commission.

Himes, J. G., N. J. Douglass, R. A. Pruner, A. M. Croft, and E. M. Seckinger. 2006. *Status and distribution of the Snowy Plover in Florida.* 2006 study final report. Tallahassee, FL: Florida Fish and Wildlife Conservation Commission.

Lamonte, K. M., N. J. Douglass, J.G. Himes, and G. E. Wallace. 2006. *Status and distribution of the Snowy Plover in Florida.* 2002 study final report. Tallahassee, FL: Florida Fish and Wildlife Conservation Commission.

Leatherman, S.P. 1988. *Barrier Island Handbook*. Coastal publications series, Laboratory for Coastal Research, University of Maryland.

Lott, C.A. In press. *Conservation and management of eastern Gulf Coast Snowy Plovers (Charadrius alexandrinus): Summary of a workshop held in Plant City, Florida, November 7-8, 2007*. Vicksburg, MS: U.S. Army Corps of Engineers, Dredging Operations and Environmental Research Program, Engineer Research and Development Center.

Lott, C.A., C.S. Ewell, Jr., and K.A. Volansky. 2009a. *Habitat associations of shoreline-dependent birds in barrier island ecosystems during fall migration in Lee County, Florida*. ERDC/EL TR-09-14. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Lott, C.A., P. Durkee, W. Geirhart, and P. Kelly. 2009b. *Florida Coastal Engineering and Bird Conservation Geographic Information System (GIS) Manual*. ERDC/EL TR-09-15 Vicksburg, MS: U.S. Army Engineer Research and Development Center.

MacKenzie, D.I., J.D. Nichols, J.A. Royle, K.H. Pollock, J.E. Hines and L.L. Bailey. 2005. *Occupancy estimation and modeling: Inferring patterns and dynamics of species occurrence*. San Diego, CA: Elsevier.

Page, G. W., J. S. Warriner, J. C. Warriner, and P. W. C. Patton. 1995. Snowy Plover (Charadrius alexandrinus). In *The Birds of North America*. No. 154, ed. A. Poole and F. Gill. The Academy of Natural Sciences and Washington, DC: The American Ornithologists' Union.

Rehfisch, M.M., G.E. Austin, M.J.S. Armitage, P.W. Atkinson, S.J. Holloway, A.J. Musgrove, and M.S. Pollitt. 2003. Numbers of wintering waterbirds in Great Britain and the Isle of Man (1994/1995–1998/1999):II. Coastal waders (Charadrii). *Biological Conservation* 112: 329–341.

Sprandel, G. L., J. A. Gore, and D. T. Cobb. 1997. *Winter shorebird survey*. Final Perf. Rep. Tallahassee, FL: Florida Game and Fresh Water Fish Comm.

Stucker, J.H., and F.J. Cuthbert. 2006. Distribution of non-breeding Great Lakes Piping Plovers along Atlantic and Gulf of Mexico Coastlines: 10 Years of band resightings. A report to the USFWS East Lansing and Panama City field offices.

U.S. Army Corps of Engineers. 2006. *Draft regional biological assessment for beach activities along the Atlantic and Gulf Coasts of Florida*.

U.S. Fish and Wildlife Service (USFWS). 1996. *Piping Plover (Charadrius melodus), Atlantic Coast Population, Revised Recovery Plan*. Hadley, MA.

U.S. Fish and Wildlife Service (USFWS). 2001. Endangered and threatened wildlife and plants; Final determinations of critical habitat for wintering Piping Plovers; Final rule. 50 CFR Part 1.7.

U.S. Fish and Wildlife Service (USFWS). 2003. *Recovery Plan for the Great Lakes Piping Plover (Charadrius melodus)*. Ft. Snelling, MN.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
September 2009	Final report	

4. TITLE AND SUBTITLE

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

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 (*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.

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	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (include area code)
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		47	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. 239.18

ERDC/EL TR-09-14

Environmental Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Dredging Operations and Environmental Research Program

Habitat Associations of Shoreline-Dependent Birds in Barrier Island Ecosystems During Fall Migration in Lee County, Florida

Casey A. Lott, Charlie S. Ewell, Jr., and Kelly L. Volansky

September 2009

Dredging Operations and Environmental Research Program

ERDC/EL TR-09-14
September 2009

Habitat Associations of Shoreline-Dependent Birds in Barrier Island Ecosystems During Fall Migration in Lee County, Florida

Casey A. Lott and Kelly L. Volansky

American Bird Conservancy
P.O. Box 249
The Plains, VA 20198

Charlie S. Ewell, Jr.

Florida Ornithological Society
115 S.W. 51 Terrace
Cape Coral, FL 33914

Final report

Prepared for U.S. Army Corps of Engineers
Washington, DC 20314-1000

Abstract: The tendency to survey shoreline-dependent birds by taxonomic grouping has led to an incomplete picture of avian habitat associations within Florida's Barrier Island ecosystems. Planning for the conservation of Florida's shoreline-dependent birds requires a greater understanding of regional and site-specific habitat associations within the community of shoreline-dependent birds during fall migration, when many species are near peak annual abundances. Between August 15 and October 28, 2006 almost 45,000 observations of 42 species at 10 coastal study sites were recorded in southwestern Lee County, Florida. Counts varied strongly by species, site, behavior, and habitat. This study documents striking differences in the community of birds using the study area for foraging and for roosting. Foraging birds were comprised of primarily shorebirds and herons using low-energy intertidal areas and wrack lines around bay beaches, lagoons, and inlet shorelines. Seabirds, particularly terns, skimmers, and pelicans were dominant roosting birds, using intertidal areas on flood shoals, bay beaches, and lagoons. Several plover species roosted almost exclusively along inlet shorelines in and around old, decaying wrack. A small number of heavily used sites contributed a majority of all observations, including a new inlet/washover area that was created by Hurricane Charley in 2004, known locally as Charley Pass.

Contents

Figures and Tables iv

Preface ix

1 Introduction 1
Background 1
Shoreline-dependent bird habitat use 2

2 Methods 4
Bird counts 4
Interpretation of counts 8

3 Results 10
Counts summarized by behavior, species, and site 11
Counts summarized by habitat use 15

4 Discussion 21

References 24

Appendix A: Lee County Study Sites 26

Appendix B: Lee County Fall Migration Survey Data Form 71

Appendix C: Site-specific Results 75

Report Documentation Page

Figures and Tables

Figures

Figure 1. Lee County Study area. Surveyed sites are in yellow. 5
Figure 2. Foraging substrate use by 23 shoreline-dependent species with ≥33 cumulative observations. 15
Figure 3. Roosting substrate use by 19 shoreline-dependent species with ≥17 cumulative observations. 16
Figure 4. Foraging landform use by 23 shoreline-dependent species with ≥33 cumulative observations. 17
Figure 5. Roosting landform use by 19 shoreline-dependent species with ≥17 cumulative observations. 18
Figure 6. Correspondence plot illustrating foraging landform use for species with >33 cumulative foraging observations. 19
Figure 7. Correspondence plot illustrating roosting landform use for species with >17 cumulative roosting observations 20
Figure A1. Charley Pass Survey Area. 26
Figure A2. P58-Charley Pass, North Captiva Island: Boats parked in the Gulf on the north side of the entrance to the pass. 27
Figure A3 P59-Charley Pass, North Captiva Island. Boat anchored on the shallow flood shoal on the bay side of the island in Pine Island Sound 28
Figure A4. P60-Charley Pass, North Captiva Island. Mud flats and ephemeral pools on the flood shoal. 28
Figure A5. P61-Charley Pass, North Captiva Island: Early Dunlin (9-10-06) with Ruddy Turnstones and Sanderlings (juvenile and adult) 29
Figure A6. P62-Charley Pass, North Captiva Island: Roosting larids (Sandwich Terns, Royal Terns, Black Skimmers, Laughing Gulls) on flood shoal. 29
Figure A7. P63-Charley Pass, North Captiva Island: Roosting larids (Sandwich Terns, Royal Terns, Black Skimmers, Laughing Gulls) on flood shoal. 30
Figure A8. P64-Charley Pass, North Captiva Island: Walkers on the inlet shoreline. 30
Figure A9. Redfish Pass Survey Area 31
Figure A10. P57-North side of Redfish Pass (North Captiva Island). 32
Figure A11. Sanibel Lighthouse Survey Area. 33
Figure A12. P54-Sanibel Lighthouse: The lighthouse and beach at the entrance to San Carlos Bay. 34
Figure A13. P55-Sanibel Lighthouse: The fishing pier extending into San Carlos Bay 34
Figure A14. P56-Sanibel Lighthouse: The inlet shoreline with dense Red Drift Algae covering the intertidal zone. 35
Figure A15. Bunche Beach County Preserve Survey Area. 36
Figure A16. Bunche Beach County Preserve. 37

Figure A17. P45-Bunche Beach County Preserve: Moderate fresh wrack (Red Drift Algae) in the intertidal zone at medium tide. 38
Figure A18. P46-Bunche Beach County Preserve, mudflats west of the parking area at low tide. Red Drift Algae is present in the intertidal zone 38
Figure A19. P47-Bunche Beach County Preserve: Little Blue Heron foraging in dense wrack (Red Drift Algae) in the intertidal zone. 39
Figure A20. P48-Bunche Beach County Preserve: Ephemeral pool located at the west end of the beach face area. 39
Figure A21. P49-Bunche Beach County Preserve: Mud flats and ephemeral pools located at the west end of the beach face area. 40
Figure A22. P50-Bunche Beach County Preserve: Great White Heron (form of Great Blue Heron) foraging in open water along the bay beach. 40
Figure A23. P51-Bunche Beach County Preserve: Mudflat and ephemeral pools located at the west end of the beach face area. 41
Figure A24. P52-Bunche Beach County Preserve: Mud flats and ephemeral pools located at the east end of the beach face area. 41
Figure A25. P53-Bunche Beach County Preserve: Shorebirds and Snowy Egrets foraging in an ephemeral pool at the east end of the beach face area. 42
Figure A 26. Bowditch Pointe County Park Survey Area. 42
Figure A27. P36-Bowditch Pointe County Park: The main shorebird and larid roosting and foraging area along the intertidal zone of the inlet shoreline at medium tide. 43
Figure A28. P37-Bowditch Pointe County Park: Ephemeral pool (west end of Estero Island and entrance to San Carlos Bay) and the roosting and foraging area along the intertidal zone of the inlet shoreline at low tide (same area as P36). 44
Figure A29. P38-Bowditch Pointe County Park: Roosting group including Marbled Godwit, Willet, Short-billed Dowitcher, and Sandwich Tern. 44
Figure A30. P39-Bowditch Pointe County Park: Piping Plover roosting in old wrack. During the surveys, four to five Piping Plovers were usually present. 45
Figure A31. P40-Bowditch Pointe County Park: Snowy Plover roosting in old wrack. During the surveys, one to two Snowy Plovers were usually present. 45
Figure A32. P41-Bowditch Pointe County Park: Dunlin and Western Sandpiper foraging in fresh wrack (Red Drift Algae) along the intertidal zone. 46
Figure A33. P42-Bowditch Point County Park: Two people walking with a dog off-leash. Roosting shorebirds and larids were flushed as a result. 46
Figure A34. P43-Bowditch Pointe County Park: A park worker driving on the beach. Birds were flushed as a result. 47
Figure A35. P44-Bowditch Pointe County Park: Area where shorebirds and larids typically roost. 47
Figure A36. Little Estero Lagoon Survey Area. 48
Figure A37. P26-Little Estero Lagoon: beach adjacent to the Holiday Inn where ephemeral pools can be found. 49
Figure A38. P27-Little Estero Lagoon: Beach concession stand on the beach face adjacent to the Holiday Inn. 50
Figure A39. P28-Little Estero Lagoon: Most recent location of the channel connecting the lagoon to the Gulf. 50

Figure A40. P29-Little Estero Lagoon: Small sandbar located just outside the channel that presently connects the lagoon to the Gulf. 51
Figure A41. P30-Little Estero Lagoon: This area located in the central lagoon has been the main shorebird foraging and larid roosting area for the past 10 years 51
Figure A42. P31-Little Estero Lagoon: This mud flat area is a result of a previous inlet/cut area. 52
Figure A43. P32-Little Estero Lagoon: This is an area at the south end of the lagoon that Red Knot seemed to favor for foraging during the survey. 52
Figure A44. P33-Little Estero Lagoon: Red Knots foraging in an ephemeral pool at the south end of the lagoon. 53
Figure A45. P34-Little Estero Lagoon: Example of the banded Red Knots found in large numbers at the lagoon in September. 53
Figure A46. P35-Little Estero Lagoon: Area close to the southern tip of the lagoon. 54
Figure A47. Big Carlos Pass Survey Area. 54
Figure A48. P19-Big Carlos Pass: Bridge connecting Estero Island and Lover's Key. 55
Figure A49. P20-Big Carlos Pass: Boats are parked along this stretch of beach at Lover's Key almost daily. 56
Figure A50. P21-Big Carlos Pass: Lover's Key (south side) shoreline along Big Carlos Pass. 56
Figure A51. P22-Big Carlos Pass: Lover's Key (south side) shoreline along Big Carlos Pass. 57
Figure A52. P23-Big Carlos Pass: View of the entrance to Big Carlos Pass from Lover's Key. Estero Island is in the upper right. 57
Figure A53. P24-Big Carlos Pass: View from under the bridge over Big Carlos Pass from Estero Island (north side). 58
Figure A54. P25-Big Carlos Pass: View into Big Carlos Pass looking south from Little Estero Lagoon. 58
Figure A55. Lover's Key Lagoon Survey Area. 59
Figure A56. P14-Lover's Key lagoon: Posted dunes are shown in the foreground, the sand-bar in the upper right, and a small section of the tram bridge in the far right. 60
Figure A57. P15-Lover's Key lagoon: Dunes and postings that protect the area just to the north of the previous picture. 60
Figure A58. P16-Lover's Key lagoon: Tram bridge that crosses the lagoon. 61
Figure A59. P17- Lover's Key lagoon: Gazebo just behind a dune restoration area. 61
Figure A60. P18- Lover's Key lagoon: The beach face on the Gulf side of the lagoon is a very popular beach area on weekends and holidays. 62
Figure A61. New Pass Survey Area. 62
Figure A62. P9-New Pass: View of Big Hickory Island across the pass from Lover's Key (north side). 63
Figure A63. P10-New Pass: Boats parked on Big Hickory Island (south side). 64
Figure A64. P11-New Pass: Beach and intertidal area along the pass shoreline on Lover's Key (north side). 64
Figure A65. P12- New Pass: Boat traffic in the pass. 65
Figure A66. P13- New Pass: Ebb shoal outside the pass. 65
Figure A67. Big Hickory Pass Survey Area. 66
Figure A68. P1-Big Hickory Pass. 67

Figure A69. P2-Big Hickory Pass. 67
Figure A70. P3-Big Hickory Pass: Difference between low and high tide is apparent by comparing this spot with P2. 68
Figure A71. P4-Big Hickory Pass. 68
Figure A72. P5-Big Hickory Pass: The inlet side of the spit with fishermen on the Bonita Beach (south) side of the pass. 69
Figure A73. P6-Big Hickory Pass: This is the main foraging area for shorebirds when the mud flat and ephemeral pool are present at low tide. 69
Figure A74. P7-Big Hickory Pass: Ephemeral pool located on the mudflat on the Bonita Beach (south) side of the pass. 70
Figure A75. P8-Big Hickory Pass: View of Big Hickory Island, which is located on the north side of the pass. 70

Tables

Table 1. Distribution of site visits by survey week. Surveys began on August 15 and ended on October 28, 2006. 6
Table 2. Tide height and direction by survey week. Sites are sorted from northwest to southeast. 6
Table 3 . Species cumulative counts. 10
Table 4. Magnitude of site use by all species. 12
Table 5. Percent of foraging observations by site by species. 13
Table 6. Percent of roosting observations by site by species. 14
Table C1. Cumulative and maximum counts by behavior at Charley Pass. Species are listed in taxonomic order. 76
Table C2. Charley Pass disturbance factors. 77
Table C3. Cumulative and maximum counts by behavior at Redfish Pass. Species are listed in taxonomic order. 77
Table C4. Redfish Pass disturbance factors. 78
Table C5 Cumulative and maximum counts by behavior at Sanibel Lighthouse. Species are listed in taxonomic order. 79
Table C6. Foraging substrate and landform use by all species at Sanibel Lighthouse. 80
Table C7. Roosting substrate and landform use by all species at Sanibel Lighthouse. 80
Table C8. Sanibel Lighthouse disturbance factors. 80
Table C9. Cumulative and maximum counts by behavior at Bunche Beach. 82
Table C10. Species with >10 percent of their regional foraging observations recorded at Bunche Beach. 83
Table C11. Foraging substrate and landform use by all species at Bunche Beach. 84
Table C12. Bunche Beach disturbance factors. 84
Table C13. Cumulative and maximum counts by behavior at Bowditch Point. 86
Table C14. Foraging substrate and landform use at Bowditch Point. 87
Table C15. Roosting landform and substrate use at Bowditch Point. 87
Table C16. Bowditch Point disturbance factors. 87
Table C17. Cumulative and maximum counts by behavior at Little Estero Lagoon. 88

Table C18. Species with more than 10 percent of their regional foraging observations recorded at Little Estero Lagoon 89
Table C19. Species with more than 10 percent of their regional roosting observations recorded at Little Estero Lagoon 90
Table C20. Foraging substrate and landform use by all species at Little Estero Lagoon 91
Table C21. Roosting substrate and landform use by all species at Little Estero Lagoon 91
Table C22. Little Estero Lagoon disturbance factors 91
Table C23. Cumulative and maximum counts by behavior at Big Carlos Pass. Species are listed in taxonomic order 92
Table C24. Big Carlos Pass disturbance factors 93
Table C25. Cumulative and maximum counts by behavior at Lover's Key Lagoon. Species are listed in taxonomic order 94
Table C26. Foraging substrate and landform use by all species at Lover's Key Lagoon 95
Table C27. Roosting substrate and landform use by all species at Lover's Key Lagoon 95
Table C28. Lover's Key Lagoon disturbance factors 96
Table C29. Cumulative and maximum counts by behavior at New Pass. Species are listed in taxonomic order 96
Table C30. New Pass disturbance factors 97
Table C31. Cumulative and maximum counts by behavior at Big Hickory Pass 98
Table C32. Foraging substrate and landform use by all species at Big Hickory Pass 99
Table C33. Roosting substrate and landform use by all species at Big Hickory Pass 99
Table C34. Big Hickory Pass disturbance factors 99

Preface

This study was coordinated by American Bird Conservancy under contract with the U.S. Army Engineer Research and Development Center – Environmental Laboratory (ERDC-EL), as part of a larger effort to understand the impacts of coastal engineering on birds. Point of contact at ERDC-EL is Dr. Richard A. Fischer.

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: Dr. Steven L. Ashby, Principal Investigator for the Environmental Consideration Work Unit (EL), Mark R. Graves (EL), Jeff Lillycrop and Jennifer Wozencraft of the JALBTCX for supplying the data and assisting in product development; and Stephen Boutelle of Lee County, Nancy Douglass of the Florida Fish and Wildlife Conservation Commission, and Brad Smith of the Sanibel Captive Conservation Foundation for their insights and assistance in the planning and execution of this study.

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

1 Introduction

Background

In Florida, many different taxonomic groups of birds are frequently referred to as "shorebirds" due to their strong association with coastal habitats (http://myfwc.com/shorebirds/). A global term for this group of ecologically related species that may be less taxonomically misleading is "shoreline-dependent birds." Shoreline-dependent birds have at least one part of their annual cycle (e.g., breeding, migration, or winter) when a large part of their population is restricted to the mosaic of coastal habitat types near shorelines (e.g., intertidal areas, dry beaches and dunes, coastal wetlands, or near-shore shallow waters). Some shoreline-dependent birds spend their entire life on the coast and rarely occur at inland locations, such as American Oystercatchers (Nol and Humphrey 1994). However, others may have large inland populations (in addition to coastal populations), or individuals of some populations may spend at least one part of the year away from the coast (e.g., Great Blue Herons, White Ibises) (Butler 1992, Kushlan and Bildstein 1992).

The tendency to survey shoreline-dependent birds by taxonomic grouping (e.g., shorebirds or wading birds) or taxonomic subgroups with similar aggregating behaviors (e.g., solitary plovers, colonial waterbirds) has led to an incomplete picture of avian habitat associations within Florida's coastal Barrier Island or Estuarine ecosystems; particularly for non-breeding birds. For example, within any barrier island habitat complex, intertidal flats are extensively used for foraging by many species of both non-breeding shorebirds and wading birds, although these two taxonomic groups are infrequently surveyed together. Similarly, barrier island beaches and shoals are extensively used for roosting by many species of both non-breeding shorebirds and seabirds, although these two taxonomic groups are also infrequently surveyed together. Additionally, no large-scale coordinated efforts have attempted to count shoreline-dependent birds during fall or spring migration, when many birds are abundant at stopover sites in Florida.

Consequently, despite a large amount of coordinated (and uncoordinated) coastal bird surveys (Sprandel et al. 1997, Douglass and Coburn 2002, Ferland and Haig 2002, Lamonte et al. 2006, Gore et al. 2007) the year-round distribution, abundance, and habitat associations of Florida's shoreline-dependent birds is still

poorly known. This impedes sound management of Florida's coastlines for birds, since there are no data to assess if recommendations for one species may conflict with the needs of another. Similarly, it is impossible to propose management recommendations that would positively affect the entire community of shoreline-dependent birds when neither this community, nor the habitat needs of its constituents, has been adequately described. Similarly, impacts of various management activities on shoreline-dependent birds (e.g., coastal engineering, beach management activities) can be only partially addressed (relative to data for the limited number of species or seasons where data have been collected).

This report presents results of a regional survey of all shoreline-dependent birds during fall migration in Lee County, Florida, during the fall of 2006. This study was designed to describe behavior-specific (e.g., foraging or roosting) distribution, relative abundance, and habitat associations for all species, regardless of taxonomy. Similar surveys, following the methods of this study, in additional regions, and during all parts of the year (breeding season, fall migration, winter, and spring migration), would provide a much stronger foundation for the management and monitoring of shoreline-dependent birds than is currently present. In particular, surveys during fall and spring migration would help to assess the importance of different stopover sites during these important seasons for shoreline-dependent birds in Florida.

Shoreline-dependent bird habitat use

Shoreline-dependent birds are common during all seasons in Florida, and at least some shoreline-dependent wading birds, shorebirds, and/or seabirds are present in every month of the year (Stevenson and Anderson 1994, Pranty 2005). Typically the annual cycle of birds is divided into the breeding and non-breeding portions of the year. Population limitation can occur during any portion of the annual cycle and threats may differ during different portions of the annual cycle both within and among species (Newton 2004). The non-breeding period includes the entire time period from post-breeding dispersal of both young and adults away from the nesting area until the beginning of the next breeding season. During the non-breeding season, adults are no longer tied to nests or young and activity areas are typically larger and more complex than during the breeding season. Habitat requirements for individual shoreline-dependent birds can be different for foraging and for roosting. Therefore, the distribution of non-breeding birds may be related to some mosaic of foraging and roosting habitats that are regionally present at different times during the tidal cycle. The spatial

and temporal extent of movements among foraging and roosting sites during the non-breeding season is unknown for many species, but see Gunnels (1999).

In addition to natural coastal processes, the distribution and quality of bird habitat on Florida's coasts may be strongly affected by human disturbance or coastal engineering (Lamonte et al. 2006). Many habitats used by birds in Florida are affected by large scale beach management activities such as shoreline protection through beach nourishment, dune building and planting, or removal of wrack from beaches, otherwise known as "beach cleaning" or "beach raking." Florida's coastal bird habitats are also affected by inlet management through activities such as jetty construction or inlet bypassing. The effects of coastal sediment management on birds have rarely been studied in Florida (see http://el.erdc.usace.army.mil/dots/coastalbirds.html for efforts in other areas). Planning for the conservation of Florida's shoreline-dependent birds, and understanding the specific impacts of human disturbance or coastal engineering, both require a greater understanding of shoreline-dependent bird habitat associations. Understanding the specific habitat associations of different species and/or communities of shoreline dependent birds will help to frame the study of the effects of human disturbance and/or coastal engineering on habitat availability and quality. In an effort to better understand these relationships, American Bird Conservancy conducted a fall migration study at 10 coastal locations within Lee County, Florida during the fall of 2006.

2 Methods

Bird counts

Charlie Ewell, a board member of the Florida Ornithological Society, conducted regular counts of shoreline-dependent birds at 10 different sites in southwestern Lee County, between August 15 and October 28, 2006. The entire study area covered the southeastern portion of the chain of nine barrier islands in Lee County (from Gasparilla Island to Little Hickory Island) that front the large estuary of Charlotte Harbor and the adjacent Estero Bay. Figure 1 is a regional map of the study area. Within the southwestern Lee County study area, 10 sites were selected for several reasons: 1) to cover all major inlets between North Captiva Island and Bonita Beach, near the Collier County Line; 2) to include important shorebird areas around Charlotte Harbor's southeastern opening, San Carlos Bay; and 3) to cover two important lagoons near Estero Bay. These 10 study sites did not represent complete coverage of all possible locations used by shoreline-dependent birds in Lee County. In particular, the large lagoon at Cayo Costa (which was difficult to access) and the managed impoundments and mudflats of Ding Darling National Wildlife Refuge were not sampled.

Site selection was practically limited by the absence of roads connecting all of these barrier islands. Most of the 10 selected sites could be accessed by car; however, two sites (Charley Pass and Redfish Pass at the western limit of the study area) required boat access and these sites were visited less frequently. Figure 1 shows the location of all study sites and the two other sites listed above that were not sampled. Eight of the 10 study sites were surveyed on a regular rotation during the 11 weeks between August 15 and October 28, 2006, and individual sites were visited once every 10-12 days. This resulted in seven different counts for all sites except Sanibel Lighthouse, which was visited eight times. The two sites requiring boat access (Charley Pass and Redfish Pass) were visited only three times during the study period. Table 1 shows the distribution of site visits by week.

Since survey protocol dictated that sites were visited on a regular rotation throughout fall migration, and there was only a single surveyor for this study, it was not practical to schedule visits at consistent tides.

Figure 1. Lee County Study area. Surveyed sites are in yellow.

Therefore, different tide heights and directions were encountered at random at each site. Table 2 shows tide heights and direction for each site visit by week. Since counts are influenced by both date (due to the phenology of fall migration) and tides, a superior study design (if more resources were available) would be to conduct counts at each site at multiple standard tides (e.g. low, medium, and high tides) on each date (see protocols for the Wetland Bird Survey http://www.bto.org/survey/webs/index.htm). Controlling for tides in this manner would facilitate clearer comparisons of site use by both tide and date (and the interaction of these two factors).

Table 1. Distribution of site visits by survey week. Surveys began on August 15 and ended on October 28, 2006. Sites are sorted from northwest to southeast.

Site	1	2	3	4	5	6	7	8	9	10	11
Charley Pass		x		x		x					
Redfish Pass		x		x		x					
Sanibel Lighthouse	x	x	x		x	x	x		x		x
Bunche Beach	x	x	x			x	x		x		x
Bowditch Point	x		x		x	x	x		x	x	
Little Estero Lagoon	x	x		x	x	x		x		x	
Big Carlos Pass	x	x		x	x	x		x		x	
Lovers Key Lagoon	x		x	x		x	x	x		x	
New Pass	x		x	x		x	x	x		x	
Big Hickory Pass	x		x	x		x	x	x		x	

Table 2. Tide height and direction by survey week. Sites are sorted from northwest to southeast.

Site	1	2	3	4	5	6	7	8	9	10	11
Charley Pass		L, R		L, R		L, R					
Redfish Pass		L, R		L, R		L, R					
Sanibel Lighthouse	L, F	M, F	M, F		M, F	M, F	M, R		L, R		M, F
Bunche Beach	L, R	M, F	L, F			M, F	M, R		L, R		M, F
Bowditch Point	M, F		H, F		M, R	H, F	M, R		H, R	M, R	
Little Estero Lagoon	L, F	H, F		L, R	H, R	L, R		H, R		L, F	
Big Carlos Pass	L, F	H, F		L, F	H, R	L, R		H, R		L, R	
Lovers Key Lagoon	L, F		L, R	L, F		M, F	H, F	M, R		M, R	
New Pass	L, R		L, R	L, R		M, F	H, F	M, R		H, R	
Big Hickory Pass	L, F		L, F	L, F		H, F	H, F	M, R		M, R	

Tide height: L=Low M=Mid H=High Tide direction: F=Falling R=Rising

At each site, all potential foraging and roosting areas were surveyed with spotting scope and binoculars during each visit. Because of variation in the size of sites, some sites could be covered from a single observation location and other sites required walking or boating to multiple locations to cover the entire site. Appendix A includes maps that define the limits of survey coverage for each site and describe important foraging and roosting locations within each site. During each visit, in addition to bird observation data, data were also collected on: 1) survey effort, 2) weather conditions, 3) tide conditions, 4) possible disturbance factors, and 5) habitat conditions. For each site, individual bird observations were recorded separately based on unique combinations of four factors (each

with several levels): 1) species, 2) behavior (foraging or roosting), 3) habitat substrate (e.g., intertidal sand/mud, dry beach, old wrack), and 4) habitat landform (e.g., inlet shoreline, bayside beach, flood shoal). See Appendix B for the full datasheet, which includes a list of all possible levels for each factor.

Bird observations were recorded based on unique combinations of these four factors. For example, three dunlin foraging on intertidal flats on an inlet shoreline would be recorded as a single line on the datasheet. Two dunlin roosting on a dry beach along the same inlet shoreline would then be recorded on a separate line, and so on. This approach was slightly cumbersome in the field compared to simply counting numbers of birds; however, this level of detailed data collection was critical to document habitat use. This approach to field data collection allowed counts in the resulting database to be summarized by any combination of the four main factors, plus the additional factor of site (e.g. all dunlin counts, all dunlin foraging observations, all dunlin foraging observations in different habitat substrates, all dunlin roosting observations by landform, all species foraging substrate use by site). All data were entered and proofed from field datasheets to a Microsoft Access database, which is available from the lead author. If others wish to replicate this survey protocol, blank datasheets, and a blank database, ready for data entry, are available from the lead author.

Correspondence plots are used to illustrate patterns in both foraging and roosting habitat of the shoreline-dependent bird community. Correspondence analysis is a multivariate graphical technique that is useful to understand resource use in community ecology when observations are assigned to categories (McCune and Grace 2002). Correspondence analysis starts with a matrix of observations by category, for example, foraging landform use by species. Counts are then standardized as percentages prior to analysis to compare substrate use among species with different abundances. Correspondence analysis then uses matrix algebra to extract "dimensions" in the data that minimize the Euclidean distances between rows and columns. Frequently, the first two dimensions in the data explain a large percentage of the variation (which is known as "inertia" in correspondence analysis). Dimension scores for each species can then be graphed in a scatter plot to explore relationships among species and categories of observations. In our correspondence plots, each species is represented by a point and each landform type is represented by a red square. Data points for species with very strong associations with a single landform are closest to the red square for that landform. Data points for species that use more than one foraging landform are located between red squares for the two (or more) landforms that they use.

Therefore, data points for species with more generalist landform use are located further away from the red squares representing individual landforms than points for species that use only a single landform. Since most species had relatively strong substrate preferences (for both foraging and roosting), correspondence plots are based on foraging and roosting landform use, with substrate preferences represented by labels for individual species.

Interpretation of counts

Before presenting results of count data, a major point of interpretation must be clarified. The potential for pseudo-replication in this dataset is high (Hurlbert 1984). Since birds within the study area were unmarked, the degree to which counts on different dates (or at different sites on proximate dates) represent unique counts of new individuals or repetitive counts of the same individuals is unknown. Since the 11-week study period included fall migration for many species, it may be presumed that many individual birds are counted only once during stopover and that visits to the same site approximately 10 days apart would record different individual birds. If this were true, cumulative counts across all weeks would represent the total number of individuals using a site. However, if stopover lengths are longer than intervals between counts, or if some individuals are year-round or winter residents, then counts on different dates would include multiple counts of the same individuals. If all birds were resident, then average counts across all weeks would best represent the number of individuals using a site.

If most birds at a site are migrants, then average counts across all weeks would underestimate site importance since early or late-season counts will be much lower than counts during the peak migration time period (usually narrow) when most birds are passing through the study area (peak migration dates vary by species). In this case, the maximum number of birds counted during any one visit (for each species) might be the best index to site importance for migrants, and this number could be interpreted as the minimum number of birds that used a site during the entire study period. This number will almost always underestimate site use (since some different individuals are likely to be present on days before or after the date when the maximum count occurred); however, it is the only way to ensure that a count reflects unique individuals without marking all individuals within the population.

Additionally, since the spatial and temporal scale of movements of individuals among sites is unknown, it is impossible to know if individuals counted in the morning on site A are the same or different individuals than those counted in the afternoon at site B. In reality, for each site visit, some unknown proportion of counts is comprised of individuals that are counted only once and some unknown proportion of counts is comprised of individuals that are counted more than once. In this sense, all counts, whether cumulative, maximum, or averages, should be interpreted as indices of abundance, rather than population estimates. Estimating regional population size during the non-breeding season would require that all sites are counted at exactly the same time and date (to minimize movement of birds among sites within a region in response to changing tides). Regional population estimates of this sort would likely change throughout the migration period, as numbers of different species change due to date. Since most of the shoreline-dependent birds encountered during this study are migratory, and since the study took place during peak fall migration, count totals are reported as either cumulative or maximum counts, or both, depending on the objectives of individual data summaries. For species that were resident within the study area, both cumulative and maximum counts likely represent repetitive counts of the same individuals and are, as such, inflated indices of numbers of individuals.

3 Results

Almost 45,000 observations of 42 species were recorded during this study (Table 3). Twelve of these species were uncommon (≤12 total observations) and are not included in subsequent data summaries of habitat use. Counts varied strongly by species, site, behavior, and habitat. Count totals are summarized several different ways to describe regional relative abundance and habitat use, including several pooled data summaries (in the Overall Results section) and site-specific summaries (in the Site-specific Results Appendix (C).

Pooled data are used to present: 1) foraging and roosting observations by species (all sites combined); 2) foraging and roosting observations by site (all species combined); and 3) foraging and roosting substrate by species (all sites combined). Site-specific data for each of the 10 survey sites we present: 4) foraging and roosting observations by species; 5) foraging and roosting landform and substrate use; and 6) disturbance factors that may affect habitat use or quality.

Table 3 . Species cumulative counts. In this presentation, counts are pooled across all sites and weeks. Species are then sorted by the total number of observations. Counts are an index of abundance, not an estimate of total numbers of individuals.

	Cumulative counts		
Common Name	Foraging	Roosting	Total
Sandwich Tern	77	11,553	11,630
Laughing Gull	24	6,882	6,906
Western Sandpiper	3,469	1,306	4,775
Short-billed Dowitcher	3,103	569	3,672
Sanderling	2,060	157	2,217
Royal Tern	15	2,048	2,063
Brown Pelican	6	1,899	1,905
Semipalmated Plover	853	738	1,591
Black Skimmer		1,359	1,359
Least Sandpiper	1,230	24	1,254
Willet	851	280	1,131
Red Knot	1,018	17	1,035
White Ibis	848		848
Great Egret	729	2	731
Snowy Egret	653	10	663
Ruddy Turnstone	564		564

Common Name	Cumulative counts		
	Foraging	Roosting	Total
Black-bellied Plover	317	79	396
Wilson's Plover	176	211	387
Little Blue Heron	287		287
Least Tern	22	220	242
Double-crested Cormorant	1	200	201
Marbled Godwit	166	5	171
Forster's Tern		149	149
Semipalmated Sandpiper	128		128
Dunlin	104		104
Piping Plover	66	20	86
Reddish Egret	52		52
Roseate Spoonbill	46	5	51
Snowy Plover	33	17	50
Great Blue Heron	44		44
Black Tern	12		12
Spotted Sandpiper	11		11
American Avocet	4	2	6
Killdeer		5	5
Ring-billed Gull		5	5
Lesser Yellowlegs	2	2	4
Common Tern	2	2	4
Wood Stork	3		3
Whimbrel	3		3
Osprey		1	1
Cooper's Hawk	1		1
Caspian Tern		1	1

Counts summarized by behavior, species, and site

The 10 study sites had different magnitudes of site use, which varied strongly by behavior (foraging or roosting) (Table 4). To compare foraging and roosting observations among sites, counts were pooled across species and weeks. Some sites were important for both foraging and roosting (e.g., Bunche Beach, Little Estero Lagoon) and others had much higher numbers of roosting observations than foraging observations (e.g., Charley Pass, Bowditch Point, Big Hickory Pass, New Pass). Since the community structure and relative abundance of birds using any one site clearly differed by behavior, subsequent summaries of counts and

habitat use are presented by species separately for both foraging and roosting observations at each site in "Site-specific Results".

Table 4. Magnitude of site use by all species. Sites are sorted by total number of observations. Counts are an index of abundance, not an estimate of total numbers of individuals. Note that all sites were not visited the same number of times.

Site	N visits	Cumulative counts		
		Foraging	Roosting	Total
Bunche Beach	7	9,777	5,887	15,664
Charley Pass	3	982	10,452	11,434
Little Estero Lagoon	7	3,224	4,273	7,497
Bowditch Point	7	553	4,000	4,553
Lovers Key Lagoon	7	1,261	645	1,906
Big Hickory Pass	7	498	1,052	1,550
New Pass	7	54	1,117	1,171
Sanibel Lighthouse	8	357	184	541
Big Carlos Pass	7	252	1	253
Redfish Pass	3	22	157	179

Counts also varied strongly by behavior within and among species (Table 3). Note that some species were commonly observed both foraging and roosting in the study area (Semipalmated Plovers and Wilson's Plovers); however, most species were more frequently observed either foraging (e.g., Short-billed Dowitcher) or roosting (e.g., Sandwich Tern) in the study area.

Site importance varied according to the interaction between species and behavior. In other words, some sites were particularly important to a species for foraging, particularly Bunche Beach, Little Estero Lagoon, and Lovers Key Lagoon for many species and Charley Pass and Bowditch Beach for some species (Table 5). Similarly, some sites were particularly important to a species for roosting, such as Charley Pass, Bunche Beach, Bowditch Point, and Little Estero Lagoon for many species and Lover's Key Lagoon for some species (Table 6). Appendix C, "Site-specific Results," discusses the importance of individual sites to different species in greater detail.

Table 5. Percent of foraging observations by site by species. Species are sorted by abundance (only species with >33 observations are included). Sites are sorted from west to east. The importance of Charley Pass is underemphasized in this table, since this site was visited less frequently than others.

Common Name	Total	Charley Pass	Redfish Pass	Sanibel Lighthouse	Bunche Beach	Bowditch Point	Little Estero Lagoon	Big Carlos Pass	Lover's Key Lagoon	New Pass	Big Hickory Pass
Western Sandpiper	3469	5.1%	0.0%	0.3%	59.3%	4.3%	18.8%	0.0%	8.8%	0.0%	3.4%
Short-billed Dowitcher	3103	1.5%	0.0%	0.0%	89.6%	0.7%	0.5%	0.0%	7.6%	0.0%	0.2%
Sanderling	2060	11.3%	0.5%	3.2%	29.3%	5.4%	35.6%	4.5%	6.3%	1.3%	3.6%
Least Sandpiper	1230	11.9%	0.0%	0.0%	48.6%	0.1%	14.0%	0.0%	13.8%	0.0%	13.7%
Red Knot	1018	3.5%	0.0%	0.2%	18.0%	0.0%	73.2%	0.6%	3.5%	0.0%	0.6%
Semipalmated Plover	853	10.3%	0.0%	0.0%	40.7%	10.8%	25.8%	0.0%	10.9%	0.0%	1.5%
Willet	851	3.6%	0.5%	4.6%	58.3%	4.7%	18.9%	4.5%	3.8%	0.6%	2.7%
White Ibis	848	0.0%	0.0%	0.0%	88.9%	0.0%	5.4%	0.0%	5.1%	0.0%	0.6%
Great Egret	729	0.0%	0.1%	1.6%	79.3%	0.0%	13.3%	1.8%	2.2%	0.4%	1.2%
Snowy Egret	653	0.0%	0.3%	7.7%	69.2%	0.0%	12.6%	2.5%	4.6%	0.5%	2.8%
Ruddy Turnstone	564	20.0%	0.5%	5.1%	19.0%	8.2%	22.0%	8.7%	9.2%	2.1%	5.1%
Black-bellied Plover	317	11.0%	0.3%	4.4%	49.5%	2.8%	15.5%	5.4%	9.8%	0.3%	0.9%
Little Blue Heron	287	0.0%	0.0%	0.0%	94.1%	0.0%	3.5%	0.7%	1.4%	0.0%	0.3%
Wilson's Plover	176	1.1%	0.0%	0.0%	19.9%	18.8%	50.6%	0.6%	7.4%	0.6%	1.1%
Marbled Godwit	166	0.0%	0.0%	0.0%	84.9%	0.0%	7.2%	0.0%	7.8%	0.0%	0.0%
Semipalmated Sandpiper	128	23.4%	0.0%	0.0%	56.3%	0.0%	3.9%	0.0%	3.9%	0.0%	12.5%
Dunlin	104	1.0%	0.0%	0.0%	73.1%	26.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Sandwich Tern	77	0.0%	0.0%	96.1%	0.0%	0.0%	0.0%	3.9%	0.0%	0.0%	0.0%
Piping Plover	66	9.1%	0.0%	0.0%	48.5%	31.8%	10.6%	0.0%	0.0%	0.0%	0.0%
Reddish Egret	52	0.0%	0.0%	15.4%	38.5%	0.0%	19.2%	11.5%	15.4%	0.0%	0.0%
Roseate Spoonbill	46	0.0%	0.0%	0.0%	58.5%	0.0%	28.3%	0.0%	15.2%	0.0%	0.0%
Great Blue Heron	44	0.0%	0.0%	4.5%	52.3%	0.0%	13.6%	13.6%	6.8%	0.0%	9.1%
Snowy Plover	33	30.3%	0.0%	0.0%	9.1%	12.1%	48.5%	0.0%	0.0%	0.0%	0.0%

Table 6. Percent of roosting observations by site by species. Species are sorted by abundance (only species with >17 observations are included). Sites are sorted from west to east. The importance of Charley Pass is underemphasized in this table, since this site was visited less frequently than others.

Common Name	Total	Charley Pass	Redfish Pass	Sanibel Lighthouse	Bunche Beach	Bowditch Point	Little Estero Lagoon	Big Carlos Pass	Lover's Key Lagoon	New Pass	Big Hickory Pass
Sandwich Tern	11553	60.6%	0.7%	0.4%	22.5%	6.0%	3.2%	0.0%	1.9%	2.4%	2.2%
Laughing Gull	6866	17.0%	0.3%	1.6%	12.6%	13.8%	41.0%	0.0%	2.7%	5.0%	6.0%
Royal Tern	2048	41.0%	2.5%	0.4%	25.5%	6.9%	9.9%	0.0%	3.1%	4.9%	5.7%
Brown Pelican	1899	46.4%	0.0%	0.0%	22.3%	1.8%	4.7%	0.0%	3.1%	19.1%	2.6%
Black Skimmer	1359	35.7%	0.0%	0.0%	50.0%	3.3%	10.2%	0.0%	0.0%	0.0%	0.9%
Western Sandpiper	1306	0.0%	0.0%	0.0%	0.0%	81.5%	18.5%	0.0%	0.0%	0.0%	0.0%
Semipalmated Plover	738	5.4%	0.0%	0.0%	0.0%	70.2%	13.4%	0.0%	0.8%	0.0%	10.2%
Short-billed Dowitcher	569	0.0%	0.0%	0.0%	37.9%	6.7%	4.0%	0.0%	0.0%	0.0%	1.4%
Willet	280	1.8%	0.0%	0.0%	35.7%	17.1%	11.4%	0.0%	18.6%	2.1%	13.2%
Least Tern	220	0.0%	0.0%	0.0%	4.1%	75.5%	18.2%	0.0%	0.0%	0.0%	2.3%
Wilson's Plover	211	2.4%	0.0%	0.0%	0.0%	60.2%	23.7%	0.0%	1.4%	0.0%	12.3%
Double-crested Cormorant	200	0.0%	0.0%	0.0%	34.0%	0.5%	18.5%	0.0%	26.0%	15.0%	6.0%
Sanderling	157	0.0%	0.0%	0.0%	0.0%	62.4%	37.6%	0.0%	0.0%	0.0%	0.0%
Forster's Tern	149	2.0%	0.0%	1.3%	69.1%	11.4%	14.8%	0.0%	0.0%	0.0%	1.3%
Black-bellied Plover	79	31.6%	0.0%	0.0%	0.0%	19.0%	19.0%	0.0%	0.0%	0.0%	30.4%
Least Sandpiper	24	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Piping Plover	20	0.0%	0.0%	0.0%	0.0%	90.0%	10.0%	0.0%	0.0%	0.0%	0.0%
Snowy Plover	17	0.0%	0.0%	0.0%	0.0%	58.8%	41.2%	0.0%	0.0%	0.0%	0.0%
Red Knot	17	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Counts summarized by habitat use

Habitat use was characterized by two different categories: substrate and landform. Both foraging and roosting substrate use was relatively consistent among sites within a species (exceptions are presented in Appendix C "Site-Specific Results"). Four different foraging substrates (shallow water, intertidal sands and muds, fresh wrack, and ephemeral pools) were important (>44 percent of all observations) for at least one species (Figure 2). Three other foraging substrates (dry beach, rock, and vegetation) were uncommonly recorded, comprising <7 percent of all observations for all species. Ranked by total foraging observations across all sites with all species pooled, the top 4 foraging substrates were: intertidal muds and sands (8,986 observations), shallow water (2,853), ephemeral pools (2,847), and fresh wrack (2,124). The majority of foraging observations occurred on intertidal substrate for 13 species, in shallow water for 8 species, in fresh wrack for 1 species, and in ephemeral pools for 1 species (Figure 2).

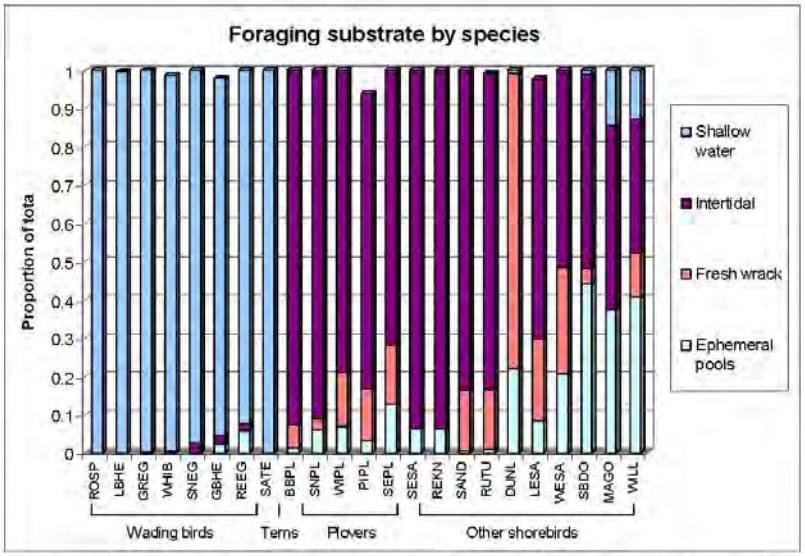


Figure 2. Foraging substrate use by 23 shoreline-dependent species with ≥33 cumulative observations. Species are grouped taxonomically and then within each taxonomic group by strength of substrate use.

Of 23 species, 19 had strong associations (>67 percent of all observations) with a single foraging substrate. Foraging substrate preference was consistent within taxonomic groups; shallow water was preferred for all wading bird species, intertidal substrates were preferred by all plovers and by most other shorebirds (with the exception of dunlins, which preferred fresh wrack).

Six different roosting substrates were important (>19 percent of all observations) for at least one species. Ranked by total roosting observations across all sites with all species pooled, the top six roosting substrates were: intertidal muds and sands (21,018 observations); dry sand (2,392); ephemeral pools (1,545); old wrack (1,197); and vegetation (52). Nine species had a majority of observations on intertidal substrates, six in old wrack, and four in dry sand (Figure 3). Of 19 species, 16 had very strong associations (>67 percent of all observations) with a single roosting substrate. Roosting substrate preference was not consistent among species within each taxonomic group, particularly among non-plover shorebirds. However, four out of five plover species had a high proportion of roosting observations in old wrack.

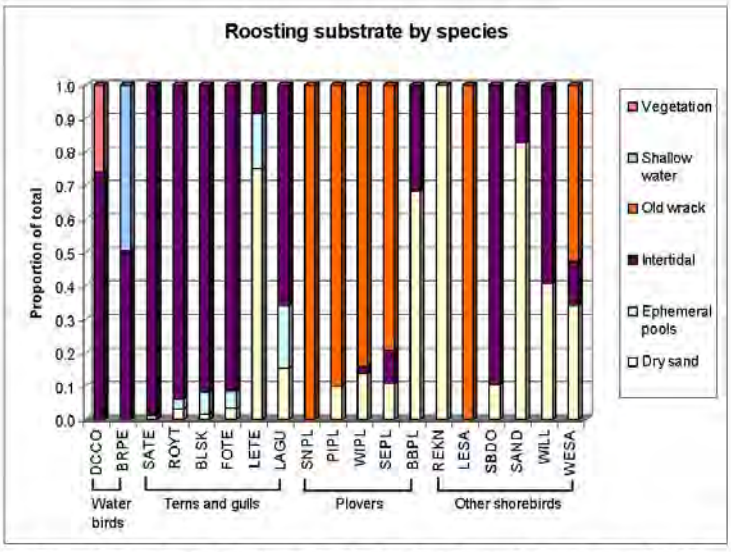


Figure 3. Roosting substrate use by 19 shoreline-dependent species with ≥17 cumulative observations. Species are grouped taxonomically and then within each taxonomic group by strength of substrate use.

Unlike substrate use, which was relatively consistent among sites, both foraging and roosting landform use varied considerably by site (see Appendix C "Site-specific Results"). Five major landforms were important (>36 percent of all observations) for foraging for at least one species (Figure 4). Ranked by total foraging observations across all sites with all species pooled, these were: bay beaches (9,812 observations); lagoons (2,444); ocean beaches (2,236); inlet shorelines (1,317); and flood shoals (1,050). Of 23 species, 17 had a majority of their foraging observations on bay beaches, 3 on ocean beaches, 2 in lagoons, and 1 along inlet shorelines (Figure 4). However, only 7 out of 23 species had very strong associations (>67 percent of all observations) with a single landform, compared to 19 of 23 species with very strong foraging substrate associations. Foraging landform preference was less consistent within taxonomic groups than it was for foraging substrates. Although bay beaches were preferred by most wading birds and inlet shorelines were preferred by terns, a mix of foraging landforms was used by different plover species and other shorebirds (Figure 4).

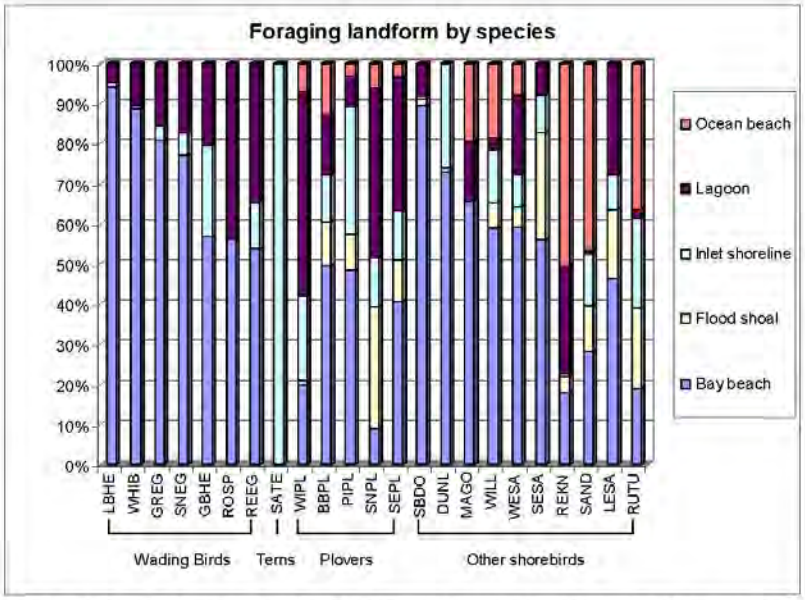


Figure 4. Foraging landform use by 23 shoreline-dependent species with ≥33 cumulative observations. Species are grouped taxonomically and then within each taxonomic group by strength of landform use.

Six different roosting landforms were important (>36 percent of all observations) for at least one species (Figure 5). Ranked by total roosting observations across all sites with all species pooled, these were: flood shoals (10,450 observations); bay beaches (5,900); ocean beaches (5,520); inlet shorelines (4,200); ebb shoals (1,117); and lagoons (525). Eight species had a majority of their roosting observations along inlet shorelines, four on bay beaches, three on flood shoals, three on ocean beaches, and one in lagoons (Figure 5). However, only 7 out of 19 species had very strong associations (>67 percent of all observations) with a single roosting landform compared to 16 of 19 species with very strong roosting substrate associations. Roosting landform preference was also less consistent within taxonomic groups than it was for roosting substrates. Although four out of five plover species preferred inlet shorelines for roosting, roosting landform preferences were mixed for other taxonomic groups (Figure 5).

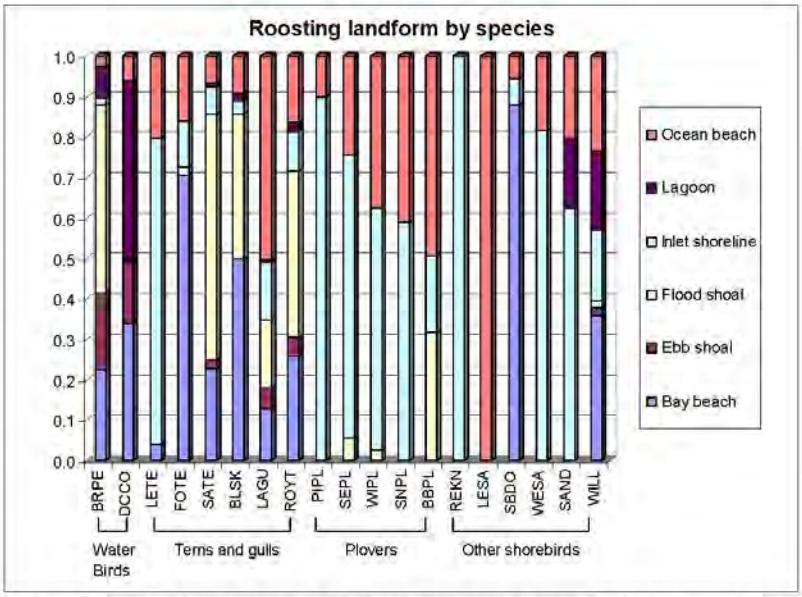


Figure 5. Roosting landform use by 19 shoreline-dependent species with ≥17 cumulative observations. Species are grouped taxonomically and then within each taxonomic group by strength of substrate use.

Correspondence plots combine information on substrate and landscape preferences by species, giving a graphical representation of how habitat resources are used by the entire shoreline-dependent bird community across all sites within the Lee County study area. The correspondence plot for foraging habitat use (Figure 6) illustrates three main patterns: 1) bay beach areas were heavily used by wading birds that foraged mostly in shallow water substrates; 2) ocean beaches were used mostly by three species of shorebirds that forage on intertidal substrates (Sanderling, Ruddy Turnstone, and Red Knot); and 3) all other species of shorebirds used a mix of landform types, regardless of their preference for intertidal substrates, fresh wrack, or ephemeral pools (Figure 6).

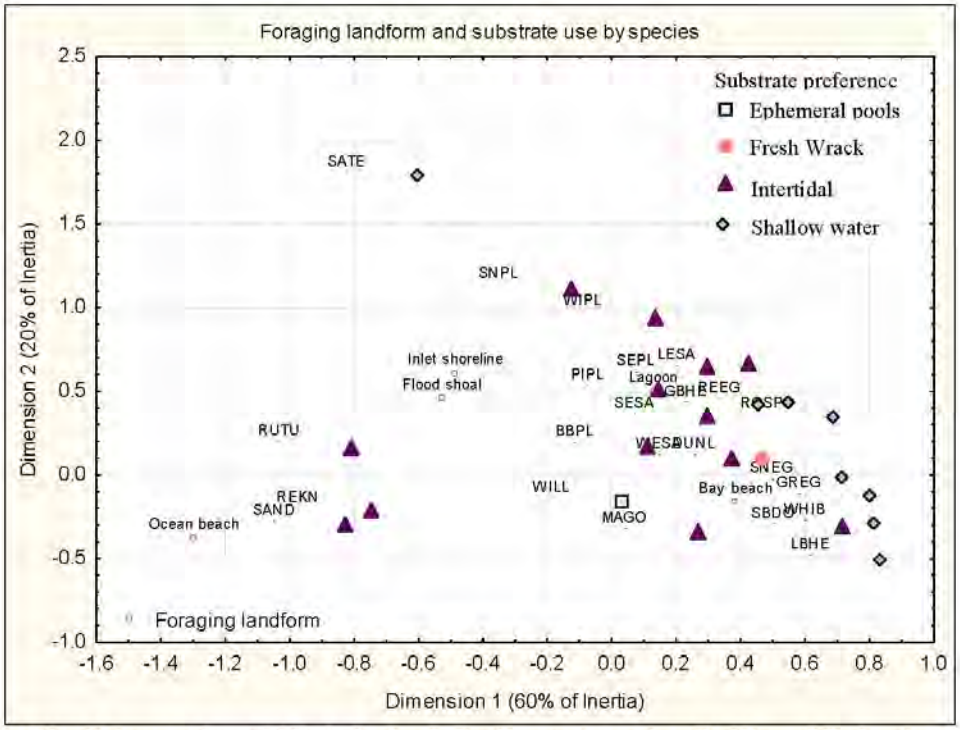


Figure 6. Correspondence plot illustrating foraging landform use for species with >33 cumulative foraging observations. Symbols indicate the substrate on which the majority of each species' observations occurred (see legend at top right of figure). Different landform types are represented by labeled squares. Species names for four-letter codes are listed in Appendix B.

The correspondence plot for roosting habitat use illustrates several strong patterns: 1) most species that roosted preferentially in old wrack substrates did so near inlet shorelines. This included 1) Western Sandpipers and all plover species except for Black-bellied Plovers; 2) three species that preferred to roost on inlet shorelines also roosted on dry sand (Least Terns, Red Knots, and Sanderlings; 3) birds that tended to roost on intertidal substrates roosted on a variety of different landform types; and 4) a few species that roosted on ocean beaches, with the exception of Black-bellied Plovers, Laughing Gulls, and Least Sandpipers, all of which used different substrates (Figure 7).

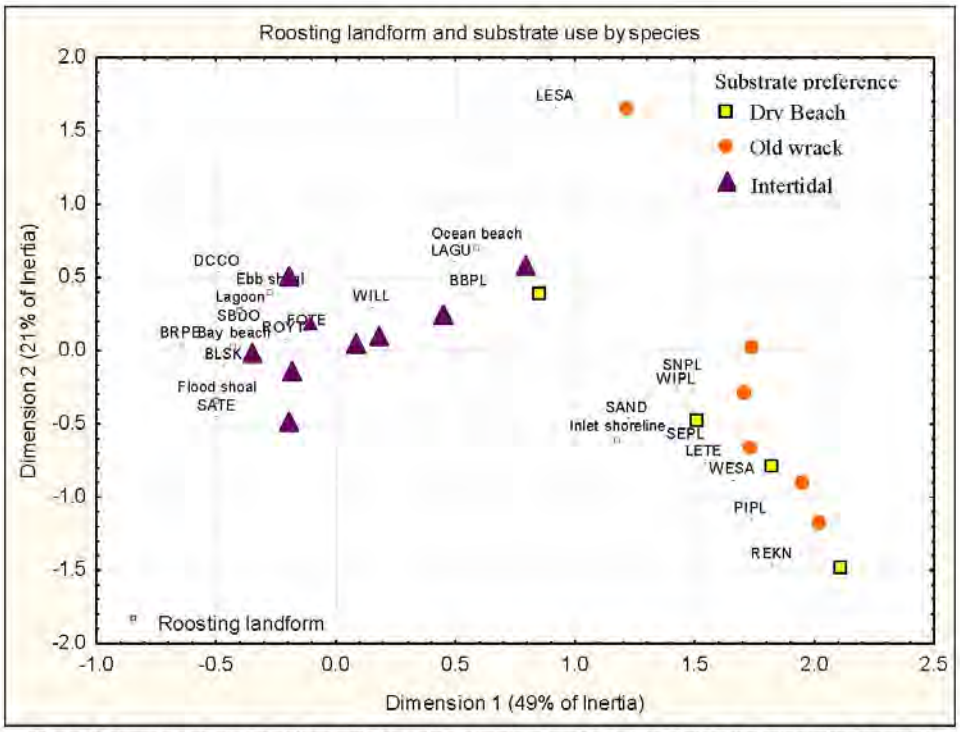


Figure 7. Correspondence plot illustrating roosting landform use for species with >17 cumulative roosting observations. Symbols indicate the substrate on which the majority of each species' observations occurred (see legend at top right of figure). Different landform types are represented by labeled squares. Species names for four-letter codes are listed in Appendix B.

4 Discussion

Survey protocols for non-breeding birds that are designed to demonstrate bird habitat associations across taxonomic lines are both feasible (since birds of many taxa occur at the same location at the same time) and advisable (since threats to coastal habitats, such as development and high human use, affect all shoreline-dependent birds, regardless of taxonomy). Conservation planning for shoreline-dependent birds will need to include strategies for both sites and species; however, protection of very important sites (such as Bunche Beach, Charley Pass, Little Estero Lagoon, Bowditch Point, and Lover's Key Lagoon) will be helpful to many species.

Within each site, different species use different resources and these resources differ depending on whether the species is foraging or roosting. In this study area, counts of foraging and roosting birds differed so strongly that it might even be said that different communities of shoreline-dependent birds used the study area for foraging and for roosting. Some species that were abundant roosting birds were scarcely observed foraging in the study area (terns, skimmers, and pelicans). Many species that were commonly observed foraging in the study area were much less frequently observed roosting (most shorebirds and herons). Capturing both foraging and roosting habitat use by all species would require an expansion of the study area chosen for this study. Most of the seabirds and waterbirds (terns, skimmers, and pelicans) that were common roosting birds in this study are known to forage offshore, in some cases, well offshore. Wading birds roosts are frequently observed outside of the barrier island/inlet system sampled during this study, in adjacent mangroves or other inland wetlands. It is less clear where important roosting areas for shorebirds, which we observed much more frequently foraging than roosting, might be located. It's possible that aerial surveys of the Charlotte Harbor Estuary at high tide would be able to locate large roosts of shorebirds. Conservation planning for shorebirds would benefit considerably from knowing the location of these roosts and achieving their protection.

Although habitat substrate and landform preference varied by species and site, some general patterns were striking within Lee County's shoreline-dependent bird community. Strongest, perhaps, was the association of

foraging birds with low-energy intertidal substrates. Some shorebirds also foraged on patchily distributed resources of fresh wrack and ephemeral pools, which were also frequently available at low-energy sites. However intertidal flats and adjacent shallow-water areas on bay beaches, lagoons, flood shoals, and inlet shorelines provided most of the foraging areas for the majority of all species. Only a few species used intertidal areas on beaches exposed to wave energy from the Gulf of Mexico and nearly no individuals used dry beaches for foraging. Given the strong association of shoreline-dependent birds with mudflats, habitat mapping of intertidal areas, although challenging (see Zharikov et al. 2005) could help to delineate important areas for shorebirds that have not been identified during road-based surveys. For example, it is possible that mudflats in remote, boat-accessible locations in Estero Bay, Pine Island Sound, and the northern bays of Port Charlotte Harbor may support large numbers of foraging birds.

Another striking pattern of habitat use was the strong preference of several plover species for roosting in old wrack on inlet shorelines. Again, few species used dry Gulf beaches for roosting, and the species that did not prefer roosting on inlet shorelines tended to roost in low-energy intertidal areas around bay beaches, flood shoals, and lagoons. An exception to this was the use of several ebb shoals for roosting, when tides were low enough to expose them.

Habitat conservation for the community of birds described in this study should focus on preservation of intertidal substrates in low-energy landforms. Engineering projects that may disrupt geomorphologic processes that create and/or maintain these habitat types should be avoided. For example, when new inlets are created during hurricanes, such as the inlet at Charley Pass, they should be allowed to remain open and/or close on their own, as long as they present no danger to human life. These areas become extremely important for both foraging and roosting birds, often supplying many acres of new intertidal substrates, which may be in short supply in some regions. Since these areas also receive tremendous recreational use (Charley Pass received by far the most disturbance of any site in this study) new inlets/washover areas should receive increased protection from state wildlife agencies. Similarly, areas that receive habitat renewal through overwash should not have this process altered by the installation of high berms.

Since the greatest amount of habitat use occurred in low-energy areas around bays and inlets, any engineering activity that increases wave energy in these areas, which may result in habitat loss through erosion or the coarsening of intertidal sediments, should be avoided. This may include the mining of ebb shoals for beach nourishment projects if shoal removal will result in an increase of wave energy that could damage an important site for shoreline-dependent birds. Similarly, mining flood shoals for material for beach nourishment projects, or to remove navigation hazards, could result in the direct loss of considerable habitat for shoreline-dependent birds.

In this study, wrack was used by several different species of shorebirds. Fresh red drift algae in the intertidal zone was commonly used for foraging by many species and older wrack, deposited higher on the beach by seasonally high tides or storm surges, was particularly important as a roosting substrate for several high-priority plover species. County and city ordinances to protect this resource should be enforced and wrack should not be removed from beaches unless a significant human health hazard can be documented.

Finally, this study focused only on the fall migration period in the barrier island/inlet system fronting the Charlotte Harbor Estuary in Lee County. Similarly detailed investigations of habitat use during other seasons (winter, spring migration, and breeding) and at other locations would be very helpful to determine the best strategies for the year-round conservation of shoreline-dependent birds in Florida. Additional regional surveys using these protocols would be helpful to understand the generality of patterns of habitat use observed in this study.

References

Butler, R. W. 1992. Great Blue Heron (*Ardea herodias*). In *the Birds of North America, No. 25*, eds. A. Poole, P. Stettenheim, and F. Gill. Philadelphia, PA: The Birds of North America, Inc.

Douglass, N.J., and L.M. Coburn. 2002. Survey of breeding American oystercatcher (*Haematopus palliatus*) populations in Florida. Final Performance Report. Tallahassee, FL: Florida Fish and Wildlife Conservation Commission.

Ferland, C.L., and S.M. Haig. 2002. *2001 International Piping Plover Census*. Corvallis, OR: U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center.

Gore, J. A., J. A. Hovis, G. L. Sprandel, and N. J. Douglass. 2007. *Distribution and abundance of breeding seabirds along the coast of Florida, 1998 – 2000*. Final Performance Report. Tallahassee, FL: Florida Fish and Wildlife Conservation.

Gunnels, C.M. 1999. Survey and home range analyses of wintering shorebirds using the Lanark Reef shorebird complex, Franklin Co., Florida. MS thesis, West Virginia University.

Hurlbert, S.H. 1984. Pseudoreplication and the design of ecological field experiments. *Ecological Monographs* 54: 187-211.

Kushlan, J. A., and K. L. Bildstein. 1992. White Ibis (*Eudocimus albus*). In *the Birds of North America, No. 9*, eds. A. Poole, P. Stettenheim, and F. Gill. Philadelphia, PA: The Birds of North America, Inc., Philadelphia, PA.

Lamonte, K. M., N. J. Douglass, J. G. Himes, and G. E. Wallace. 2006. *Status and distribution of the Snowy Plover in Florida*. 2002 Study Final Report. Tallahassee, FL: Florida Fish and Wildlife Conservation Commission.

McCune, B., and J. B. Grace. 2002. *Analysis of ecological communities*. Gleneden Beach, OR: MjM Software.

Newton, I. 2004. Population limitation in migrants. *Ibis* 146:197–226.

Nol, E., and R. C. Humphrey. 1994. American Oystercatcher (Haematopus palliatus). In *the Birds of North America, No. 82*, eds. A. Poole and F. Gill. Philadelphia, PA: The Birds of North America, Inc.

Pranty, B. 2005. *A birder's guide to Florida*. American Birding Association, Inc.

Sprandel, G. L., J. A. Gore, and D. T. Cobb. 1997. *Winter shorebird survey*. Final Performance Report. Tallahassee, FL: Florida Fish and Wildlife Conservation Commission.

Stevenson, H.M. and B.H. Anderson. 1994. *Birdlife of Florida*. University of Florida Press.

Zharikov, Y., G.A. Skilleter, R. Loneragan, T. Taranto, and B.E. Cameron. 2005. Mapping and characterizing subtropical estuarine landscapes using aerial photography and GIS for potential application in wildlife conservation and management. *Biological Conservation* 125: 87-100.

Appendix A: Lee County Study Sites

This appendix contains aerial maps that define the limits of survey coverage for each study site. Each map contains a series of polygons and two letters. These represent important foraging and roosting locations within each site (Fx=features from description that follows) and photographs of these areas (Px=photo locations). Study sites are presented west to east.

Charley Pass area (North Captiva Island)

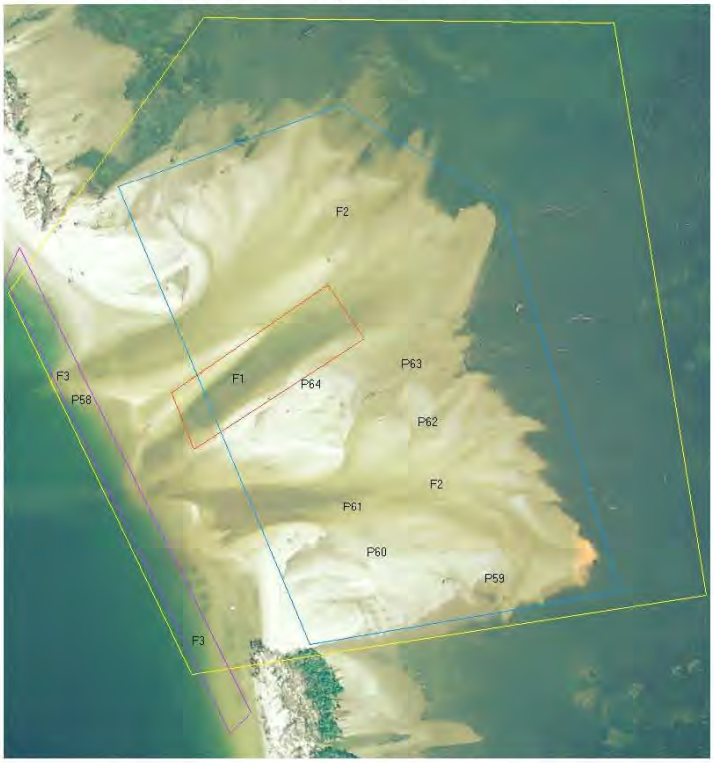


Figure A1. Charley Pass Survey Area.

Charley Pass: This area is the "pass" or "cut" that was created along a narrow stretch of North Captiva Island by the passage of Hurricane

Charley. It was initially described by the Florida DEP as being 0.3 mile wide. It has since narrowed to close to under 50 m by the authors estimation (F1). An extensive flood shoal was created as a result of the cut (F2). The shoal attracted thousands of birds in the fall of 2006, the majority being Sandwich Terns and immature Brown Pelicans. At low tide, it was an attractive foraging area for sandpipers and plovers, and at high tide the shoal was still shallow enough for most birds to use as a roost area. Charley Pass is a popular boating destination. Weekends and holidays outside of winter consistently host 30-50 boats anchoring outside the Gulf side of the pass (F3). Many boaters come ashore and explore the mudflats. Birds are typically flushed by these activities.

Figure A2. P58-Charley Pass, North Captiva Island: Boats parked in the Gulf on the north side of the entrance to the pass. This sight is duplicated on the south side of the pass as well. Both sides will have boats anchored offshore on weekends outside of winter.

Figure A3 P59-Charley Pass, North Captiva Island: Boat anchored on the shallow flood shoal on the bay side of the island in Pine Island Sound. This is not a common site due to the shallowness of the area. The majority of foraging and roosting birds are located on the bayside.

Figure A4. P60-Charley Pass, North Captiva Island: Mud flats and ephemeral pools on the flood shoal.

Figure A5. P61-Charley Pass, North Captiva Island: Early Dunlin (9-10-06) with Ruddy Turnstones and Sanderlings (juvenile and adult).

Figure A6. P62-Charley Pass, North Captiva Island: Roosting laridS (Sandwich Terns, Royal Terns, Black Skimmers, Laughing Gulls) on flood shoal.

Figure A7. P63-Charley Pass, North Captiva Island: Roosting larids (Sandwich Terns, Royal Terns, Black Skimmers, Laughing Gulls) on flood shoal. Photo shows only a portion of the 2,000-3,000 larids that were consistently present during the survey.

Figure A8. P64-Charley Pass, North Captiva Island: Walkers on the inlet shoreline. This activity would result in birds flushing.

Redfish Pass

Figure A9. Redfish Pass Survey Area.

Redfish Pass: This inlet is between North Captiva Island and Captiva Island. All areas within the yellow polygon were surveyed during each visit. The north and south sides of the pass were surveyed separately. Redfish Pass has groins on each side of the inlet, with the North Captiva side (north side) having three (F1). Captiva Island has one groin, which was refurbished after Hurricane Charley (F2). Captiva Island also has an elevated area on the inlet beach that larids and shorebirds use for roosting (F3). The property behind this beach belongs to the South Seas Island Resort. The aerial photograph shows a golf course (F4) and small marina (F5) very close to the inlet. Bird use is minimal on the north side of the pass.

Figure A10. P57-North side of Redfish Pass (North Captiva Island).

Sanibel Lighthouse area

Figure A11. Sanibel Lighthouse Survey Area.

Sanibel Lighthouse: This area is a city park at the southeast end of Sanibel Island. It is on the northwest side of the entrance to San Carlos Bay. All areas within the yellow polygon were surveyed during each visit. The Gulf beach is very busy on weekends and holidays (F1), and a popular fishing pier exists on the bay side of the park (F2). Shorebirds and larids use the area sporadically, while wading birds seem to have a consistent presence on both the inlet beach (F3) and the pier.

Figure A12. P54-Sanibel Lighthouse: The lighthouse and beach at the entrance to San Carlos Bay.

Figure A13. P55-Sanibel Lighthouse: The fishing pier extending into San Carlos Bay.

Figure A14. P56-Sanibel Lighthouse: The inlet shoreline with dense Red Drift Algae covering the intertidal zone. Algae were present most of the survey. It began in the spring of 2006 and has continued into the spring season of 2007. Density of the algae varied and disposing of it is controversial on the island. The fresh wrack created by this condition was a popular foraging area for shorebirds throughout the survey area. As the algae aged and dried, fewer birds were observed foraging in it. Large amounts of algae would accumulate and begin to decompose. The associated smell was unpopular with tourists. The city is currently deciding on how to remove the algae and not disturb the island's population of Snowy Plovers once their nesting season begins in the spring of 2007.

Bunche Beach County Preserve

Figure A15. Bunche Beach County Preserve Survey Area.

Bunche Beach County Preserve: This area is located on the mainland side (north) of San Carlos Bay. The narrow beach face is approximately 1 mile long (F1) and has extensive mud flats and ephemeral pools at lower tides (F2). The beach face runs east-west, and is a portion of the 731-acre San Carlos Bay/Bunche Beach County Preserve. It is in Unit FL-25 Critical Habitat for Piping Plover as designated by US Fish and Wildlife. All areas within the yellow polygon were surveyed during each visit. This included the mudflats (F3) to the west of the beach face that are not accessible on foot, but easily viewed by spotting scope, as well as the mudflats (F4) and a wading bird roost island (F5) to the southeast (also not accessible on foot, but viewable by spotting scope). Most foraging and roosting by shorebirds, wading birds, and larids occur at or beyond the east and west ends of the beach face. These mud flats are cut off by the presence of tidal creeks. Bunche Beach is a popular destination with fishermen, beachgoers, and

walkers. Birds using the mud flats are typically flushed when people are present. Bunche Beach and similar habitat extending west to the Sanibel Causeway toll (the entrance to the Caloosahatchee River) are used by more birds for foraging and roosting than any other locations in Lee County. Bowditch Pointe County Park is located directly south across San Carlos Bay (F6).

Figure A1.6. Bunche Beach County Preserve. This image shows the entire Bunche Beach area: both the surveyed area (see Figure A1.5 for reference; the end of survey area on this image is delineated by yellow text and yellow line in center of photo) and the extensive mud flats to the west, which were not surveyed. These mud flats extend west to Sanibel Island Causeway (shown in left side of photo).

Figure A17. P45-Bunche Beach County Preserve: Moderate fresh wrack (Red Drift Algae) in the intertidal zone at medium tide. Old wrack is present at the high tide line. The parking area for the preserve is in the background.

Figure A18. P46-Bunche Beach County Preserve, mudflats west of the parking area at low tide. Red Drift Algae is present in the intertidal zone. The western side of the preserve is most used by shorebirds to forage and roost. Beach walking is common here. Foraging shorebirds are typically flushed by this activity (shorebirds are present just to the left of the people in the upper left of the picture).

Figure A19. P47-Bunche Beach County Preserve: Little Blue Heron foraging in dense wrack (Red Drift Algae) in the intertidal zone.

Figure A20. P48-Bunche Beach County Preserve: Ephemeral pool located at the west end of the beach face area.

Figure A21. P49-Bunche Beach County Preserve: Mud flats and ephemeral pools located at the west end of the beach face area.

Figure A22. P50-Bunche Beach County Preserve: Great White Heron (form of Great Blue Heron) foraging in open water along the bay beach.

Figure A23. P51-Bunche Beach County Preserve: Mudflat and ephemeral pools located at the west end of the beach face area.

Figure A24. P52-Bunche Beach County Preserve: Mud flats and ephemeral pools located at the east end of the beach face area.

Figure A25. P53-Bunche Beach County Preserve: Shorebirds and Snowy Egrets foraging in an ephemeral pool at the east end of the beach face area.

Bowditch Pointe County Park

Figure A 26. Bowditch Points County Park Survey Area.

Bowditch Pointe County Park: This is a 17-acre county park located at the northern tip of Estero Island. Seven acres are a developed park and 10 acres a preserve. It is located on the southeastern side of the entrance to San Carlos Bay and is directly across the bay from Bunche Beach. All areas within the yellow polygon were surveyed during each visit. The beach face at the tip of the island has benefited greatly from shifting sands and has grown since the time of the photo. The expanded area (F1) is primarily a roost location for larids and shorebirds that forage at Bunche Beach, but many small sandpipers and plovers also forage here along the intertidal zone or in the small ephemeral pools (F2) often present at lower tides. Bowditch Point is included with Bunche Beach in Unit FL-25 Critical Habitat for Piping Plover. It is a popular destination for beachgoers on weekends, and also with daily walkers who approach from the south. The beach is small in this area and birds are continuously flushed.

Figure A27. P36-Bowditch Pointe County Park: The main shorebird and larid roosting and foraging area along the intertidal zone of the inlet shoreline at medium tide. This picture shows the diversity of shorebirds and larids present at Bowditch Point. At almost all of the study sites, larids were typically observed roosting in the intertidal zone or on a mud flat and most shorebirds were typically observed roosting in wrack on the beach face, especially old wrack if present. This picture shows these seeming roosting preferences.

Figure A28. P37-Bowditch Pointe County Park: Ephemeral pool (west end of Estero Island and entrance to San Carlos Bay) and the roosting and foraging area along the intertidal zone of the inlet shoreline at low tide (same area as P36). Larids often roost in this general area and shorebirds often roost in old wrack on the beach face to the right. The beach at Bunche Beach County Preserve is visible in the background across San Carlos Bay.

Figure A29. P38-Bowditch Pointe County Park: Roosting group including Marbled Godwit, Willet, Short-billed Dowitcher, and Sandwich Tern.

Figure A30. P39-Bowditch Pointe County Park: Piping Plover roosting in old wrack. During the surveys, four to five Piping Plovers were usually present.

Figure A31. P40-Bowditch Pointe County Park: Snowy Plover roosting in old wrack. During the surveys, one to two Snowy Plovers were usually present.

Figure A32. P41-Bowditch Pointe County Park: Dunlin and Western Sandpiper foraging in fresh wrack (Red Drift Algae) along the intertidal zone.

Figure A33. P42-Bowditch Point County Park: Two people walking with a dog off-leash. Roosting shorebirds and larids were flushed as a result. City ordinances against flushing birds and walking dogs off-leash exist. The county also does not permit dogs in the county park. Bowditch Point is easily accessed by people with dogs, however, as only a sign is posted. No full-time staff is present and the ordinances are not enforced.

Figure A34. P43-Bowditch Pointe County Park: A park worker driving on the beach. Birds were flushed as a result. This was the only time this activity was witnessed. County administrators were provided with a picture in an effort to address use of the route used by maintenance workers.

Figure A35. P44-Bowditch Pointe County Park: Area where shorebirds and larids typically roost. The beach face for Bunche Beach County Preserve is seen across San Carlos Bay.

Little Estero Lagoon

Figure A36. Little Estero Lagoon Survey Area.

Little Estero Lagoon area: This long and narrow area is approximately 25 acres and receives an estimated 36,500 visitors annually. The lagoon stretches from Big Carlos Pass northward for approximately 1 mile. All areas within the yellow polygon were surveyed during each visit. The land side of the lagoon is mostly developed with residential buildings with some dune scrub (F1) present as a buffer along the southern half of the lagoon. The Gulf-side of the lagoon is comprised of an open beach and dune system (F2) in the southern two-thirds while the northern third has mangroves between the lagoon and the beach (F3). Foraging by shorebirds and wading birds occurs throughout the lagoon, but is more predominant in the northern two-thirds. Post Hurricane Charley, more spring and fall migrants have been observed in the southern third of the lagoon. An extensive mud flat exists in the central portion of the lagoon, which attracts numerous larids to roost and shorebirds to forage (F4). The channel connecting the lagoon to the Gulf is south of the mangroves and north of the largest mudflat (F5). The channel location changes

approximately every two years as the influence of weather and tides makes this a dynamic coastal area. The majority of nesting activity occurs along the outer beach dunes of the southern half of the lagoon where Least Tern, Wilson's Plover and an occasional Snowy Plover are known to nest. This stretch of beach has built up a higher elevation and supports suitable nesting vegetation (F6). At the northern end of the lagoon is a very wide beach face that begins at the Fort Myers Beach Holiday Inn and continues north for about 0.5 mile (F7). This beach area is controlled by the hotels and condominiums that border and maintain it. The beach is raked above the wrack line (a city ordinance protects the wrack). Multiple concession stands including beach chairs, umbrellas, cabanas, jet skis, and parasailing exist on the beach. While this is an extremely busy and disturbed area, it also can be quite active with shorebirds and larids both roosting and foraging. A few portions of this beach host large ephemeral pools after heavy rains or extreme high tides (F8). These areas were included in the surveys, although they are technically outside the critical wildlife area boundary. It should also be noted that locally the lagoon area is referred to as Little Estero Lagoon, but the official name of the area is state designated Little Estero Island Critical Wildlife Area. It is also Unit FL-26 Critical Habitat for Piping Plover as designated by US Fish and Wildlife.

Figure A37. P26-Little Estero Lagoon: beach adjacent to the Holiday Inn where ephemeral pools can be found. None were present this day, as they are reliant on heavy rains or extreme high tides. Cabanas are visible in the upper background.

Figure A38. P27-Little Estero Lagoon: Beach concession stand on the beach face adjacent to the Holiday Inn.

Figure A39. P28-Little Estero Lagoon: Most recent location of the channel connecting the lagoon to the Gulf. It is passable on foot at low tide and is a popular area with fishermen.

Figure A40. P29-Little Estero Lagoon: Small sandbar located just outside the channel that presently connects the lagoon to the Gulf.

Figure A41. P30-Little Estero Lagoon: This area located in the central lagoon has been the main shorebird foraging and larid roosting area for the past 10 years.

Figure A42. P31-Little Estero Lagoon: This mud flat area is a result of a previous inlet/cut area (closed by Hurricane Charley). It was the favored foraging area for the 10 Piping Plover that were present in the winter of 2005-2006.

Figure A43. P32-Little Estero Lagoon: This is an area at the south end of the lagoon that Red Knot seemed to favor for foraging during the survey. Ephemeral pools, shallow water areas, and mud flats are created here as the tide goes out. In general, spring and fall migrants use the south end of the lagoon to forage and roost, but summering and wintering shorebirds tend to favor the central lagoon area.

Figure A44. P33-Little Estero Lagoon: Red Knots foraging in an ephemeral pool at the south end of the lagoon (area was mentioned in P30).

Figure A45. P34-Little Estero Lagoon: Example of the banded Red Knots found in large numbers at the lagoon in September. Most of these birds were banded the previous winter in southwest Florida. This individual was banded 2 January 06 at North Captiva Island by Brian Harrington.

Figure A46. P35-Little Estero Lagoon: Area close to the southern tip of the lagoon. It is occasionally used by shorebirds for foraging and roosting; more so during migration periods than summer or winter.

Big Carlos Pass

Figure A47. Big Carlos Pass Survey Area.

Big Carlos Pass: This inlet is very wide and is located between Estero Island on the north and Lover's Key on the south. All areas within the yellow polygon were surveyed during each visit. The north and south sides of the pass were surveyed separately. The Estero Island side is completely developed with condominiums and beaches are raked from the buildings to the high tide line (F1). Most wrack below this point is not removed unless there is a nuisance situation. A city ordinance protects the wrack from removal. The north end of this area abuts the Little Estero Lagoon Critical Wildlife Area. The south end is at the base of a bridge and is popular with fishermen and waders. An extreme low tide here will expose a small mud flat that attracts shorebirds (F2). The Lover's Key side of the pass is an undeveloped state park (with the exception of some condominiums on the bay side of the bridge), but is accessible to beachgoers by a parking lot (F3). Bird use is limited on the south side of the pass as the beach is very narrow and is popular with beachgoers and boaters (F4). The proximity of Little Estero Lagoon to the north (F5) and Estero Bay (F6) to the east are also factors, as those locations may attract birds away from the busy inlet area.

Figure A48. P19-Big Carlos Pass: Bridge connecting Estero Island and Lover's Key.

Figure A49. P20-Big Carlos Pass: Boats are parked along this stretch of beach at Lover's Key almost daily.

Figure A50. P21-Big Carlos Pass: Lover's Key (south side) shoreline along Big Carlos Pass.

Figure A51. P22-Big Carlos Pass: Lover's Key (south side) shoreline along Big Carlos Pass.

Figure A52. P23-Big Carlos Pass: View of the entrance to Big Carlos Pass from Lover's Key. Estero Island is in the upper right.

Figure A53. P24-Big Carlos Pass: View from under the bridge over Big Carlos Pass from Estero Island (north side). A few wading birds were typically present at this location.

Figure A54. P25-Big Carlos Pass: View into Big Carlos Pass looking south from Little Estero Lagoon. This is where the survey area for the north side of Big Carlos Pass meets the survey area for Little Estero Lagoon Critical Wildlife Area.

Lover's Key Lagoon

Figure A55. Lover's Key Lagoon Survey Area.

Lover's Key Lagoon area: This area is within Lover's Key State Park and includes a lagoon with a sandbar area that may have resulted from past storm washovers. The sandbar is built up enough to be partially present at high tide, making it a popular roosting and foraging area. Low tide exposes a mud flat around the sandbar (F1). The lagoon itself is often shallow enough for wading birds to forage or roost at any tide. An area of exposed dead mangroves is a popular roosting area for Double Crested Cormorant and Brown Pelican (F2). The dune area between the lagoon and the Gulf was a Least Tern nesting area in spring 2006 and is posted year round (F3). The beach is a popular public destination with a gazebo, rest rooms, and a food concession (F4). The beach is accessed via a tram that shuttles people across the lagoon from the parking lot (F5).

Figure A56. P14-Lover's Key lagoon: Posted dunes are shown in the foreground, the sandbar in the upper right, and a small section of the tram bridge in the far right.

Figure A57. P15-Lover's Key lagoon: Dunes and postings that protect the area just to the north of the previous picture.

Figure A58. P16-Lover's Key lagoon: Tram bridge that crosses the lagoon.

Figure A59. P17- Lover's Key lagoon: Gazebo just behind a dune restoration area. Restrooms are beyond the gazebo, and a food concession is in the background to the right.

Figure A60. P18- Lover's Key lagoon: The beach face on the Gulf side of the lagoon is a very popular beach area on weekends and holidays. Least Terns nest on the right side of the sting fence at this location. ATV tracks that run parallel to the fence belong to the Florida Park Service.

New Pass area

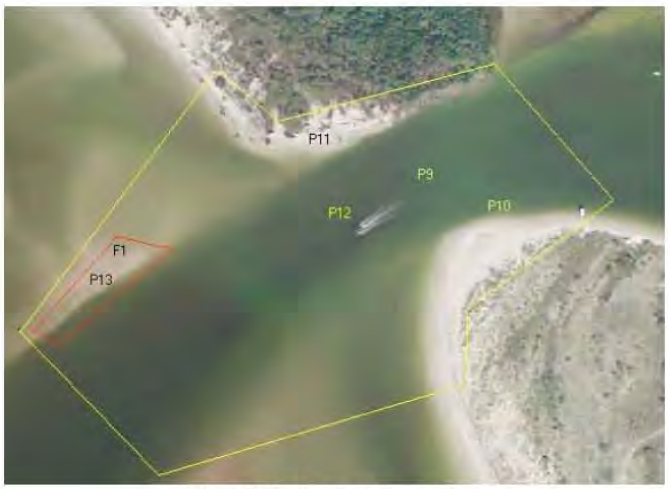


Figure A61. New Pass Survey Area

New Pass: This inlet is between Lover's Key on the north and Big Hickory Island on the south. All areas within the yellow polygon were surveyed during each visit. North and south sides of the pass were surveyed separately. Neither side of this pass is heavily used by birds, as both shorelines are fairly narrow. This pass is about 75 m in width and is heavily used by boaters to access the Gulf. There is an ebb shoal 100+ m outside the pass that is exposed at low tide and used primarily for roosting by larids and pelicans (F1). Boaters also use this shoal to anchor and fish or wade in the shallow water.

Figure A62. P9-New Pass: View of Big Hickory Island across the pass from Lover's Key (north side).

Figure A63. P10-New Pass: Boats parked on Big Hickory Island (south side).

Figure A64. P11-New Pass: Beach and intertidal area along the pass shoreline on Lover's Key (north side). Photo shows the limited amount of land available for bird use on this side of the pass. During the previous spring, this area was built up with more sand and was used as a roost area by larids. ATV tracks in the intertidal zone are from the Florida Park Service. They are the only operators of ATVs, as the entire island is a state park.

Figure A65. P12- New Pass: Boat traffic in the pass.

Figure A66. P13- New Pass: Ebb shoal outside the pass. The shallowness of the area can be seen, as well as the boat usage (which can be quite heavy at times) and people wading. When a sandbar is exposed, it is a popular roosting area for larids.

Big Hickory Pass

Figure A67. Big Hickory Pass Survey Area.

Big Hickory Pass: This inlet separates Big Hickory Island on the north and Bonita Beach on the south. All areas within the yellow polygon were surveyed during each visit. North and south sides of the pass were surveyed separately. The south side of this location is used by shorebirds and larids for both roosting and foraging. A spit and mudflat area create a narrow pass (estimated 35-40 m in width). Much of this area remains exposed at high tide (F1), but there is an ephemeral pool created during varying low tides (F2). It is an attractive area to fishermen. Roosting and foraging birds are disturbed at all tide levels as the fishermen move around the area. The north side of the pass is limited to a small beach face that boaters use as a parking area (F3). There are three groins on the south side of the inlet (F4).

Figure A68. P1-Big Hickory Pass. Three groins are located on the Bonita Beach (south) side of the pass. Few birds were observed near or between the groins during the fall surveys. The southernmost groin is in the foreground.

Figure A69. P2-Big Hickory Pass. This is low tide and the northernmost of the three groins is in the foreground. The exposed area to the center right is a spit and the far right is a mudflat on the inlet shoreline. The mud flat holds an ephemeral pool at low tide.

Figure A70. P3-Big Hickory Pass: Difference between low and high tide is apparent by comparing this spot with P2. Northernmost groin is just to the left of this picture. The spit (center top of picture) is a popular roost site for larids. Mud flat to the right is submerged at high tide.

Figure A71. P4-Big Hickory Pass. A fisherman on the Gulf side of the spit on the Bonita Beach (south) side of the pass. A number of vehicle tracks are present.

Figure A72. P5-Big Hickory Pass: The inlet side of the spit with fishermen on the Bonita Beach (south) side of the pass.

Figure A73. P6-Big Hickory Pass: This is the main foraging area for shorebirds when the mud flat and ephemeral pool are present at low tide. Larids are seen roosting and bathing, while shorebirds are foraging in and along the inlet side of the spit as the tide is receding and the flat and pool are exposed.

Figure A74. P7-Big Hickory Pass: Ephemeral pool located on the mudflat on the Bonita Beach (south) side of the pass. This is another view of at the area in Figure A73 (P6) at a lower tide.

Figure A75. P8-Big Hickory Pass: View of Big Hickory Island, which is located on the north side of the pass. The pass is very narrow (the picture was taken from the south side). A few boats can be seen parked in the top center of the photo. This area is heavily used on weekends.

Appendix B: Lee County Fall Migration Survey Data Form

Florida Coastal Bird and Bird Habitat Survey Datasheet **Page 1**

Survey location

Site Name _____ **Survey segment type** (*circle one below*)
Island Name (if applicable)_____ **Point to point (linear) area search (polygon)**

Start GPS location (if linear survey) N_____W_____
End GPS location (if linear survey) N_____W_____
Record a general GPS location for survey areas for area searches in the Start GPS field only.

Limits of all area search sites should be illustrated by drawing polygons on top of aerial photos

Survey effort details (use 24hr clock, e.g., 1400)

Date _____ **Weekend? y n Observer** _____ **Start Time** _____ **End Time** _____

Weather and tide conditions

Temp (°F) _____ **General weather (circle one) Sunny Partly cloudy Cloudy Rain Fog**
Wind speed (Beaufort scale) _____ **Wind direction (16 points, e.g. NNE)** _____
Tide (circle one) low (intertidal area 76-100% exposed) medium (26-75%) high (0-25%)
Tide direction (circle one) falling rising

Bird observations (*shorebirds, seabirds, wading birds, raptors, and egg predators only*)

Sp.	Number	Individ./ Prs./chks (i/p/c)	Behav.[b] (nC/nS/r/f)	GPS location[c] North	West	Substr./ Habitat[d]	Landsc.[e]	Band[f]

Lee County Coastal Bird and Bird Habitat Survey Datasheet Page 2

Disturbance data

people (on foot) present _____
ATVs or ATV tracks present y n location (circle one) beach dune both
Vehicles or vehicle tracks present y n location (circle one) beach dune both
Dog tracks present y n location (circle one) beach dune both
Racoon tracks present y n location (circle one) beach dune both
# of dogs observed _____ # of cats observed _____
# of boats parked within 50m of shore _____ # of boats traveling within 50m of shore _____
# of major access points (parking lot, major trail, dune walkover, or marina) _____
Notes on disturbance _____

Habitat data

% shoreline covered with wrack (linear coverage parallel to shore) _____
Average width wrack (perpendicular to shore) in .25 meter increments (e.g., 1.75, 3.5) _____
Wrack density (circle one) sparse moderate dense
Beach cleaning (e.g., raking, wrack removal) evident y n % of area cleaned _____

Washover fans present y n Ephemeral pools present y n
Sand spits present y n Emergent offshore shoals present y n
Bay side flats accessible to chicks y n Lagoon areas accessible to chicks y n

% of area immediately landward of beach covered by various landforms (sum = 100)

Sparsely vegetated dunes	_____	Heavily vegetated dunes	_____
Houses or other buildings	_____	Engineering structures	_____
Coastal scrub or climax vegetation	___	Other _____	_____

Footnotes describing codes and formats

[b] nC= nesting confirmed, nS= nesting suspected, r= roost/loaf/preen, f= foraging

[c] Provide GPS locations for the following two types of observations only: 1) all color banded birds (any season); 2) all SNPL, WIPL, AMOY, BLSK, or LETE nesting pairs (nS), nests (nC), or colonies (nC) (breeding only).

[d] dry sand (ds), intertidal sand or mud (in), fresh wrack (fw), old wrack (ow), ephemeral pool (ep), vegetation (ve), rubble/rock (ru), open water (ow).

[e] ocean beach (ob), bay beach (bb), washover/blowout (wa), dune (du), back dune (bd), supratidal/salt pan (st), upland (up), inlet shoreline (in), ebb shoal (es), flood shoal (fs), salt marsh (sm), tidal creek (tc), lagoon (la), dredged-material island (di), natural island (ni), oyster reef/shellfish bed (oy), river outlet (ri), mangrove (ma), seagrass (sg). Rocky shore (rs), jetty/groin (je), developed (de), shallow water (sw).

[f] Reporting format for color bands describes bands in four different positions with a standard syntax. This is: upper left (tibia), lower left (tarsus): upper right (tibia) , lower right (tarsus). The standard syntax is a comma between upper and lower bands and a colon between left and right leg (or x,x:y,y where x is the bird's left leg and y is the bird's right leg). Codes for different bands are: X: metal, f: flag, R: red, Y: yellow, O: orange, B: dark blue; b: light blue; W: white, G: dark green; g: light green; L: black; A: gray; T: other (describe); –: no band; N: band not seen; /: split band; //:triple split band. Report split bands as top color/ bottom color (e.g. L/g is a split band with black over light green). Report stacked bands as top color bottom color with no syntax (e.g., Lg is a black band stacked on top of a light green band). Report colored flags with the color code and then the letter f for flag with no syntax (e.g., Rf is a red flag).

Beaufort scale number	Descriptive term	Units in km/h	Units in knots	Description on Land	Description at Sea
0	Calm	0	0	Smoke rises vertically	Sea like a mirror.
1-3	Light winds	19 km/h or less	10 knots or less	Wind felt on face; leaves rustle; ordinary vanes moved by wind.	Small wavelets, ripples formed but do not break: A glassy appearance maintained.
4	Moderate winds	20 - 29 km/h	11-16 knots	Raises dust and loose paper; small branches are moved.	Small waves - becoming longer; fairly frequent white horses.
5	Fresh winds	30 - 39 km/h	17-21 knots	Small trees in leaf begin to sway; crested wavelets form on inland waters.	Moderate waves, taking a more pronounced long form; many white horses are formed - a chance of some spray.
6	Strong winds	40 - 50 km/h	22-27 knots.	Large branches in motion; whistling heard in telephone wires.	Large waves begin to form; the white foam crests are more extensive with probably some spray.
7	Near gale	51 - 62 km/h	28-33 knots	Whole trees in motion; inconvenience felt when walking against wind.	Sea heaps up and white foam from breaking waves begins to be blown in streaks along direction of wind.
8	Gale	63 - 75 km/h	34-40 knots	Twigs break off trees; progress generally impeded.	Moderately high waves of greater length: edges of crests begin to break into spindrift; foam is blown in well-marked streaks along the direction of the wind.
9	Strong gale	76 - 87 km/h	41-47 knots	Slight structural damage occurs -roofing dislodged; larger branches break off.	High waves; dense streaks of foam; crests of waves begin to topple, tumble and roll over; spray may affect visibility.
10	Storm	88 - 102 km/h	48-55 knots	Seldom experienced inland; trees uprooted; considerable structural damage.	Very high waves with long overhanging crests; the resulting foam in great patches is blown in dense white streaks; the surface of the sea takes on a white appearance; the tumbling of the sea becomes heavy with visibility
11	Violent storm	103 -117 km/h	56-63 knots	Very rarely experienced - widespread damage.	Exceptionally high waves; small and medium sized ships occasionally lost from view behind waves; the sea is completely covered with long white patches of foam; the edges of wave crests are blown into froth.
12+	Hurricane	118 km/h or more	64 knots or more		The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected.

ENGLISH NAME	CODE	SCIENTIFIC NAME	ENGLISH NAME	CODE	SCIENTIFIC
American White Pelican	AWPE	Pelecanus erythrorhynchos	American Avocet	AMAV	Recurvirostra
Brown Pelican	BRPE	Pelecanus occidentalis	Greater Yellowlegs	GRYE	Tringa
Double-crested Cormorant	DCCO	Phalacrocorax auritus	Lesser Yellowlegs	LEYE	Tringa flavipes
Great Cormorant	GRCO	Phalacrocorax carbo	Solitary Sandpiper	SOSA	Tringa solitaria
Great Blue Heron	GBHE	Ardea herodias	Willet	WILL	Catoptrophorus
Great Egret	GREG	Ardea alba	Whimbrel	WHIM	Numenius
Snowy Egret	SNEG	Egretta thula	Long-billed Curlew	LBCU	Numenius
Little Blue Heron	LBHE	Egretta caerulea	Hudsonian Godwit	HUGO	Limosa
Tricolored Heron	TRHE	Egretta tricolor	Marbled Godwit	MAGO	Limosa fedoa
Reddish Egret	REEG	Egretta rufescens	Ruddy Turnstone	RUTU	Arenaria
Cattle Egret	CAEG	Bubulcus ibis	Red Knot	REKN	Calidris canutus
Green Heron	GRHE	Butorides virescens	Sanderling	SAND	Calidris alba
Black-crowned Night-Heron	BCNH	Nycticorax nycticorax	Semipalmated Sandpiper	SESA	Calidris pusilla
Yellow-crowned Night-Heron	YCNH	Nyctanassa violacea	Western Sandpiper	WESA	Calidris mauri
White Ibis	WHIB	Eudocimus albus	Least Sandpiper	LESA	Calidris minutilla
Glossy Ibis	GLIB	Plegadis falcinellus	Dunlin	DUNL	Calidris alpina
Roseate Spoonbill	ROSP	Platalea ajaja	Curlew Sandpiper	CUSA	Calidris
Wood Stork	WOST	Mycteria americana	Short-billed Dowitcher	SBDO	Limnodromus
Osprey	OSPR	Pandion haliaetus	Unidentified Dowitcher	UNDO	Limnodromus
Bald Eagle	BAEA	Haliaeetus leucocephalus	Long-billed Dowitcher	LBDO	Limnodromus
Northern Harrier	NOHA	Circus cyaneus	Laughing Gull	LAGU	Larus atricilla
Sharp-shinned Hawk	SSHA	Accipiter striatus	Ring-billed Gull	RBGU	Larus
Cooper's Hawk	COHA	Accipiter cooperii	Herring Gull	HERG	Larus
Unidentified Accipiter Hawk	UNAH	Accipiter (sp)	Lesser Black-backed Gull	LBBG	Larus fuscus
Red-shouldered Hawk	RSHA	Buteo lineatus	Unidentified Gull	UNGU	Larus (sp)
Red-tailed Hawk	RTHA	Buteo jamaicensis	Gull-billed Tern	GBTE	Sterna nilotica
American Kestrel	AMKE	Falco sparverius	Caspian Tern	CATE	Sterna caspia
Merlin	MERL	Falco columbarius	Royal Tern	ROYT	Sterna maxima
Peregrine Falcon	PEFA	Falco peregrinus	Sandwich Tern	SATE	Sterna
Black-bellied Plover	BBPL	Pluvialis squatarola	Roseate Tern	ROST	Sterna dougallii
Snowy Plover	SNPL	Charadrius alexandrinus	Common Tern	COTE	Sterna hirundo
Wilson's Plover	WIPL	Charadrius wilsonia	Least Tern	LETE	Sterna
Semipalmated Plover	SEPL	Charadrius semipalmatus	Yellow-billed Tern	YBTE	Sterna
Piping Plover	PIPL	Charadrius melodus	Black Skimmer	BLSK	Rynchops niger
Killdeer	KILL	Charadrius vociferus	American Crow	AMCR	Corvus
American Oystercatcher	AMOY	Haematopus palliatus	Fish Crow	FICR	Corvus
Black-necked Stilt	BNST	Himantopus mexicanus	Unidentified Crow	UNCR	Corvus (sp)

Appendix C: Site-specific Results

Counts by species varied considerably from site to site. Therefore, cumulative and maximum counts are presented separately by species for each site. Site-specific summaries highlight sites where >10 percent of a species' foraging or roosting observations occurred. Foraging and roosting landform use showed considerable variation among sites, as there was greater variation in the presence of different landforms among sites than substrates, which were consistently available at multiple sites. Where more than one landform or substrate was used at a site, tables describe habitat use for all species combined. Site-specific results are presented from northwest to southeast.

Charley Pass

Counts by species

The 11,434 observations at Charley Pass comprised 25.6 percent of all observations across the study area. Roosting observations for this site totaled 10,452, which amounted to 91.4 percent of all the observations for the site and 37.6 percent of all roosting observations for the entire study area. Twenty-one species were observed at Charley Pass, several of which were recorded in relatively large numbers for both foraging and roosting (Table C1). Of the 23 species with >33 foraging observations across the entire study area, seven species had >10 percent of their regional foraging observations at this site. From the highest to lowest percentage of regional foraging observations, these were: Snowy Plover, Semipalmated Plover, Ruddy Turnstone, Least Sandpiper, Sanderling, Black-bellied Plover, and Semipalmated Plover (Table 5 in the main text). Snowy Plovers were recorded foraging at only four locations. The 10 foraging observations for Snowy Plover at Charley pass represent 30.3 percent of all foraging observations for this species. Six species had >10 percent of their regional roosting observations at this site. From the highest to lowest percentage of regional roosting observations, these were: Sandwich Terns, Brown Pelicans, Royal Terns, Black Skimmers, Black-bellied Plovers, and Laughing Gulls (Table 6 in the main text). The 7,000 roosting observations

for Sandwich Terns represented 60.6 percent of all roosting observations for this species.

Table C1. Cumulative and maximum counts by behavior at Charley Pass. Species are listed in taxonomic order.

Species	Code	Cumulative Counts		Maximum Count	
		Foraging	Roosting	Foraging	Roosting
Brown Pelican	BRPE		881		500
Black-bellied Plover	BBPL	35	25	15	25
Snowy Plover	SNPL	10		6	
Wilson's Plover	WIPL	2	5	2	5
Semipalmated Plover	SEPL	88	40	50	40
Piping Plover	PIPL	6		6	
Willet	WILL	56	5	29	5
Lesser Yellowlegs	LEYE		2		2
Ruddy Turnstone	RUTU	113		42	
Red Knot	REKN	40		26	
Sanderling	SAND	232		103	
Semipalmated Sandpiper	SESA	30		17	
Western Sandpiper	WESA	178		100	
Least Sandpiper	LESA	146		54	
Dunlin	DUNL	1		1	
Short-billed Dowitcher	SBDO	45		23	
Laughing Gull	LAGU		1167		925
Forster's Tern	FOTE		3		3
Royal Tern	ROYT		839		500
Sandwich Tern	SATE		7000		3000
Black Skimmer	BLSK		485		200

Habitat use by landform and substrate

All foraging and roosting observations at this site were recorded on a single landform, the large flood shoal that was created when this new inlet opened during the passing of Hurricane Charley in 2004. Refer to Figures A1 through A8 for images of the flood shoal at Charley Pass. All observations were either on intertidal or shallow water substrates, and substrate preferences by species at this site closely matched the overall substrate preferences shown in Figures 2 and 3 in the main text.

Disturbance

Disturbance was high at this site as the flood shoal at Charley Pass is a very popular destination for boaters (Table C2). This site had the highest numbers of people, parked boats, and dogs within the entire study area, despite the fact that this site required boat access.

Table C2. Charley Pass disturbance factors.

Avg N people	37
Max N people	42
ATVs present	No
Vehicles present	No
Ave N dogs	2
Ave N parked boats	22
N access points	1
Beach cleaning present	No

Redfish Pass

The 179 observations at this site comprised 0.4 percent of all observations across the study area. Species diversity was low at Redfish Pass as only nine species were observed at this site (Table C3). No species had >11 foraging observations at this site and the majority of observations (87.7 percent) at this site were roosting larids (Table C3). No species had >10 percent of their regional foraging or regional roosting observations at this site.

Table C3. Cumulative and maximum counts by behavior at Redfish Pass. Species are listed in taxonomic order.

		Cumulative Counts		Maximum Count	
Species	Code	Foraging	Roosting	Foraging	Roosting
Great Egret	GREG	1		1	
Snowy Egret	SNEG	2		2	
Black-bellied Plover	BBPL	1		1	
Willet	WILL	4		2	
Ruddy Turnstone	RUTU	3		3	
Sanderling	SAND	11		6	
Laughing Gull	LAGU		22		11
Royal Tern	ROYT		52		27
Sandwich Tern	SATE		83		32

Habitat use by landform and substrate

All foraging and roosting observations at this site were recorded at a single landform, the inlet shoreline. Refer to Figures A9 and A10 for images of the Redfish Pass study area. No wrack was present at this site and all observations occurred either on intertidal or shallow-water substrates, with substrate preferences by species at this site closely matching the overall substrate preferences shown in Figures 2 and 3 in the main text.

Disturbance

Disturbance at Redfish Pass was very low relative to other sites (Table C4).

Table C4. Redfish Pass disturbance factors.

Avg N people	1
Max N people	3
ATVs present	No
Vehicles present	No
Ave N dogs	0
Ave N parked boats	0
N access points	0
Beach cleaning present	No

Sanibel Lighthouse

The 541 observations at this site comprised only 1.2 percent of all observations across the study area. Sixty-six percent of all observations at this site were foraging observations. Of the 19 species observed at Sanibel Lighthouse, a majority (>68 percent) of these used the site exclusively for foraging (Table C5). Counts within each species observed, however, were relatively low. Of the 23 species with >33 foraging observations across the entire study area, only two species, Sandwich terns and Reddish Egrets, had >10 percent of their regional foraging observations at this site (Table C5) and no species had >10 percent of their regional roosting observations at this site. Across the whole study area, very few Sandwich Terns were observed foraging (compared to the large number observed roosting). The 74 Sandwich Tern foraging observations at Sanibel Lighthouse represented 96.1 percent of all foraging observations for this species.

Table C5. Cumulative and maximum counts by behavior at Sanibel Lighthouse. Species are listed in taxonomic order.

Species	Code	Cumulative Counts		Maximum Count	
		Foraging	Roosting	Foraging	Roosting
Brown Pelican	BRPE	1		1	
Great Blue Heron	GBHE	2		1	
Great Egret	GREG	12	2	4	2
Snowy Egret	SNEG	50	10	12	10
Reddish Egret	REEG	8		2	
Black-bellied Plover	BBPL	14		4	
Willet	WILL	39		8	
Ruddy Turnstone	RUTU	29		7	
Red Knot	REKN	2		2	
Sanderling	SAND	66		19	
Western Sandpiper	WESA	10		10	
Short-billed Dowitcher	SBDO	1		1	
Laughing Gull	LAGU	19	112	17	32
Least Tern	LETE	1		1	
Black Tern	BLTE	12		12	
Common Tern	COTE	2		2	
Forster's Tern	FOTE		2		2
Royal Tern	ROYT	15	9	15	7
Sandwich Tern	SATE	74	49	62	21

Habitat use by landform and substrate

Birds were observed foraging at three major landforms at Sanibel Lighthouse (Table C6). From most to least common, these were: the inlet shoreline, the ocean beach, and the bay beach. Refer to Figures A11 through A14 for images of the Sanibel Lighthouse study area. Foraging observations were common for three substrates. From most to least common, these were: shallow water, fresh wrack, and intertidal sands and muds (Table C6).

Birds were observed roosting at three landforms at Sanibel lighthouse (Table C7). From most to least common, these were: ocean beach, inlet shoreline, and bay beach. Birds were observed roosting mostly on intertidal substrates, or secondarily, on dry sand. A very small number of birds were observed roosting in shallow water (Table C7).

Table C6. Foraging substrate and landform use by all species at Sanibel Lighthouse.

	Foraging landform			
Foraging substrate	Bay beach	Inlet shoreline	Ocean beach	Totals
Fresh wrack		65	82	147
Intertidal	22	2	7	31
Shallow water	58	121		179
Totals	80	176	89	357

Table C7. Roosting substrate and landform use by all species at Sanibel Lighthouse.

	Roosting landform			
Roosting substrate	Bay beach	Inlet shoreline	Ocean beach	Totals
Dry sand	10		46	56
Intertidal	26	47	53	126
Shallow water	2			2
Totals	38	47	99	184

Disturbance

As Sanibel Lighthouse is located within a city park, it is a popular public destination. A high number of people were observed at Sanibel Lighthouse and dogs were recorded present during four of the eight site visits (Table C8).

Table C8. Sanibel Lighthouse disturbance factors.

Avg N people	26
Max N people	45
ATVs present	No
Vehicles present	No
Ave N dogs	1
Ave N parked boats	0
N access points	2
Beach cleaning present	No

Bunche Beach

Bunche Beach proved to be the most important of the study sites as the greatest number of birds (both foraging and roosting combined) were recorded here. Despite the high count totals for Bunche Beach, these are likely underestimates, since extensive mud flats exist to the immediate west of where the survey area ended and extend west to the Sanibel Island Causeway. These mud flats were not accessible by foot, since they are separated from the accessible mudflats by a tidal creek, nor could they be viewed by spotting scope. Birds using these flats for foraging and/or roosting were therefore not included in these counts. Figure A15 delineates the area that was surveyed at Bunche Beach. Figure A16 shows all of Bunche Beach including these extensive flats to the west that were not able to be surveyed.

The 15,664 observations at this site comprised 35 percent of all observations across the study area. Foraging observations at Bunche Beach totaled 9,777, which amounted to 62.4 percent of all observations at this site and 57.6 percent of all foraging observations for the entire study area. Roosting observations totaled 5,887, which amounted to 37.6 percent of all the observations for the site and 21.2 percent of all roosting observations for the entire study area. Bunche Beach ranked highest in species diversity with 39 species observed; 22 of the 39 species (>56 percent) used Bunche Beach exclusively for foraging (Table C9).

Bunche Beach is a very important site for many foraging and roosting species. Of the 23 species with more than 33 foraging observations across the entire study area, 21 species had more than 10 percent of their regional foraging observations at this site (Table C10). Bunche Beach is so important for foraging species that 12 of these 21 species had more than 50 percent of their regional foraging observations recorded at this site (Table C10). Piping Plovers were recorded foraging at only four sites with the highest count recorded at Bunche Beach. The 32 foraging observations for Piping Plover at this site represented 48.5 percent of all foraging observations for this species.

Table C9. Cumulative and maximum counts by behavior at Bunche Beach. Species are listed in taxonomic order.

Species	Code	Cumulative Counts		Maximum Count	
		Foraging	Roosting	Foraging	Roosting
Brown Pelican	BRPE		424		156
Double-crested Cormorant	DCCO		68		33
Great Blue Heron	GBHE	23		12	
Great Egret	GREG	578		200	
Snowy Egret	SNEG	452		100	
Little Blue Heron	LBHE	270		144	
Reddish Egret	REEG	20		6	
White Ibis	WHIB	754		400	
Roseate Spoonbill	ROSP	26	5	10	5
Wood Stork	WOST	3		3	
Osprey	OSPR		1		1
Black-bellied Plover	BBPL	157		42	
Snowy Plover	SNPL	3		1	
Wilson's Plover	WIPL	35		6	
Semipalmated Plover	SEPL	347		60	
Piping Plover	PIPL	32		6	
American Avocet	AMAV	4	2	4	2
Spotted Sandpiper	SPSA	1		1	
Willet	WILL	496	100	177	100
Lesser Yellowlegs	LEYE	2		2	
Marbled Godwit	MAGO	141		32	
Ruddy Turnstone	RUTU	107		42	
Red Knot	REKN	183		140	
Sanderling	SAND	584		180	
Semipalmated Sandpiper	SESA	72		40	
Western Sandpiper	WESA	2057		500	
Least Sandpiper	LESA	573		137	
Dunlin	DUNL	76		53	
Short-billed Dowitcher	SBDO	2781	500	800	500
Laughing Gull	LAGU		863		200
Ring-billed Gull	RBGU		3		2
Least Tern	LETE		9		8
Caspian Tern	CATE		1		1
Common Tern	COTE		1		1
Forster's Tern	FOTE		103		40
Royal Tern	ROYT		523		250
Sandwich Tern	SATE		2605		2000
Black Skimmer	BLSK		679		215

Nine species had more than 10 percent of their regional roosting observations at this site. From the highest to lowest percentage of regional roosting observations, these were: Short-billed Dowitcher, Forster's Tern, Black Skimmer, Willet, Double-crested Cormorant, Royal Tern, Sandwich Tern, Brown Pelican, and Laughing Gull (Table C10). The 500 Short-billed Dowitcher roosting observations at Bunche Beach represented 87.9 percent of all roosting observations for this species. The 103 Forster's Tern roosting observations at Bunche Beach represented 69.1 percent of all roosting observations for this species. The 679 Black Skimmer roosting observations at Bunche Beach represented 50 percent of all roosting observations for this species.

Table C10. Species with >10 percent of their regional foraging observations recorded at Bunche Beach.

Species	N Foraging	Regional Percentage of Foraging Observations
Little Blue Heron	270	94.1%
Short-billed Dowitcher	2781	89.6%
White Ibis	754	88.9%
Marbled Godwit	141	84.9%
Great Egret	578	79.3%
Dunlin	76	73.1%
Snowy Egret	452	69.2%
Western Sandpiper	2057	59.3%
Willet	496	58.3%
Roseate Spoonbill	26	56.5%
Semipalmated Sandpiper	72	56.3%
Great Blue Heron	23	52.3%
Black-bellied Plover	157	49.5%
Piping Plover	32	48.5%
Least Sandpiper	573	46.6%
Semipalmated Plover	347	40.7%
Reddish Egret	20	38.5%
Sanderling	584	28.3%
Wilson's Plover	35	19.9%
Ruddy Turnstone	107	19.0%
Red Knot	183	18.0%

Habitat use by landform and substrate

Birds were observed foraging at two major landforms at Bunche Beach (Table C11). Essentially all foraging observations (99.7 percent) were recorded on the bay beach with the remaining small number of observations recorded on the ocean beach. Refer to Figures A15 through A25 in Appendix A for images of the Bunche Beach study area. Foraging observations were commonly recorded on four substrates. From most to least common, these were: intertidal substrates, ephemeral pool, shallow water, and fresh wrack (Table C11).

All roosting observations at Bunche Beach were recorded on a single landform, the bay beach. Essentially all roosting observations were recorded on intertidal substrates, with only 5 out of 5,887 observations occurring in shallow water.

Table C11. Foraging substrate and landform use by all species at Bunche Beach.

	Foraging Landform		
Foraging Substrate	**Bay Beach**	**Ocean Beach**	**Totals**
Ephemeral pool	2164		2164
Fresh wrack	1550		1550
Intertidal	3912	32	3944
Shallow water	2119		2119
Totals	9745	32	9777

Disturbance

Bunche Beach is a county preserve and is a popular public destination. A high number of people were recorded at Bunche Beach (Table C12).

Table C12. Bunche Beach disturbance factors.

Avg N people	22
Max N people	38
ATVs present	No
Vehicles present	No
Ave N dogs	0
Ave N parked boats	0
N access points	1
Beach cleaning present	No

Bowditch Point

The 4,553 observations at this site comprised 10.2 percent of all observations across the study area. Roosting observations at Bowditch Point totaled 4,000, which amounted to 87.9 percent of all observations at this site and 14.4 percent of all roosting observations for the entire study area. Twenty-two species were recorded at Bowditch Point with only three species using this site exclusively for foraging (Table C13). Of the 23 species with more than 33 foraging observations across the entire study area, five species had more than 10 percent of their regional foraging observations at this site. From the highest to lowest percentage of regional foraging observations, these were: Piping Plover, Dunlin, Wilson's Plover, Snowy Plover, and Semipalmated Plover (Table 5 in the main text). Bowditch Point recorded the second highest count for foraging Piping Plovers. The 21 foraging observations for Piping Plover at this site represented 31.8 percent of all foraging observations for this species. Bowditch Point was very important for many roosting species. Twelve species had more than 10 percent of their regional roosting observations at this site. From the highest to lowest percentage of regional roosting observations, these were: Red Knot, Piping Plover, Western Sandpiper, Least Tern, Semipalmated Plover, Sanderling, Wilson's Plover, Snowy Plover, Black-bellied Plover, Willet, Laughing Gull, and Forster's Tern (Table 6 in the main text). All Red Knot roosting observations in this study were recorded at Bowditch Point. Piping Plovers and Snowy Plovers were recorded roosting at only two locations, one of which was Bowditch Point. The 18 Piping Plover roosting observations at Bowditch Point represent 90 percent of all roosting observations for this species. The 10 Snowy Plover roosting observations at Bowditch Point represent 58.8 percent of all roosting observations for this species.

Table C13. Cumulative and maximum counts by behavior at Bowditch Point. Species are listed in taxonomic order.

Species	Code	Cumulative Counts		Maximum Count	
		Foraging	Roosting	Foraging	Roosting
Brown Pelican	BRPE		34		34
Double-crested Cormorant	DCCO		1		1
Black-bellied Plover	BBPL	9	15	3	5
Snowy Plover	SNPL	4	10	2	3
Wilson's Plover	WIPL	33	127	14	47
Semipalmated Plover	SEPL	92	518	44	125
Piping Plover	PIPL	21	18	5	4
Willet	WILL	40	48	8	25
Marbled Godwit	MAGO		5		5
Ruddy Turnstone	RUTU	46		15	
Red Knot	REKN		17		11
Sanderling	SAND	111	98	37	45
Western Sandpiper	WESA	148	1064	75	400
Least Sandpiper	LESA	1		1	
Dunlin	DUNL	27		27	
Short-billed Dowitcher	SBDO	21	38	21	17
Laughing Gull	LAGU		947		420
Least Tern	LETE		166		165
Forster's Tern	FOTE		17		9
Royal Tern	ROYT		142		55
Sandwich Tern	SATE		690		500
Black Skimmer	BLSK		45		21

Habitat use by landform

All foraging and roosting observations at Bowditch Point were recorded on a single landform, the inlet shoreline. Refer to Figures A26 through A35 for images of the Bowditch Point study area. Birds were observed foraging mostly in fresh wrack, or secondarily, on intertidal substrates. Small numbers of birds were observed foraging in ephemeral pools, dry sand, and shallow water (Table C14).

Roosting observations were recorded on three substrates. From most to least common these were intertidal substrates, old wrack, and dry sand (Table C15).

Table C14. Foraging substrate and landform use at Bowditch Point.

	Foraging landform
Foraging substrate	Inlet shoreline
Dry sand	9
Ephemeral pool	35
Fresh wrack	325
Intertidal	178
Shallow water	6
Totals	553

Table C15. Roosting landform and substrate use at Bowditch Point.

	Roosting landform
Roosting substrate	Inlet shoreline
Dry sand	796
Intertidal	2074
Old wrack	1130
Totals	**4000**

Disturbance

Bowditch Point is a popular destination for the public. ATV's were recorded during each of the seven site visits (Table C16).

Table C16. Bowditch Point disturbance factors.

Avg N people	9
Max N people	24
ATVs present	Yes
Vehicles present	No
Ave N dogs	0
Ave N parked boats	0
N access points	1
Beach cleaning present	No

Little Estero Lagoon

The 7,497 observations at this site comprised 16.8 percent of all observations across the study area. Foraging observations at Little Estero Lagoon totaled 3,224, which amounted to 43 percent of all observations at this site and 19 percent of all foraging observations for the entire study area. Roosting observations totaled 4,273, which amounted to 57 percent of all the observations for the site and 15.4 percent of all roosting observations for the entire study area. Little Estero Lagoon (Table C17), ranked second highest in species diversity, with 34 species observed.

Table C17. Cumulative and maximum counts by behavior at Little Estero Lagoon. Species are listed in taxonomic order.

Species	Code	Cumulative Counts		Maximum Count	
		Foraging	Roosting	Foraging	Roosting
Brown Pelican	BRPE		89		32
Double-crested Cormorant	DCCO		37		12
Great Blue Heron	GBHE	6		2	
Great Egret	GREG	97		56	
Snowy Egret	SNEG	82		19	
Little Blue Heron	LBHE	10		4	
Reddish Egret	REEG	10		3	
White Ibis	WHIB	46		19	
Roseate Spoonbill	ROSP	13		12	
Cooper's Hawk	COHA	1		1	
Black-bellied Plover	BBPL	49	15	13	8
Snowy Plover	SNPL	16	7	6	5
Wilson's Plover	WIPL	89	50	25	25
Semipalmated Plover	SEPL	220	99	139	53
Piping Plover	PIPL	7	2	3	2
Killdeer	KILL		5		5
Willet	WILL	118	32	20	29
Whimbrel	WHIM	3		1	
Marbled Godwit	MAGO	12		11	
Ruddy Turnstone	RUTU	124		34	
Red Knot	REKN	745		432	
Sanderling	SAND	734	59	200	32
Semipalmated Sandpiper	SESA	5		5	
Western Sandpiper	WESA	651	242	211	132
Least Sandpiper	LESA	172	24	52	24

Species	Code	Cumulative Counts		Maximum Count	
		Foraging	Roosting	Foraging	Roosting
Short-billed Dowitcher	SBDO	14	23	8	23
Laughing Gull	LAGU		2812		1000
Ring-billed Gull	RBGU		2		2
Least Tern	LETE		40		36
Common Tern	COTE		1		1
Forster's Tern	FOTE		22		9
Royal Tern	ROYT		203		44
Sandwich Tern	SATE		371		82
Black Skimmer	BLSK		138		63

Little Estero Lagoon is a very important site for many foraging and roosting species. Of the 23 species with more than 33 foraging observations across the entire study area, 16 species had more than 10 percent of their regional foraging observations at this site (Table C18). Little Estero Lagoon recorded the highest number of foraging Red Knots and Snowy Plovers. Fourteen species had more than 10 percent of their regional roosting observations at this site (Table C19). All Least Sandpiper roosting observations in this study were recorded at Little Estero Lagoon.

Table C18. Species with more than 10 percent of their regional foraging observations recorded at Little Estero Lagoon.

Species	N Foraging	Regional Percentage of Foraging Observations
Red Knot	745	73.2
Wilson's Plover	89	50.6
Snowy Plover	16	48.5
Sanderling	734	35.6
Roseate Spoonbill	13	28.3
Semipalmated Plover	220	25.8
Ruddy Turnstone	124	22.0
Reddish Egret	10	19.2
Western Sandpiper	651	18.8
Black-bellied Plover	49	15.5
Least Sandpiper	172	14.0
Willet	118	13.9
Great Blue Heron	6	13.6
Great Egret	97	13.3
Snowy Egret	82	12.6
Piping Plover	7	10.6

Table C19. Species with more than 10 percent of their regional roosting observations recorded at Little Estero Lagoon.

Species	N Roosting	Regional Percentage of Roosting Observations
Least Sandpiper	24	100.0
Snowy Plover	7	41.2
Laughing Gull	2812	41.0
Sanderling	59	37.6
Wilson's Plover	50	23.7
Black-bellied Plover	15	19.0
Western Sandpiper	242	18.5
Double-crested Cormorant	37	18.5
Least Tern	40	18.2
Forster's Tern	22	14.8
Semipalmated Plover	99	13.4
Willet	32	11.4
Black Skimmer	138	10.2
Piping Plover	2	10.0

Habitat use by landform and substrate

All foraging and roosting observations were recorded on two major landforms at Little Estero Lagoon, the lagoon and the ocean beach. Refer to Figures A36 through A46 for images of the Little Estero Lagoon study area. Foraging observations were recorded on five substrates. The majority of observations were recorded on intertidal substrates followed by ephemeral pools and shallow water. A very small number of foraging observations were recorded in shallow water and rubble/rock (Table C20). Roosting observations were recorded on four substrates. From most to least common these were ephemeral pools, dry sand, intertidal substrates, and old wrack (Table C21).

Table C20. Foraging substrate and landform use by all species at Little Estero Lagoon.

Foraging substrate	Foraging landform		Totals
	Lagoon	Ocean beach	
Ephemeral pool	27	373	400
Intertidal	1112	1397	2509
Rubble/rock	11		11
Shallow water	264	10	274
Vegetation	30		30
Totals	1444	1780	3224

Table C21. Roosting substrate and landform use by all species at Little Estero Lagoon.

Roosting substrate	Roosting landform		Totals
	Lagoon	Ocean beach	
Dry sand		1355	1355
Ephemeral pool		1545	1545
Intertidal	344	651	995
Old wrack		378	378
Totals	344	3929	4273

Disturbance

Little Estero Lagoon has four access points, making it one of the most easily accessed sites. As a result, Little Estero Lagoon experiences high disturbance. In addition to a high number of people, ATV's and vehicles were present during each site visit and beach cleaning was recorded on six of the seven site visits (Table C22).

Table C22. Little Estero Lagoon disturbance factors.

Avg N people	28
Max N people	41
ATVs present	Yes
Vehicles present	Yes
Ave N dogs	0
Ave N parked boats	0
N access points	4
Beach cleaning present	Yes

Big Carlos Pass

The 253 observations at this site comprised 0.6 percent of all observations across the study area. Over 99 percent of all the observations recorded here were foraging observations. Fifteen species were recorded at Big Carlos Pass with 14 of them using the site exclusively for foraging (Table C23). Of the 23 species with more than 33 foraging observations across the entire study area, only two species, Great Blue Heron and Reddish Egret, had more than 10 percent of their regional foraging observations at this site (Table 5 in the main text) and no species had more than 10 percent of their regional roosting observations at this site.

Table C23. Cumulative and maximum counts by behavior at Big Carlos Pass. Species are listed in taxonomic order.

Species	Code	Cumulative Counts		Maximum Count	
		Foraging	Roosting	Foraging	Roosting
Brown Pelican	BRPE	1		1	
Great Blue Heron	GBHE	6		1	
Great Egret	GREG	13		3	
Snowy Egret	SNEG	16		4	
Little Blue Heron	LBHE	2		1	
Reddish Egret	REEG	6		1	
Black-bellied Plover	BBPL	17		5	
Wilson's Plover	WIPL	1		1	
Willet	WILL	38		6	
Ruddy Turnstone	RUTU	49		9	
Red Knot	REKN	6		6	
Sanderling	SAND	92		15	
Laughing Gull	LAGU		1		1
Least Tern	LETE	2		2	
Sandwich Tern	SATE	3		3	

Habitat use by landform and substrate

All foraging and roosting observations occurred along the inlet shoreline Substrate use by species was the same as shown in Figures 2 and 3. Refer to Figures A47 through A54 for images of the Big Carlos Pass study area.

Disturbance

Big Carlos Pass experienced several disturbance factors. In addition to a moderate number of people present, ATV's, vehicles, and beach cleaning were recorded during each of the seven site visits (Table C24).

Table C24. Big Carlos Pass disturbance factors.

Avg N people	6
Max N people	13
ATVs present	Yes
Vehicles present	Yes
Ave N dogs	0
Ave N parked boats	0
N access points	1
Beach cleaning present	Yes

Lover's Key Lagoon

The 1,906 observations at this site comprised 4.3 percent of all observations across the study area. Over 66 percent of all observations at Lover's Key Lagoon were foraging observations. Of 26 species observed at Lover's Key Lagoon, 18 of them used this site exclusively for foraging (Table C25). Of the 23 species with more than 33 foraging observations across the entire study area, four species had more than 10 percent of their regional foraging observations at this site. From the highest to lowest percentage of regional foraging observations, these were: Reddish Egret, Roseate Spoonbill, Least Sandpiper, and Semipalmated Plover (Table 5 in the main text). Two species, Double-crested Cormorant and Willet, had more than 10 percent of their regional roosting observations at this site (Table 6 in the main text).

Table C25. Cumulative and maximum counts by behavior at Lover's Key Lagoon. Species are listed in taxonomic order.

Species	Code	Cumulative Counts		Maximum Count	
		Foraging	Roosting	Foraging	Roosting
Brown Pelican	BRPE		59		24
Double-crested Cormorant	DCCO		52		12
Great Blue Heron	GBHE	3		1	
Great Egret	GREG	16		4	
Snowy Egret	SNEG	30		11	
Little Blue Heron	LBHE	4		1	
Reddish Egret	REEG	8		2	
White Ibis	WHIB	43		15	
Roseate Spoonbill	ROSP	7		7	
Black-bellied Plover	BBPL	31		12	
Wilson's Plover	WIPL	13	3	7	3
Semipalmated Plover	SEPL	93	6	32	6
Spotted Sandpiper	SPSA	10		4	
Willet	WILL	32	52	12	52
Marbled Godwit	MAGO	13		8	
Ruddy Turnstone	RUTU	52		12	
Red Knot	REKN	36		23	
Sanderling	SAND	129		32	
Semipalmated Sandpiper	SESA	5		5	
Western Sandpiper	WESA	306		82	
Least Sandpiper	LESA	170		39	
Short-billed Dowitcher	SBDO	236		164	
Laughing Gull	LAGU	5	188	4	84
Least Tern	LETE	19		19	
Royal Tern	ROYT		64		35
Sandwich Tern	SATE		221		142

Habitat use by landform and substrate

All foraging and roosting observations were recorded on two major landforms at Lover's Key Lagoon, the lagoon and the ocean beach. Refer to Figures A55 through A60 for images of the Lover's Key Lagoon study area. Foraging observations were recorded on three substrates with the majority of foraging observations occurring on intertidal substrates followed by

shallow water. A small number of birds were recorded in fresh wrack (Table C26).

Roosting observations were recorded on four substrates. From most to least common these were intertidal substrates, shallow water, vegetation, and dry sand (Table C27).

Table C26. Foraging substrate and landform use by all species at Lover's Key Lagoon.

	Foraging landform		
Foraging substrate	Lagoon	Ocean beach	Totals
Fresh wrack		48	48
Intertidal	909	175	1084
Shallow water	128	1	129
Totals	1037	224	1261

Table C27. Roosting substrate and landform use by all species at Lover's Key Lagoon.

	Roosting landform		
Roosting substrate	Lagoon	Ocean beach	Totals
Dry sand		37	37
Intertidal	76	421	497
Shallow water	59		59
Vegetation	52		52
Totals	187	458	645

Disturbance

Lover's Key Lagoon is visited by a moderate number of people. This site also experiences disturbance by ATV's, which were present during six of the seven site visits. A small number of boats were observed on two of the seven site visits (Table C28).

Table C28. Lover's Key Lagoon disturbance factors.

Avg N people	17
Max N people	24
ATVs present	Yes
Vehicles present	No
Ave N dogs	0
Ave N parked boats	1
N access points	1
Beach cleaning present	No

New Pass

The 1,171 observations at this site comprised 2.6 percent of all observations across the study area. Over 95 percent percent of all observations at New Pass were roosting observations. Twelve species were observed at New Pass (Table C29). Of the 23 species with more than 33 foraging observations across the entire study area, no species had more than 10 percent of their regional foraging observations at this site and two species, Brown Pelican and Double-crested Cormorant, had more than 10 percent of their regional roosting observations at this site (Table 6 in the main text).

Table C29. Cumulative and maximum counts by behavior at New Pass. Species are listed in taxonomic order.

		Cumulative Counts		Maximum Count	
Species	Code	Foraging	Roosting	Foraging	Roosting
Brown Pelican	BRPE	2	362	2	100
Double-crested Cormorant	DCCO		30		10
Great Egret	GREG	3		1	
Snowy Egret	SNEG	3		2	
Black-bellied Plover	BBPL	1		1	
Wilson's Plover	WIPL	1		1	
Willet	WILL	5	6	2	6
Ruddy Turnstone	RUTU	12		5	
Sanderling	SAND	27		8	
Laughing Gull	LAGU		343		106
Royal Tern	ROYT		100		28
Sandwich Tern	SATE		276		76

Habitat use by landform and substrate

All but three foraging observations were recorded on the inlet shoreline. Refer to Figures A61 through A66 for images of the New Pass study area. Foraging observations were recorded on three substrates. From most to least common, these were: intertidal substrates, fresh wrack, and shallow water. All roosting observations were on intertidal substrates on the inlet's ebb shoal.

Disturbance

A relatively low number of people were recorded at New Pass throughout the entire study period. ATV's, however, were present during each of the seven site visits (Table C30).

Table C30. New Pass disturbance factors.

Avg N people	2
Max N people	10
ATVs present	Yes
Vehicles present	No
Ave N dogs	0
Ave N parked boats	1
N access points	1
Beach cleaning present	No

Big Hickory Pass

The 1,550 observations at this site comprised 3.5 percent of all observations across the study area. Almost 68 percent percent of all observations at Big Hickory Pass were roosting observations. Twenty-four species were observed at Big Hickory Pass (Table C31). Of the 23 species with more than 33 foraging observations across the entire study area, only two species, Least Sandpiper and Semipalmated Sandpiper, had more than 10 percent of their regional foraging observations at this site (Table 5 in the main text). Four species had more than 10 percent of their regional roosting observations at this site. From the highest to lowest percentage of regional roosting observations, these were: Black-bellied Plover, Willet, Wilson's Plover, and Semipalmated Plover (Table 6 in the main text).

Table C31. Cumulative and maximum counts by behavior at Big Hickory Pass. Species are listed in taxonomic order.

Species	Code	Cumulative Counts		Maximum Count	
		Foraging	Roosting	Foraging	Roosting
Brown Pelican	BRPE	2	50	2	19
Double-crested Cormorant	DCCO	1	12	1	5
Great Blue Heron	GBHE	4		1	
Great Egret	GREG	9		3	
Snowy Egret	SNEG	18		8	
Little Blue Heron	LBHE	1		1	
White Ibis	WHIB	5		3	
Black-bellied Plover	BBPL	3	24	2	8
Wilson's Plover	WIPL	2	26	2	7
Semipalmated Plover	SEPL	13	75	6	24
Willet	WILL	23	37	6	19
Ruddy Turnstone	RUTU	29		8	
Red Knot	REKN	6		5	
Sanderling	SAND	74		16	
Semipalmated Sandpiper	SESA	16		8	
Western Sandpiper	WESA	119		42	
Least Sandpiper	LESA	168		64	
Short-billed Dowitcher	SBDO	5	8	5	8
Laughing Gull	LAGU		427		140
Least Tern	LETE		5		5
Forster's Tern	FOTE		2		2
Royal Tern	ROYT		116		24
Sandwich Tern	SATE		258		72
Black Skimmer	BLSK		12		12

Habitat use by landform and substrate

Foraging observations at Big Hickory Pass were recorded on three landforms: a flood shoal, an inlet shoreline, and the ocean beach (Table 38). Refer to Figures A67 through A75 for images of the Big Hickory Pass study area. Foraging observations were recorded on three substrates. From most to least common, these were ephemeral pools, intertidal substrates, and shallow water (Table C32).

All roosting observations at Big Hickory Pass were recorded on one landform, the ocean beach. The majority of all roosting observations were recorded on intertidal substrates followed by dry sand substrates (Table C33).

Table C32. Foraging substrate and landform use by all species at Big Hickory Pass

	Foraging landform			
Foraging substrate	Flood shoal	Inlet shoreline	Ocean beach	Totals
Ephemeral pool	4	251		255
Intertidal	64	23	112	199
Shallow water		44		44
Totals	68	318	112	498

Table C33. Roosting substrate and landform use by all species at Big Hickory Pass.

	Roosting landform
Roosting substrate	Ocean beach
Dry sand	162
Intertidal	874
Totals	1036

Disturbance

People were observed at Big Hickory Pass during six out of seven visits. Boats were present at four of the seven site visits and typically were in small numbers (three or less; one visit recorded 10 boats) (Table C34).

Table C34. Big Hickory Pass disturbance factors.

Avg N people	3
Max N people	13
ATVs present	No
Vehicles present	No
Ave N dogs	0
Ave N parked boats	1
N access points	1
Beach cleaning present	No

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
September 2009	Final repot	

4. TITLE AND SUBTITLE

Habitat Associations of Shoreline-Dependent Birds in Barrier Island Ecosystems During Fall Migration in Lee County, Florida

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Casey A. Lott, Charlie S. Ewell, Jr., and Kelly L. Volansky

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

The American Bird Conservancy
P.O. Box 249
The Plains, VA 20198;
Florida Ornithological Society
115 S. W. 51 Terrace
Cape Coral, FL 33914

8. PERFORMING ORGANIZATION REPORT NUMBER

ERDC/EL TR-09-14

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

The tendency to survey shoreline-dependent birds by taxonomic grouping has led to an incomplete picture of avian habitat associations within Florida's Barrier Island ecosystems. Planning for the conservation of Florida's shoreline-dependent birds requires a greater understanding of regional and site-specific habitat associations within the community of shoreline-dependent birds during fall migration, when many species are near peak annual abundances. Between August 15 and October 28, 2006 almost 45,000 observations of 42 species at 10 coastal study sites were recorded in southwestern Lee County, Florida. Counts varied strongly by species, site, behavior, and habitat. This study documents striking differences in the community of birds using the study area for foraging and for roosting. Foraging birds were comprised of primarily shorebirds and herons using low-energy intertidal areas and wrack lines around bay beaches, lagoons, and inlet shorelines. Seabirds, particularly terns, skimmers, and pelicans were dominant roosting birds, using intertidal areas on flood shoals, bay beaches, and lagoons. Several plover species roosted almost exclusively along inlet shorelines in and around old, decaying wrack. A small number of heavily used sites contributed a majority of all observations, including a new inlet/washover area that was created by Hurricane Charley in 2004, known locally as Charley Pass.

15. SUBJECT TERMS

Avian habit
Florida Barrier Islands
Lee County, Florida
Seabirds
Shorebirds
Shoreline-dependent birds

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER *(include area code)*
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		109	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. 239.18

Email from Ann Hodgson

From: HODGSON, Ann
To: Imperiled
Cc: WRAITHMELL, Julie
Subject: Status of colonial waterbird populations in the Tampa Bay area from 1984-2009
Date: Friday, October 29, 2010 5:20:28 PM
Attachments: Hodgson-twenty_five_years-06-21-10.pdf

Attached is our recent report:

TWENTY-FIVE YEARS AFTER BASIS: AN UPDATE ON THE CURRENT STATUS AND RECENT TRENDS OF COLONIAL WATERBIRD POPULATIONS IN TAMPA BAY

Ann B. Hodgson, Audubon of Florida, Florida Coastal Islands Sanctuaries, 410 S. Ware Boulevard, Suite 702, Tampa, Florida 33619, ahodgson@audubon.org

Ann F. Paul, Audubon of Florida, Florida Coastal Islands Sanctuaries, 410 S. Ware Boulevard, Suite 702, Tampa, Florida 33619, apaul@audubon.org

Representatives of 4 orders dominate the avifauna of Tampa Bay: pelecaniformes (pelicans, cormorants, anhingas); ciconiiformes (herons, ibis, spoonbills, storks); anseriformes (waterfowl); and charadriiformes (shorebirds, gulls, and terns). The first bay-wide assessment of colonial waterbird populations was presented at BASIS by Paul and Woolfenden (1985). Twelve of the 22 colonies they reported have been abandoned since due to various causes of habitat loss or disturbance and c. 59,000 pairs (mostly Laughing Gulls) nested on 5 colonies that no longer support very large populations. After 1985, 50 new colonies became active, including 15 inland colonies, of which 16 were abandoned later. Using annual breeding bird surveys, we provide recent trends in the populations of 30 bird species breeding in Tampa Bay, 13 of which receive enhanced conservation protection through their listing by federal or state agencies. The Tampa Bay breeding population totals 30,000-58,000 nesting pairs, averaging 39,000 annually. The 2009 nesting population (all species) was 58,500 at 44 colonies. Up to 50% of the total colonial waterbird nesting occurs in Hillsborough Bay; the remainder is distributed at colony sites around Tampa Bay. Human disturbance has become the most significant cause of nesting failure annually, accompanied by anthropogenically-induced predator population increases and urban development affecting the number and ecological integrity of estuarine and palustrine wetland foraging sites. We provide a suite of habitat and population management recommendations that should be implemented to conserve the bay's avifauna. Please cite the information as:

Hodgson, A. and A. Paul. 2010. Twenty-Five Years after Basis I: An Update on the Current Status and Recent Trends in Bird Colonial Waterbird Populations of Tampa Bay, in: Cooper, S.T. (ed.). 2010. Proceedings, Tampa Bay Area Scientific Information Symposium, BASIS 5: 20-23 October 2009. St. Petersburg, FL. 538 pp.

Please call if you have further questions.

best, Ann

Ann B. Hodgson, Ph. D., P.W. S.
Gulf Coast Ecosystem Science Coordinator
Audubon of Florida
Florida Coastal Islands Sanctuaries Program
410 Ware Blvd., STE 702
Tampa, FL 33619

TWENTY-FIVE YEARS AFTER BASIS: AN UPDATE ON THE CURRENT STATUS AND RECENT TRENDS OF COLONIAL WATERBIRD POPULATIONS IN TAMPA BAY

Ann B. Hodgson, Audubon of Florida, Florida Coastal Islands Sanctuaries, 410 S. Ware Boulevard, Suite 702, Tampa, Florida 33619, ahodgson@audubon.org

Ann F. Paul, Audubon of Florida, Florida Coastal Islands Sanctuaries, 410 S. Ware Boulevard, Suite 702, Tampa, Florida 33619, apaul@audubon.org

ABSTRACT

Representatives of 4 orders dominate the avifauna of Tampa Bay: pelecaniformes (pelicans, cormorants, anhingas); ciconiiformes (herons, ibis, spoonbills, storks); anseriformes (waterfowl); and charadriiformes (shorebirds, gulls, and terns). The first bay-wide assessment of colonial waterbird populations was presented at BASIS by Paul and Woolfenden (1985). Twelve of the 22 colonies they reported have been abandoned since due to various causes of habitat loss or disturbance and c. 59,000 pairs (mostly Laughing Gulls) nested on 5 colonies that no longer support very large populations. After 1985, 50 new colonies became active, including 15 inland colonies, of which 16 were abandoned later. Using annual breeding bird surveys, we provide recent trends in the populations of 30 bird species breeding in Tampa Bay, 13 of which receive enhanced conservation protection through their listing by federal or state agencies. The Tampa Bay breeding population totals 30,000-58,000 nesting pairs, averaging 39,000 annually. The 2009 nesting population (all species) was 58,500 at 44 colonies. Up to 50% of the total colonial waterbird nesting occurs in Hillsborough Bay; the remainder is distributed at colony sites around Tampa Bay. The Cockroach Bay-Terra Ceia Bay, Hillsborough Bay, Johns Pass, and Lower Tampa Bay Important Bird Areas are listed by Audubon of Florida among its 100 Important Bird Areas in Florida. Lower Tampa Bay and Hillsborough Bay were designated by Birdlife International and the National Audubon Society, Inc. in 2003 and 2009, respectively, as "Important Bird Area of Global Significance". Human disturbance has become the most significant cause of nesting failure annually, accompanied by anthropogenically-induced predator population increases and urban development affecting the number and ecological integrity of estuarine and palustrine wetland foraging sites. We provide a suite of habitat and population management recommendations that should be implemented to conserve the bay's avifauna. Hodgson and Paul

INTRODUCTION

The species richness of colonial waterbirds that nest in the Tampa Bay estuarine system is unique, as many birds of temperate North America breed here, as well as some typically "tropical" birds (Reddish Egrets, Roseate Spoonbills) that do not nest further north, and some species that nest only in low numbers anywhere in Florida (Caspian, Royal, Sandwich, and Gull-billed terns) (Howell 1932, Paul and Woolfenden 1985, Paul and Schnapf 1997, Paul and Paul 2005, Hodgson, Paul and Rachal 2006).

Within Tampa Bay, colonial waterbirds (pelecaniformes [pelicans, cormorants, anhingas]; ciconiiformes [herons, ibis, spoonbills, storks]; and charadriiformes [shorebirds, gulls, and terns]) nest preferably on small islands that are off-shore, separated by open water and deep channels with tidal currents that discourage predatory mammals from swimming to them, and

have no resident mammalian predators. Large numbers of birds of many species may breed at a single site. Generally, sites occupied by larids are sparsely vegetated sand or shell beaches or dredged spoil material, while pelecaniform and ciconiiform birds nest where shrubs or trees are available (Schreiber and Schreiber 1978). Thirteen species are currently listed by the state and federal wildlife management agencies to receive elevated regulatory protection. Several other species that nest in the watershed, although not formally listed, are very rare (Willet, Wilson's Plover, Gull-billed, Caspian, Royal, and Sandwich terns) and warrant comparable protection. The importance of Tampa Bay's bird community has been widely recognized by national and international authorities. The Cockroach Bay-Terra Ceia Bay, Hillsborough Bay, Johns Pass, and Lower Tampa Bay Important Bird Areas (IBAs) are listed by Audubon of Florida among its 100 Important Bird Areas in Florida, and BirdLife International and the National Audubon Society recognized Lower Tampa Bay and Hillsborough Bay as globally-significant IBAs in 2003 and 2009, respectively.

In this paper, we briefly summarize the current status and population trends of 30 species of birds nesting in the Tampa Bay system, mostly colonial but also some territorial nesters that often select sites within a mixed species colony, review current management programs to protect them, and provide conservation recommendations to maintain stable populations in the future.

METHODS

We (Florida Coastal Islands Sanctuaries [FCIS]) surveyed colonial waterbird colonies and territorial shorebirds from 1985 to 2009 in Tampa Bay, using direct nest counts or flight line counts, and counting nesting pairs and productivity (chicks/nest) when possible (Buckley and Buckley 1976; King 1978; Erwin and Ogden 1980, Portnoy 1980; Erwin 1981, Paul et al. 2004). Laughing Gulls were censused using a circular plot technique and extrapolating nesting density among areas of similar nesting density (Patton and Hanners 1984). We added colony locations to the survey schedule as they were discovered. We also included 15 bird colonies that occur on the bay's periphery at inland locations within the Tampa Bay Estuary Program's watershed boundaries in Hillsborough, Pasco, and Polk counties, but not colonies outside the watershed in Clearwater Harbor and St. Josephs Sound, although they contribute to the regional population (Agency on Bay Management 1995). Numbers of colonies surveyed varied inter-annually contingent on colony activity, personnel, weather, and other constraints. English and scientific names follow the Check-list of North American Birds 7th edition (American Ornithologists' Union 1998) and 50th Supplement (Chesser et al. 2009).

RESULTS

In Tampa Bay, 58,424 nesting pairs of colonial birds (all species), 42.7% of which were Laughing Gulls, bred at 44 colonies in 2009 (Table 1). The 10 year (2000-2009) mean number of nesting pairs (all species) was 44,141 (SD 10,946.57), and the mean number of active colonies was 32 (SD 6.88) (Table 2).

Of the 71 colonies mapped in the Tampa Bay watershed, 22 were discussed in BASIS, of which 12 (54.5%) were abandoned ("winked out") later for various reasons (altered habitats [e.g., urban development, plant succession], predators, human disturbance) since 1985, including 5 colonies that supported most of the gull population (Figs. 1, 2, 3). In the past 25 years we located and surveyed 50 new sites undescribed in 1985; however, 16 colonies (32.0%) subsequently collapsed and were abandoned. Cumulatively, the inland colonies supported 10.0% of the regional population. Of the initial 22 colonies, all but six were islands (Paul and

Woolfenden 1985). Five were small colonies of Yellow-crowned Night-Herons or Great Blue Herons nesting high in tall oak trees or slash pines near the bay, and the last site was the shore of the Howard Frankland Causeway, where the Florida Department of Transportation planted the roadside in the early 1990s to discourage Black Skimmers from nesting and causing traffic hazards. All recently-active colonies were islands, except the Mobbly powerlines, scattered oystercatcher territories in Apollo Beach, and the Cockroach Bay borrow pit.

In 1985, the Alafia Bank Bird Sanctuary, Washburn Sanctuary, and Tarpon Key National Wildlife Refuge were the three largest mixed colonies of pelecaniforms, herons and ibis in the region. In 2009, pelicans nested at only four sites, Washburn Sanctuary had very few pairs since 2004, and Tarpon Key was abandoned in 2005, so that the three largest colonies with similar species composition were Egmont Key National Wildlife Refuge and State Park (33,700 pairs, of which 300 were pelicans and >25,000 were larids), the Richard T. Paul Alafia Bank Bird Sanctuary (10,500 pairs, only 150 pairs of pelicans), and Alligator Lake (745 pairs), which had no pelicans.

Table 1. Colony characteristics and management status of colonial waterbird colonies in Tampa Bay, Florida, USA, in 2009.

Colony Number	*Name*	Bay Segment	Taxa	Species *(n)*	Pairs *(n)*	Abandoned after 1984	New since 1984	Ownership / Management	Protected status	Regional population (%)	Active within last 5 yrs?	*Latitude*	*Longitude*
25	Dogleg Key	BCB	P, Ci	12	296		X	FDEP-AP / FCIS	Y	0.51	Y	27.8021	-82.7618
26	Johns Pass, Little Bird Key	BCB	Ci	1	2			Suncoast Seabird Sanctuary	Y	0.00	Y	27.7932	-82.7777
27	Johns Pass, Middle Bird Island	BCB	Ci	2	5			FDEP-AP	Y	0.01	Y	27.7913	-82.7739
28	Johns Pass, Eleanor Island	BCB	Ci			X		City of Treasure Island	Y	0.00	Y	27.7878	-82.7738
29	South Pasadena Marker 34	BCB	L			X	X	City of Pasadena		0.00	N	27.7431	-82.7299
30	Sunset Beach	BCB	L			X	X	City of Treasure Island	N	0.00	N	27.7391	-82.7565
31	Don CeSar Colony	BCB	P, Ci	6	50		X	Private	N	0.09	Y	27.7059	-82.7352
32	Bayway Spoil	BCB	L			X		Developed	N	0.00	N	27.7094	-82.6995
33	Indian Key NWR	BCB	Ci			X	X	USFWS NWR	Y	0.00	Y	27.7011	-82.6909
34	Little Bird Key NWR	BCB	Ci	5	16		X	USFWS NWR	Y	0.03	Y	27.6852	-82.7169
35	Cow and Calf Islands	BCB	P, Ci	2	9		X	FDEP-AP		0.02	Y	27.6856	-82.6916
36	Darling Key	BCB	P, Ci	3	17		X	FDEP-AP		0.03	Y	27.6765	-82.6813
37	Jackass Key NWR	BCB	P, Ci	4	30		X	USFWS NWR	Y	0.05	Y	27.6693	-82.7177
38	Tarpon Key NWR	BCB	P, Ci			X		USFWS NWR	Y	0.00	N	27.6666	-82.6932
39	Whale Island NWR	BCB	P, Ci			X	X	USFWS NWR	Y	0.00	N	27.6626	-82.6930
40	Shell Key County Preserve	BCB	Ch					Florida / Pinellas County	Y	0.00	Y	27.6645	-82.7445
41	Mule Key NWR	BCB	P, Ci			X	X	USFWS NWR	Y	0.00	Y	27.6619	-82.7178
42	Listen Key NWR	BCB	P, Ci			X	X	USFWS NWR	Y	0.00	N	27.6596	-82.7179
43	Sister Key	BCB	P, Ci			X	X	Florida / Pinellas County		0.00	N	27.6503	-82.7312
44	Ft. DeSoto Park	LTB	L, Ch			X	X	Pinellas County	Y	0.00	N	27.6488	-82.7433
45	Egmont Key NWR/State Park	LTB	P, Ci, Ch	10	36,521		X	USFWS NWR / Florida State Parks	Y	62.51	Y	27.5894	-82.7614

Colony Number	*Name*	Bay Segment	Taxa	Species *(n)*	Pairs *(n)*	Abandoned after 1984	New since 1984	Ownership / Management	Protected status	Regional population (%)	Active within last 5 yrs?	*Latitude*	*Longitude*
46	Little Bayou Bird Island	MTB	P, Ci	10	140		X	FDEP-AP / FCIS	Y	0.24	Y	27.7196	-82.6312
47	Coffeepot Bayou Bird Island	MTB	P, Ci	14	612		X	Private	Y	1.05	Y	27.7916	-82.6241
48	Gandy Radio Tower	OTB				X	X	Unknown	N	0.00	N	27.8772	-82.5902
49	Howard Frankland	OTB	L			X		FDOT	N	0.00	N	27.9046	-82.6335
50	Cooper's Point	OTB				X		Pinellas County / City of Clearwater	N	0.00	N	27.9730	-82.6891
51	Alligator Lake	OTB	P, Ci	12	745			City of Safety Harbor / Pinellas County	Y	1.27	Y	27.9813	-82.6990
52	Philippe Park	OTB	Ci			X		Pinellas County	N	0.00	N	28.0053	-82.6778
53	Mobbly Bay Powerlines	OTB	P	1	19		X	Progress Energy	N	0.03	Y	28.0038	-82.6677
54	Courtney Campbell Causeway	OTB	L			X	X	FDOT	N	0.00	N	27.9736	-82.5958
55	Wilson Property/Grand Hyatt	OTB	Ci			X		Private	N	0.00	N	27.9654	-82.5514
56	Sunset Park	OTB				X		City of Tampa	N	0.00	N	27.9374	-82.5201
57	Westshore	OTB				X		City of Tampa	N	0.00	N	27.9002	-82.5361
58	McKay Bay	HB				X	X	City of Tampa / TPA	Y	0.00	N	27.9371	-82.4143
59	Hooker's Point	HB				X	X	TPA	Y	0.00	N	27.9076	-82.4338
60	Tampa Port Authority Spoil Island 2D	HB	Ch	9	2,152			TPA / FCIS	Y	3.68	Y	27.8805	-82.4313
61	Fantasy Island	HB	Ch	1	1			TPA / FCIS	Y	0.00	Y	27.8683	-82.4253
62	Spoil Area C	HB	L, Ch			X	X	Mosaic	Y	0.00	N	27.8571	-82.4003
63	Richard T. Paul Alafia Bank Bird Sanctuary	HB	P, Ci, Ch	16	6,234			Mosaic / FCIS	Y	10.67	Y	27.8483	-82.4106
64	Tampa Port Authority Spoil Island 3D	HB	Ch	2	23			TPA / FCIS	Y	0.04	Y	27.8331	-82.4352

Colony Number	*Name*	Bay Segment	Taxa	Species *(n)*	Pairs *(n)*	Abandoned after 1984	New since 1984	Ownership / Management	Protected status	Regional *population* (%)	Active within last 5 yrs?	*Latitude*	*Longitude*
65	Port Redwing	HB	L, Ch			X	X	TPA	Y	0.00	N	27.8132	-82.3951
66	Fishhook Spoil Island	HB	Ch	2	13			TPA / TECO	Y	0.02	Y	27.8024	-82.4152
67	Apollo Beach Oystercatchers	HB	Ch	2	15		X	Private	N	0.03	Y	27.7733	-82.4318
68	Mouth of Little Manatee River	MR	P, Ci			X		FDEP Cockroach Bay Aquatic Preserve	N	0.00	N	27.7160	-82.4823
69	Cockroach Bay Preserve	MTB	Ch	1	30		X	ELAPP	Y	0.05	Y	27.6955	-82.5079
70	Hole in the Wall, Cockroach Bay Preserve 1	MTB	Ci				X	ELAPP	Y	0.02	Y	27.6811	-82.5183
71	Hole in the Wall, Cockroach Bay Preserve 2	MTB	Ci	1	20		X	ELAPP	Y	0.02	Y	27.6799	-82.5198
72	Hole in the Wall, Cockroach Bay Preserve 3	MTB	Ci				X	ELAPP	Y	0.02	Y	27.6764	-82.5169
73	Piney Point	MTB	P, Ci	14	2,795		X	SWFWMD	Y	4.78	Y	27.6505	-82.5462
74	Manbirtee Key	MTB	Ci, Ch	4	24			MCPA / FCIS	Y	0.04	Y	27.6359	-82.5740
75	Two Brothers Island	LTB	Ci			X		Private	N	0.00	N	27.5935	-82.5847
76	Skyway Bridge Least Tern colony	LTB	L			X	X	FDOT	N	0.00	N	27.5808	-82.6090
77	Miguel Bay Colony	LTB	P, Ci				X	FDEP-AP / FCIS	Y	0.00	Y	27.5708	-82.5995
78	Passage Key	LTB	P, Ci, L, Ch			X		USFWS NWR	Y	0.00	Y	27.5545	-82.7404
79	Nina Washburn Sanctuary	TCB	P, Ci	7	52			FCIS	Y	0.09	Y	27.5527	-82.5999
80	Washburn Junior/Terra Ceia Bay Little Bird Key	TCB	P, Ci	14	407		X	FDEP Terra Ceia Aquatic Preserve / FCIS	Y	0.70	Y	27.5285	-82.6015
81	Dot Dash Dit Colony	MR	P, Ci	13	2,360			Private / Florida / FCIS	Y	4.04	Y	27.4993	-82.5243
82	Heath Yellow-crowned Night-Heron Colony	HC	Ci	1	5		X	Private	N	0.01	Y	27.8772	-82.3129
83	Office/Ferman Bird Colony	HC	P, Ci	8	74		X	Private	Y	0.13	Y	27.9448	-82.3417

Colony Number	*Name*	Bay Segment	Taxa	Species *(n)*	Pairs *(n)*	Abandoned after 1984	New since 1984	Ownership / Management	Protected status	Regional *population* (%)	Active within last 5 yrs?	*Latitude*	*Longitude*
84	Robles Park	HC	Ci	4	31		X	City of Tampa	Y	0.05	Y	27.9740	-82.4550
85	Corporex Colony	HC	P, Ci	7	94		X	Private	N	0.16	Y	27.9786	-82.3857
86	East Lake Island	HC	P, Ci	5	14		X	Florida Audubon Society	Y	0.02	Y	27.9922	-82.3784
87	Temple Crest/Orange Lake/Wargo Bird Colony	HC	P, Ci	8	51		X	City of Tampa / TPA	N	0.09	Y	28.0193	-82.4174
88	River Cove Yellow-crowned Night-Heron colony	HC	Ci				X	Hillsborough County	N	0.02	Y	28.0192	-82.4486
89	Citrus Park Bird Colony	HC	P, Ci	9	486		X	Private	N	0.83	Y	28.0699	-82.5834
90	Heron Point	PaC	P, Ci	7	57		X	Private	N	0.10	Y	28.2157	-82.4349
91	Saddlebrook	PaC	P, Ci	3	48		X	Private	Y	0.08	Y	28.2277	-82.3297
92	Cypress Creek Preserve	HC	P, Ci	11	3,294		X	ELAPP	Y	5.64	Y	28.1629	-82.3975
93	Cross Creek Colony	HC	P, Ci	2	8		X	Private	N	0.01	Y	28.1424	-82.3520
94	Medard County Park	HC	P, Ci	10	477		X	Hillsborough County	Y	0.82	Y	27.9218	-82.1630
95	Alafia River Corridor Preserve	HC	P, Ci	5	46		X	ELAPP	Y	0.08	Y	27.8756	-82.1053
96	Wood Lake/Somerset Lake	PoC	P, Ci	14	1,151		X	City of Lakeland / Private	Y	1.97	Y	28.0036	-81.9311
	Totals				58,424	27	48			100.00			

Taxa: P-pelecaniformes, Ci-ciconiiformes, Ch-charadriiformes, L-larids.

Values are number of species, nesting pairs, and % of 2009 regional nesting population.

Abbreviations: ELAPP – Environmental Lands Acquisition & Protection Program, FDEP-AP - Florida Department of Environmental Protection Aquatic Preserves, FDOT – Florida Department of Transportation, MCPA – Manatee County Port Authority, TPA – Tampa Port Authority, USFWS NWR - U. S. Fish & Wildlife Service National Wildlife Refuge.

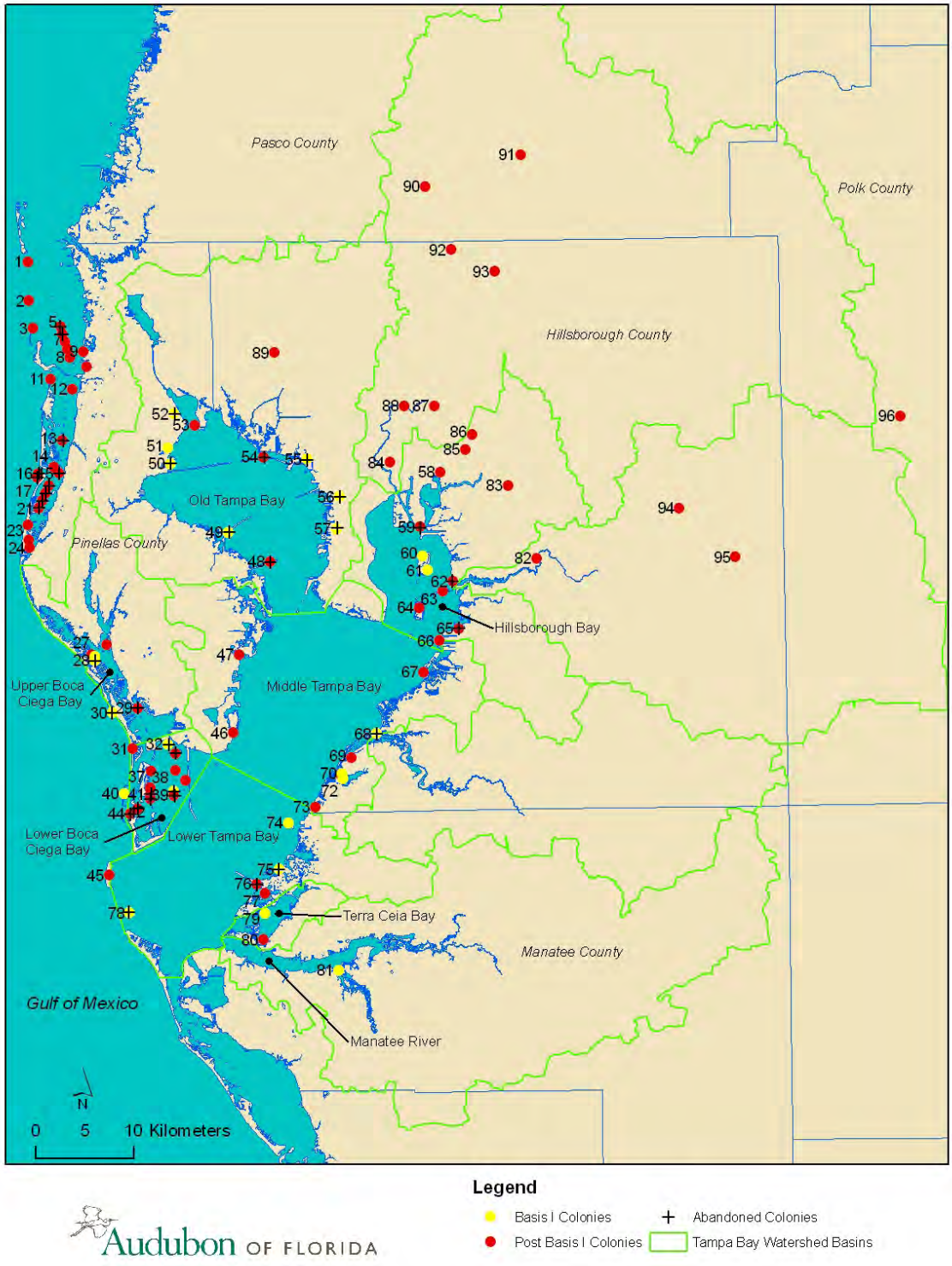


Figure 1. Bird colonies in the Tampa Bay, Florida, USA, ecosystem from 1984-2009 (colonies 1-24 are excluded because they are not in the Tampa Bay watershed).

Figure 2. Bird colonies in Boca Ciega Bay, Florida, USA, from 1984-2009.

Figure 3. Bird colonies in Terra Ceia Bay, Florida, USA, from 1984-2009.

Table 2. Nesting pairs (no./species) of 30 colonial waterbirds and shorebirds and assessment of recent population trends in Tampa Bay, Florida, USA, from 2000-2009.

Species	Mean	SD	Population trend
Brown Pelican	1,024	326.15	45 is the major nesting site since 2004 when 79 and 38 collapsed; widespread also at several smaller colonies, declining
Double-crested Cormorant	455	68.48	Widely distributed at 7 sites; shifted from 79 and 38 when they collapsed; stable
Anhinga	334	93.11	Widely distributed at 7 sites; stable
Least Bittern	2	1.69	Uncommon – nesting at 4 or more freshwater sites with large cattail stands; under-surveyed
Great Blue Heron	217	61.80	Widely distributed at 10 heronries, and various misc. sites; stable
Great Egret	740	148.15	Nesting at 18 sites, >100 prs at 63, 81, 25, 47, and I-25 (Clearwater Harbor) in that order; stable
Snowy Egret	923	193.63	c. 75% decline since 1970s (Ogden 1978); stable last 10 yrs; 73 increased to 300 prs
Little Blue Heron	315	88.92	Nesting at 73, 63, and 94, and other sites, declined since 1950s with freshwater wetland loss; stable last 10 yrs
Tricolored Heron	788	178.87	Widespread at all mixed heronries; c. 60% of the population at 3 colonies: 73, 63 and 51; stable
Reddish Egret	57	21.19	Nesting at 6 sites: 63 largest group; 51 – only known freshwater site; c. 16% of state popn in Tampa Bay
Cattle Egret	4,146	2,836.85	Abundant at 63, 73, 51, 92, and 81; increasing since 1980s.
Green Heron	29	12.01	Nesting at 11 sites, notably 73, and other solitary locations; stable
Black-crowned Night-Heron	112	52.27	Nesting at the major heronries, notably 73, and inland sites; stable
Yellow-crowned Night-Heron	73	39.58	Nesting in mixed heronries; other small groups in tall coastal trees in residential areas; declining since 1980s; recent decline more rapid
White Ibis	9,180	3,464.63	Most common endemic wading bird; dependent on El Niño cycles and prey concentrated as freshwater wetlands draw down; most nesting at 63 and 73
Glossy Ibis	285	102.58	Nesting only at 63, 73, and 92; formerly approx. 50% were at 79; require shallow freshwater wetlands; stable to declining
Roseate Spoonbill	329	111.26	Exponential increase at 63 since 1975; radiated to 11 sites in the past 5 yrs; popn not stabilized
Wood Stork	212	116.93	Nesting only at 81, plus inland colonies 92, 93, 86, 95, and 89
Snowy Plover	0.4	1.26	Rarely nesting at 44, 40, 45 and usually unsuccessful due to disturbance
Wilson's Plover	25	20.68	Spottily distributed in salterns and suitable bare habitat; 74 recently important; stable; prob. under-surveyed
American Oystercatcher	91	13.58	C. 72 prs in Hillsborough Bay on spoil island shorelines (60, 63, 64, 66); the rest at widespread sites; stable, approx. 21% of state popn nests in Tampa Bay
Black-necked Stilt	32	31.35	Nesting sporadically at 60, 64, 69 around drying algae mats; rare
Willet	34	14.43	Rare and inconspicuously distributed in salt marshes and dune vegetation; under-surveyed
Laughing Gull	19,698	8,741.13	Nesting only at 60, 64 and 45; approx. 50% decline since early 1980s; Tampa Bay hosts c. 20% of entire southeast U. S. popn
Gull-billed Tern	8	5.69	A few pairs annually, often with Black Skimmers, nearly annually at 60 or 64

Species	Mean	SD	Population trend
Caspian Tern	83	10.57	Most nesting at 60, 64; formerly 63; Hillsborough Bay colony is the state's largest
Royal Tern	3,618	1,857.76	Nesting formerly at 63 and 78; now at 45 and Hillsborough Bay 60 or 64; increasing since 1990s
Sandwich Tern	811	341.14	All at 45 in 2009; formerly Hillsborough Bay (60, 64, or 63); poss. increasing
Least Tern	116	91.38	Most natural habitat lost; recently c. 80% are rooftop nesters; declining; most nesting on beaches unsuccessful due to human disturbance
Black Skimmer	406	192.24	In the last five years, skimmers nested at 60, 64, 45, 78, 40, and 29; stable, but in some years, zero nesting success

Values are mean and standard deviation of nesting pairs; see Table 1 for colony identification numbers.

DISCUSSION

Species richness (30 species) of the regional colonial waterbird population did not change in Tampa Bay from 1985 to 2009, with every endemic species and introduced Cattle Egrets represented. This community remains the largest and most significant colonial waterbird population in Florida outside of the Everglades. The Laughing Gull population has diminished by around 50% since the 1980s and is now concentrated in Hillsborough Bay and Egmont Key. These populations have persisted despite significant and continuing alteration of shoreline habitats, bay bottom, and freshwater wetlands, although recent population declines in Brown Pelicans, Laughing Gulls, Least Terns, and Snowy Plovers suggest that, as elsewhere in Florida, progressive urbanization threatens to further reduce the ecological integrity of the Tampa Bay ecosystem. Roseate Spoonbills and Reddish Egrets, extirpated as nesting species from Tampa Bay until the mid-1970s, have increased significantly, while widely expanding their distribution among suitable habitats in the bay, and Wood Stork, and Royal and Sandwich tern populations have increased slightly. The other pelecaniformes, ciconiiformes, charadriiformes and larids have remained relatively stable. The inland colonies are particularly important for small herons and Wood Storks.

Five additional species are found uniquely in coastal habitats: Clapper Rails, Mangrove Cuckoos, Gray Kingbirds, Black-whiskered Vireos, and Prairie Warblers. Clapper Rails occur in low and high marsh and require expansive areas of continuous cover, areas which are diminishing as the shoreline has been developed. Black-whiskered Vireos have virtually disappeared from Tampa Bay since c. 1991. Mangrove Cuckoos were found annually in mangroves in Boca Ciega Bay, Weedon Island, and Terra Ceia Bay in some years, but are infrequent now. Prairie Warblers are more widely distributed along Tampa Bay mangrove shorelines. Although Gray Kingbirds may also nest in uplands beyond the mangroves, all five species are primarily coastal birds whose populations have decreased in recent years. The four estuarine passerines are susceptible to nest parasitism by increasing populations of Brown-headed Cowbirds.

Paul and Woolfenden (1985) identified a number of biotic and abiotic stressors that influence bird abundance in Tampa Bay. In the decades leading up to the 1980s, coastal habitat loss dominated. In the 1990s, with the large increase in registered watercraft, the most significant issues to have emerged are anthropogenic disturbances from the increasing numbers of recreational boaters and beachgoers that: "…present a vast potential for annual disturbance of breeding birds", as predicted by Paul and Schnapf (1997:94), continued dredge and fill activities that have had both beneficial and negative effects for colonial waterbirds and beach-nesting species, continued loss of palustrine wetlands (particularly short hydroperiod and ephemeral "prairie ponds"), the trend toward reducing the spatial distribution of palustrine wetlands by condensing them into stormwater ponds and mitigation banks from the natural patterns that birds cue to throughout the landscape, and extremely high populations of meso-carnivores (raccoons, to a lesser extent opossums and, potentially, coyotes and invasive exotic herptiles).

Management Initiatives

Through site-specific management initiatives by FCIS at Audubon-owned and leased sanctuaries, Audubon's Project ColonyWatch, which engages volunteers to observe and protect colonies in cooperation with site managers, and a continuous effort to expand colony management partnerships among agencies and private landowners, most of the now active colonies have been posted, are managed during the year to control predators and remove entangling fishing line during the Tampa Bay Watch and Audubon Monofilament Cleanup, are regularly surveyed to establish colony species composition and productivity, and are intermittently patrolled. However, with the dramatic increase in public recreation on the water, this program is insufficient to fully protect most colonies. In the past five years we have also implemented a series of inter-agency workshops for law enforcement marine units about the biology, habitat requirements, and laws protecting colonial waterbirds.

Management Recommendations

Environmental education – In collaboration with land managers and management partners, continue to produce and distribute to the public boaters guides describing the bay's natural resources and protected areas, and present informational talks about the bay's avifauna.

Colony management - Continue current management activities, and establish and enforce spatial buffers around colonies to prevent site disturbance. Increase enforcement of wildlife protection laws.

Habitat management - Manage existing sites to provide required habitats; the spoil islands in the Hillsborough Bay Important Bird Area support some of the largest colonies of pelicans, herons, ibis, gulls, and oystercatchers in the state. Many nesting colony sites have been abandoned and fewer new sites will be available in the future given the development density. Currently functioning sites must be carefully protected.

Habitat restoration – Continue to acquire land and restore coastal ecosystems to replace the large areas of coastal mangroves, salterns, intertidal mudflats, and freshwater wetlands that have been lost; restore tidal creeks and re-establish altered coastal drainage patterns.

Wetland protection - The loss of both coastal estuarine and inland palustrine wetlands by drainage or alteration has been a dominant cause of population declines of colonial birds regionally and statewide. Locally, habitat fragmentation, seasonal wetland draw downs, and consolidation of freshwater wetlands decreases wetland functioning in the landscape, and

reduces forage availability, which particularly affects successful nesting of White Ibis, small herons, and Wood Storks.

Sea level rise – Participate in the dialogue about climate change and potential effects of sea level rise; include in future conservation planning initiatives acquisition of lands and sites that will not be affected by increasing water levels.

Maintaining the vibrant, diverse colonial waterbird population in Tampa Bay in the future will be more challenging than during the past three decades since BASIS, and much more difficult than in the decades preceding widespread coastal development. Despite 25 years of intensive public outreach and environmental education activities by Audubon and others, sedulous volunteers in Audubon's Project ColonyWatch and in the Florida Shorebird Alliance providing colony guardianship, and expanded coordination between non-governmental, local, county, state, and federal wildlife protection programs, human disturbance is an incessant threat to the persistence of local bird colonies. More protective regulations, more enforcement, and heightened public cooperation will all be needed to protect the spectacular, charismatic bird populations of Tampa Bay.

ACKNOWLEDGMENTS

We thank the many agencies and landowners that allowed access to their lands in the bay: Chassahowitzka National Wildlife Refuge Complex/Pinellas National Wildlife Refuges, Egmont Key and Passage Key National Wildlife Refuges; Florida Department of Environmental Protection Pinellas Aquatic Preserve and Terra Ceia Aquatic Preserve; Florida Parks Department, Hillsborough County; Manatee County and Manatee County Port Authority; Mosaic; Pinellas County; Cities of Clearwater, Lakeland, Pasadena, Safety Harbor, Tampa; and Treasure Island; Southwest Florida Water Management District; Tampa Port Authority; Tampa Electric Company, and many private landowners. This research was supported in part by the National Fish and Wildlife Foundation Pinellas County Environmental Fund, the U. S. Fish & Wildlife Service Coastal Program, the Tampa Port Authority, Mosaic, and many corporate and private donors. Laura Flynn, Lewis Environmental Services, Inc., prepared the figures.

LITERATURE CITED

Agency on Bay Management (ABM). 1995. Pp. 44-46 *in* State of Tampa Bay, 1994. Tampa Bay Regional

Planning Council, St. Petersburg, FL, USA. American Ornithologists' Union. 1998. Check-list of North American Birds, Seventh edition. American

Ornithologists' Union, Washington, D. C., USA.

Buckley, P. A., and F. G. Buckley. 1976. Guidelines for the protection and management of colonially nesting waterbirds. N. Atl. Reg. Office Nat. Park Serv., Boston, MA, USA.

Chesser, R. T., R. C. Banks, F. K. Barker, C. Cicero, J. L. Dunn, A. W. Kratter, I. J. Lovette, P. C. Rasmussen, J. V. Remsen, Jr., J. D. Rising, D. F. Stotz, and K. Winker. 2009. Fiftieth Supplement to the American Ornithologists' Union Check-list of North American Birds. Auk 126:705-714.

Douglass, N., and Clayton, L. C. 2004. Survey of breeding American oystercatcher (*Haematopus palliatus*) populations in Florida. Florida Fish and Wildlife Conservation Commission, Bureau of Wildlife Diversity Conservation: Avian Biological Surveys Report, Lakeland, FL.

Erwin, R. M. 1981. Censusing wading bird colonies: an update on the "flight-line" count method. Colonial Waterbirds 4:91-95.

Erwin, R. M., and J. C. Ogden. 1980. Multiple-factor influences upon feeding flight rates at wading bird colonies (Alias: are flight-line counts useful?). Proceedings of the 1979 Colonial Waterbird Group 3:225-234.

Hodgson, A. B., and A. F. Paul. 2009. Fishhook Spoil Island, Hillsborough Bay, Florida: management plan and recommendations. Audubon of Florida Florida Coastal Islands Sanctuaries Program, Tampa, FL. Tampa Port Authority, Tampa, FL, USA

Hodgson, A. B., A. F. Paul, and J. Kowalski. 2008. The effects of dredged spoil material offloading on bird nesting at Tampa Port Authority Spoil Island 2D from 1997 to 2007. Audubon of Florida Florida Coastal Islands Sanctuaries Program, Tampa, FL, and K2 Engineering, Inc., Riverview, FL, USA. Tampa Port Authority, Tampa, FL, USA.

Hodgson, A. B., A. F. Paul, and M. L. Rachal. 2006. Chapter 14: Birds *in* Bay Environmental Monitoring Report 2000-2005. Tampa Bay Estuary Program, Tampa, FL, USA.

Hodgson, A. B., A F. Paul, and M. L. Rachal. 2008. American oystercatcher nesting in Hillsborough Bay, Florida: Population trends 1990-2007 and management recommendations. Florida Coastal Islands Sanctuaries, Tampa, FL. Tampa Port Authority, Tampa, FL, USA.

Howell, A. H. 1932. Florida Bird Life. Coward-McCann, New York, USA.

King, K. A. 1978. Colonial wading bird survey and census techniques. Pp. 155-159 *in* Wading Birds. A. Sprunt IV, J. C. Ogden, and S. Winkler (Eds.). Nat. Audubon Soc. Res. Report No.7. New York, USA.

Parsons Engineering Science, Inc. 1998. McKay Bay Water Quality Management Plan. Final Report prepared for the Surface Water Improvement and Management Program of the Southwest Florida Water Management District with funding assistance provided by the US EPA, Tampa, FL, USA.

Patton, S. R., and L. A. Hanners. 1984. The history of the Laughing Gull population in Tampa Bay, Florida. Fl. Field Naturalist 12:49-57.

Paul, R., and A. Paul. 2005. Status of coastal bird populations of the Tampa Bay system. P. 19 (abstract) *in* Proceedings, Tampa Bay Area Scientific Information Symposium, BASIS 4. S. F. Treat (Ed.). 27– 30 October 2003. St. Petersburg, FL, USA.

Paul, R. T., A. F. Paul, B. B. Ackerman, and P. C. Frederick. 2004. Evaluating the potential for flight-line counts as a tool for counting nesting wading birds (Ciconiiformes). Grant #01ERGR005. U. S. Geological Survey, St. Petersburg, FL, USA.

Paul, R., and A. Schnapf. 1997. Maintaining stable populations of colonial waterbirds in the Tampa Bay system. Pp. 91-94 *in* Proceedings: Tampa Bay Area Scientific Information Symposium 3 1996. S. Treat (Ed.). Oct. 21-23, 1996. Clearwater, FL, USA.

Paul, R. T., and G. E. Woolfenden. 1985. Current status and recent trends in bird populations of Tampa Bay. Pp. 426-447 *in* Proceedings: Tampa Bay Area Scientific Information Symposium 1982. S. F. Treat, J. L Simon, R. R. Lewis, and R. L Whitman, Jr. (Eds.). Bellwether Press, Minneapolis, MN, USA.

Portnoy, J. W. 1980. Census methods for Gulf Coast waterbirds. Trans. Linn. Soc. 9:127-134.

Schreiber, R. W., and E. A. Schreiber. 1978. Colonial Bird Use and Plant Succession on Dredged Material Islands in Florida. Vol. I, Sea and wading bird colonies. U. S. Army Engineers Waterways Experiment Station Tech. Rep. D-78-14.

From: HODGSON, Ann
To: Imperiled
Cc: WRAITHMELL, Julie; Rodgers, James
Subject: RE: BRPE trend data
Date: Tuesday, November 02, 2010 1:24:07 PM
Attachments: Audubon Tampa Bay colony descriptions and map.doc

The data presented below were acquired at colonial waterbird colonies throughout the Tampa Bay region (Pinellas, Hillsborough, Manatee, Sarasota, and Polk counties) during annual colonial waterbird nesting surveys conducted by Audubon of Florida's Florida Coastal Islands Sanctuaries in cooperation with land management partners, as shown on the attached table and map.

Ann B. Hodgson, Ph. D., P.W. S.
Gulf Coast Ecosystem Science Coordinator
Audubon of Florida
Florida Coastal Islands Sanctuaries Program
410 Ware Blvd., STE 702
Tampa, FL 33619

Hodgson, A. and A. Paul. 2010. Twenty-Five Years after Basis I: An Update on the Current Status and Recent Trends in Bird Colonial Waterbird Populations of Tampa Bay, in: Cooper, S.T. (ed.). 2010. Proceedings, Tampa Bay Area Scientific Information Symposium, BASIS 5: 20-23 October 2009. St.
Petersburg, FL. 538 pp.

Table 1. Colony characteristics and management status of colonial waterbird colonies in Tampa Bay, Florida, USA, in 2009.

Colony Number	*Name*	Bay Segment	Taxa	Species *(n)*	Pairs *(n)*	Abandoned after 1984	New since 1984	Ownership / Management	Protected status	Regional *population* (%)	Active within last 5 yrs?	*Latitude*	*Longitude*
25	Dogleg Key	BCB	P, Ci	12	296		X	FDEP-AP / FCIS	Y	0.51	Y	27.8021	-82.7618
26	Johns Pass, Little Bird Key	BCB	Ci	1	2			Suncoast Seabird Sanctuary	Y	0.00	Y	27.7932	-82.7777
27	Johns Pass, Middle Bird Island	BCB	Ci	2	5			FDEP-AP	Y	0.01	Y	27.7913	-82.7739
28	Johns Pass, Eleanor Island	BCB	Ci			X		City of Treasure Island	Y	0.00	Y	27.7878	-82.7738
29	South Pasadena Marker 34	BCB	L			X	X	City of Pasadena		0.00	N	27.7431	-82.7299
30	Sunset Beach	BCB	L			X	X	City of Treasure Island	N	0.00	N	27.7391	-82.7565
31	Don CeSar Colony	BCB	P, Ci	6	50		X	Private	N	0.09	Y	27.7059	-82.7352
32	Bayway Spoil	BCB	L			X		Developed	N	0.00	N	27.7094	-82.6995
33	Indian Key NWR	BCB	Ci			X	X	USFWS NWR	Y	0.00	Y	27.7011	-82.6909
34	Little Bird Key NWR	BCB	Ci	5	16		X	USFWS NWR	Y	0.03	Y	27.6852	-82.7169
35	Cow and Calf Islands	BCB	P, Ci	2	9		X	FDEP-AP		0.02	Y	27.6856	-82.6916
36	Darling Key	BCB	P, Ci	3	17		X	FDEP-AP		0.03	Y	27.6765	-82.6813
37	Jackass Key NWR	BCB	P, Ci	4	30		X	USFWS NWR	Y	0.05	Y	27.6693	-82.7177
38	Tarpon Key NWR	BCB	P, Ci			X		USFWS NWR	Y	0.00	N	27.6666	-82.6932
39	Whale Island NWR	BCB	P, Ci			X	X	USFWS NWR	Y	0.00	N	27.6626	-82.6930
40	Shell Key County Preserve	BCB	Ch					Florida / Pinellas County	Y	0.00	Y	27.6645	-82.7445
41	Mule Key NWR	BCB	P, Ci			X	X	USFWS NWR	Y	0.00	Y	27.6619	-82.7178
42	Listen Key NWR	BCB	P, Ci			X	X	USFWS NWR	Y	0.00	N	27.6596	-82.7179
43	Sister Key	BCB	P, Ci			X	X	Florida / Pinellas County		0.00	N	27.6503	-82.7312
44	Ft. DeSoto Park	LTB	L, Ch			X	X	Pinellas County	Y	0.00	N	27.6488	-82.7433

Hodgson, A. and A. Paul. 2010. Twenty-Five Years after Basis I: An Update on the Current Status and Recent Trends in Bird Colonial Waterbird Populations of Tampa Bay, in: Cooper, S.T. (ed.). 2010. Proceedings, Tampa Bay Area Scientific Information Symposium, BASIS 5: 20-23 October 2009. St. Petersburg, FL. 538 pp.

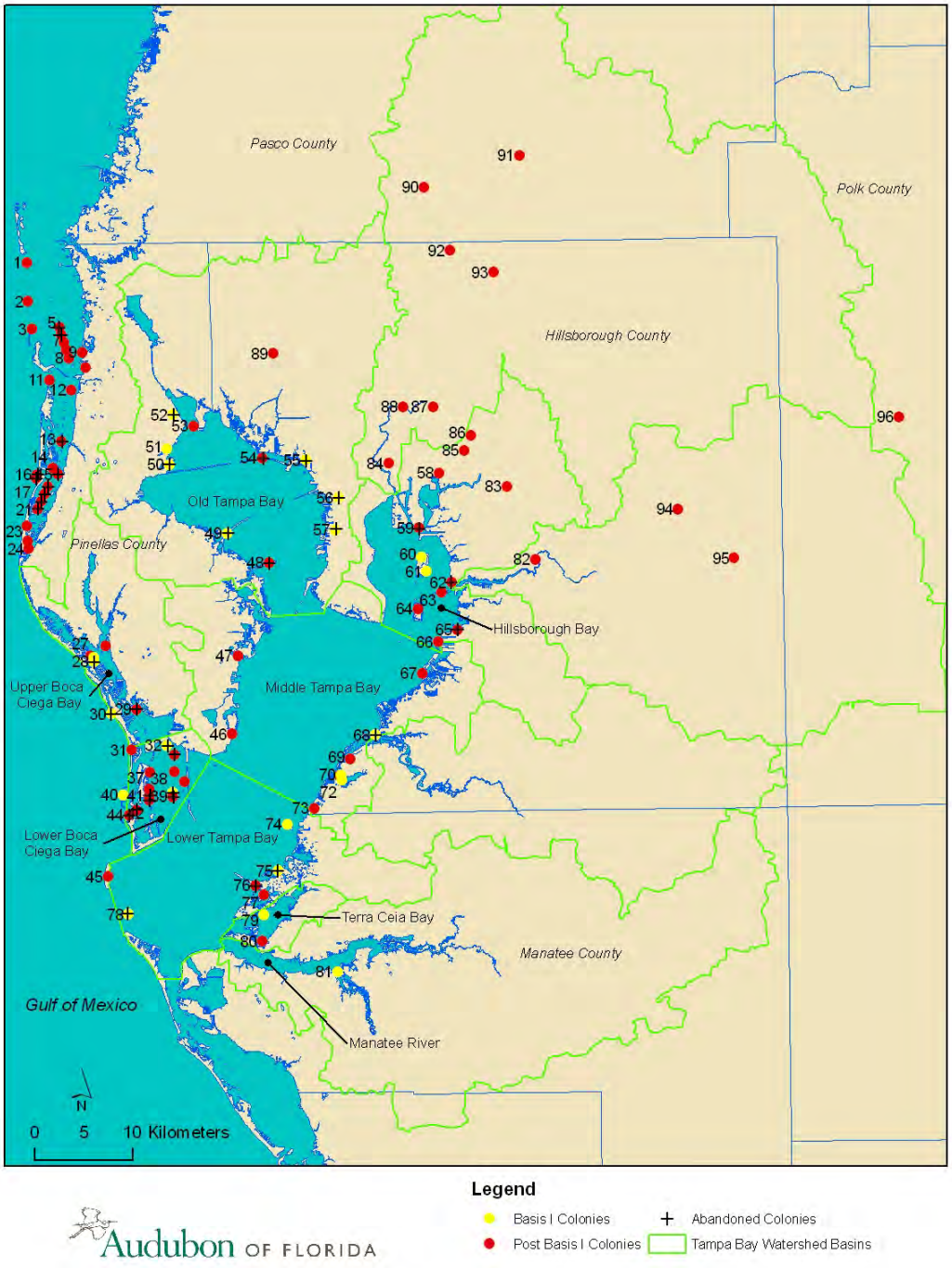
Colony Number	*Name*	Bay Segment	Taxa	Species (*n*)	Pairs (*n*)	Abandoned after 1984	New since 1984	Ownership / Management	Protected status	Regional *population* (%)	Active within last 5 yrs?	*Latitude*	*Longitude*
45	Egmont Key NWR/State Park	LTB	P, Ci, Ch	10	36,521		X	USFWS NWR / Florida State Parks	Y	62.51	Y	27.5894	-82.7614
46	Little Bayou Bird Island	MTB	P, Ci	10	140		X	FDEP-AP / FCIS	Y	0.24	Y	27.7196	-82.6312
47	Coffeepot Bayou Bird Island	MTB	P, Ci	14	612		X	Private	Y	1.05	Y	27.7916	-82.6241
48	Gandy Radio Tower	OTB				X	X	Unknown	N	0.00	N	27.8772	-82.5902
49	Howard Frankland	OTB	L			X		FDOT	N	0.00	N	27.9046	-82.6335
50	Cooper's Point	OTB				X		Pinellas County / City of Clearwater	N	0.00	N	27.9730	-82.6891
51	Alligator Lake	OTB	P, Ci	12	745			City of Safety Harbor / Pinellas County	Y	1.27	Y	27.9813	-82.6990
52	Philippe Park	OTB	Ci			X		Pinellas County	N	0.00	N	28.0053	-82.6778
53	Mobbly Bay Powerlines	OTB	P	1	19		X	Progress Energy	N	0.03	Y	28.0038	-82.6677
54	Courtney Campbell Causeway	OTB	L			X	X	FDOT	N	0.00	N	27.9736	-82.5958
55	Wilson Property/Grand Hyatt	OTB	Ci			X		Private	N	0.00	N	27.9654	-82.5514
56	Sunset Park	OTB				X		City of Tampa	N	0.00	N	27.9374	-82.5201
57	Westshore	OTB				X		City of Tampa	N	0.00	N	27.9002	-82.5361
58	McKay Bay	HB				X	X	City of Tampa / TPA	Y	0.00	N	27.9371	-82.4143
59	Hooker's Point	HB				X	X	TPA	Y	0.00	N	27.9076	-82.4338
60	Tampa Port Authority Spoil Island 2D	HB	Ch	9	2,152			TPA / FCIS	Y	3.68	Y	27.8805	-82.4313
61	Fantasy Island	HB	Ch	1	1			TPA / FCIS	Y	0.00	Y	27.8683	-82.4253
62	Spoil Area C	HB	L, Ch			X	X	Mosaic	Y	0.00	N	27.8571	-82.4003

Hodgson, A. and A. Paul. 2010. Twenty-Five Years after Basis I: An Update on the Current Status and Recent Trends in Bird Colonial Waterbird Populations of Tampa Bay, in: Cooper, S.T. (ed.). 2010. Proceedings, Tampa Bay Area Scientific Information Symposium, BASIS 5: 20-23 October 2009. St. Petersburg, FL. 538 pp.

Colony Number	*Name*	Bay Segment	Taxa	Species (*n*)	Pairs (*n*)	Abandoned after 1984	New since 1984	Ownership / Management	Protected status	Regional *population* (%)	Active within last 5 yrs?	*Latitude*	*Longitude*
63	Richard T. Paul Alafia Bank Bird Sanctuary	HB	P, Ci, Ch	16	6,234			Mosaic / FCIS	Y	10.67	Y	27.8483	-82.4106
64	Tampa Port Authority Spoil Island 3D	HB	Ch	2	23			TPA / FCIS	Y	0.04	Y	27.8331	-82.4352
65	Port Redwing	HB	L, Ch			X	X	TPA	Y	0.00	N	27.8132	-82.3951
66	Fishhook Spoil Island	HB	Ch	2	13			TPA / TECO	Y	0.02	Y	27.8024	-82.4152
67	Apollo Beach Oystercatchers	HB	Ch	2	15		X	Private	N	0.03	Y	27.7733	-82.4318
68	Mouth of Little Manatee River	MR	P, Ci			X		FDEP Cockroach Bay Aquatic Preserve	N	0.00	N	27.7160	-82.4823
69	Cockroach Bay Preserve	MTB	Ch	1	30		X	ELAPP	Y	0.05	Y	27.6955	-82.5079
70	Hole in the Wall, Cockroach Bay Preserve 1	MTB	Ci				X	ELAPP	Y	0.02	Y	27.6811	-82.5183
71	Hole in the Wall, Cockroach Bay Preserve 2	MTB	Ci	1	20		X	ELAPP	Y	0.02	Y	27.6799	-82.5198
72	Hole in the Wall, Cockroach Bay Preserve 3	MTB	Ci				X	ELAPP	Y	0.02	Y	27.6764	-82.5169
73	Piney Point	MTB	P, Ci	14	2,795		X	SWFWMD	Y	4.78	Y	27.6505	-82.5462
74	Manbirtee Key	MTB	Ci, Ch	4	24			MCPA / FCIS	Y	0.04	Y	27.6359	-82.5740
75	Two Brothers Island	LTB	Ci			X		Private	N	0.00	N	27.5935	-82.5847
76	Skyway Bridge Least Tern colony	LTB	L			X	X	FDOT	N	0.00	N	27.5808	-82.6090
77	Miguel Bay Colony	LTB	P, Ci				X	FDEP-AP / FCIS	Y	0.00	Y	27.5708	-82.5995
78	Passage Key	LTB	P, Ci, L, Ch			X		USFWS NWR	Y	0.00	Y	27.5545	-82.7404
79	Nina Washburn Sanctuary	TCB	P, Ci	7	52			FCIS	Y	0.09	Y	27.5527	-82.5999
80	Washburn Junior/Terra Ceia	TCB	P, Ci	14	407		X	FDEP Terra Ceia Aquatic	Y	0.70	Y	27.5285	-82.6015

Colony Number	*Name*	Bay Segment	Taxa	Species (*n*)	Pairs (*n*)	Abandoned after 1984	New since 1984	Ownership / Management	Protected status	Regional *population* (%)	Active within last 5 yrs?	*Latitude*	*Longitude*
	Bay Little Bird Key							Preserve / FCIS					
81	Dot Dash Dit Colony	MR	P, Ci	13	2,360			Private / Florida / FCIS	Y	4.04	Y	27.4993	-82.5243
82	Heath Yellow-crowned Night-Heron Colony	HC	Ci	1	5		X	Private	N	0.01	Y	27.8772	-82.3129
83	Office/Ferman Bird Colony	HC	P, Ci	8	74		X	Private	Y	0.13	Y	27.9448	-82.3417
84	Robles Park	HC	Ci	4	31		X	City of Tampa	Y	0.05	Y	27.9740	-82.4550
85	Corporex Colony	HC	P, Ci	7	94		X	Private	N	0.16	Y	27.9786	-82.3857
86	East Lake Island	HC	P, Ci	5	14		X	Florida Audubon Society	Y	0.02	Y	27.9922	-82.3784
87	Temple Crest/Orange Lake/Wargo Bird Colony	HC	P, Ci	8	51		X	City of Tampa / TPA	N	0.09	Y	28.0193	-82.4174
88	River Cove Yellow-crowned Night-Heron colony	HC	Ci				X	Hillsborough County	N	0.02	Y	28.0192	-82.4486
89	Citrus Park Bird Colony	HC	P, Ci	9	486		X	Private	N	0.83	Y	28.0699	-82.5834
90	Heron Point	PaC	P, Ci	7	57		X	Private	N	0.10	Y	28.2157	-82.4349
91	Saddlebrook	PaC	P, Ci	3	48		X	Private	Y	0.08	Y	28.2277	-82.3297
92	Cypress Creek Preserve	HC	P, Ci	11	3,294		X	ELAPP	Y	5.64	Y	28.1629	-82.3975
93	Cross Creek Colony	HC	P, Ci	2	8		X	Private	N	0.01	Y	28.1424	-82.3520
94	Medard County Park	HC	P, Ci	10	477		X	Hillsborough County	Y	0.82	Y	27.9218	-82.1630
95	Alafia River Corridor Preserve	HC	P, Ci	5	46		X	ELAPP	Y	0.08	Y	27.8756	-82.1053
96	Wood Lake/Somerset Lake	PoC	P, Ci	14	1,151		X	City of Lakeland / Private	Y	1.97	Y	28.0036	-81.9311
	Totals				58,424	27	48			100.00			

Hodgson, A. and A. Paul. 2010. Twenty-Five Years after Basis I: An Update on the Current Status and Recent Trends in Bird Colonial Waterbird Populations of Tampa Bay, in: Cooper, S.T. (ed.). 2010. Proceedings, Tampa Bay Area Scientific Information Symposium, BASIS 5: 20-23 October 2009. St.
Petersburg, FL. 538 pp.



Copy of the Snowy plover BSR draft report that was sent out for peer review

Biological Status Review for the Snowy Plover (*Charadrius alexandrinus)*

EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission (FWC) directed staff to evaluate all species listed as Threatened or Species of Special Concern as of September 1, 2010. Public information on the status of the snowy plover was sought from September 17 to November 1, 2010. The three-member biological review group met on November 3-4, 2010. Group members were Nancy J. Douglass (FWC lead), Elizabeth A. Forys (Professor of Environmental Science and Biology at Eckerd College), and Gary L. Sprandel (Geoprocessing Specialist, Kentucky Department of Fish and Wildlife Resources). In accordance with rule 68A-27.0012 Florida Administrative Code (F.A.C.), the Snowy Plover Biological Review Group was charged with evaluating the biological status of the snowy plover using criteria included in definitions in 68A-27.001(3) and following the protocols in the *Guidelines for Application of the IUCN Red List Criteria at Regional Levels (Version 3.0)* and *Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1)*. Please visit http://www.myfwc.com/WILDLIFEHABITATS/imperiledSpp_listingprocess.htm to view the listing process rule and the criteria found in the definitions.

The Biological Review Group concluded from the biological assessment findings that the snowy plover met criteria for listing and recommend retaining the species on the FWC list of threatened species.

This work was supported by a Conserve Wildlife Tag grant from the Wildlife Foundation of Florida.

BIOLOGICAL INFORMATION

Life History References – Butcher et al. 2007; Elliot-Smith et al. 2004; Funk et al. 2007; Gorman and Haig 2002; Himes et al. 2006; Küpper et al. 2009; Page et al. 2009; U.S. Shorebird Conservation Plan 2004; FWC 2003.

Taxonomic Classification – The most recent genetic and phenotypic findings indicate that the snowy plover of the Americas and the European Kentish plover are distinct species (Küpper et al. 2009). However, as of this report, the American Ornithologists' Union (1998) continues to treat these birds as members of the same species (*Charadruis alexandrinus)*. The subspecies classification of the two North American populations of snowy plover is also a matter of debate and the subject of recent research. The Florida population of snowy plover has historically been listed as *C. a. tenuirostris* (Cuban snowy plover), but genetic evidence supports their inclusion in *C. a. nivosus* (western snowy plover) (Funk et al. 2007; Page et al. 2009).

Population Status and Trend – The entire North American breeding population of snowy plovers is estimated at less than 18,000 individuals (Page et al. 2009). Gorman and Haig (2002) generated maps of breeding and wintering snowy plovers for the eastern U.S., Caribbean, and Bahamas based on a variety of databases, field data, and published accounts. They concluded that although data on historic abundance and trends are limited, there was evidence for regional population declines and range contractions. Butcher et al. (2007) assessed the U.S. population of snowy plovers as having a decline of at least 2.28% per year. The U.S. Shorebird Conservation Plan (2004) categorizes snowy plovers as "highly imperiled" based on evidence the species is experiencing significant population declines ($p<0.10$). In Florida, Himes et al. (2006) found that while overall numbers of breeding snowy plovers in the state were relatively stable between 2002 and 2006, the number of pairs in the Southwest region decreased by 25% during that time.

Geographic Range and Distribution – Snowy plovers occur on Florida's narrow fringe of sandy beaches along the Gulf of Mexico coast. Within Florida, the breeding population is disjunct: one group occurs in Northwest Florida from Franklin County west and the other occurs from Pasco to Collier Counties in Southwest Florida. Their historical abundance and distribution in the state has not been well documented prior to the past few decades, and breeding and wintering records for the species in Florida are incomplete. Himes et al. (2006) determined that the majority of the state's breeding population (79.7%) is located in the Northwest region, and that over half (59.9%) of Florida's breeding pairs occurred on just nine sites. In the Southwest, the total number of sites supporting breeding snowy plovers was relatively consistent from 2002 to 2006, but site locations were highly variable (Himes et al. 2006). Reviews of historical data indicate strong site fidelity in stable habitat areas, but that local populations may shift in order to adjust to coastal dynamics at less stable breeding sites.

Quantitative Analysis - There has not been a comprehensive population viability analysis on the Cuban snowy plover or the Florida population of snowy plovers. A population viability analysis conducted for the Pacific coast population of the western snowy plover (*C. a. nivosus*) concluded that productivity of at least 1.0 fledglings per breeding male per year would result in a stable population (Nur et al. 1999).

BIOLOGICAL STATUS ASSESSMENT

Threats – The U.S. Shorebird Conservation Plan (Brown et al. 2001) lists the North American population of the snowy plover as "Highly Imperiled" due to high risk factors such as beach habitat loss. Audubon's Watchlist has identified the snowy plover as a species of conservation concern due to increasingly fragmented breeding ranges, disappearance from historic breeding locations, and a variety of threats ranging from shoreline development to human disturbance (Butcher et al. 2007).

Snowy plovers are less versatile than other beach-nesting bird species and have not adapted to alternative or artificial nesting habitats such as dredge spoil islands. Breeding occurs primarily on open sandy beaches. The simple nests consist of a small, well-camouflaged scrape on the ground, making this species extremely vulnerable to disturbance and predation. Habitat loss during the past decades has been extremely high for beach-obligate species such as the snowy plover. The American Bird Conservancy (2007) lists development, recreation, pollution,

global warming, coastal engineering projects and invasive species as threats to coastal habitats. Recreational activity, shoreline hardening, mechanical raking, and increased presence of domestic cats and dogs are all examples of human-induced negative impacts to coastal habitats critical to snowy plovers (Defeo et al. 2009). Their specific breeding behavior means that in addition to being vulnerable to the aforementioned direct threats, they are also susceptible to more subtle impacts and combination effects. For example, repeated flushing off nests and eggs by human recreational disturbance can result in thermal stress for developing eggs and chicks, or expose the location of eggs or chicks to predators. In order to fledge successfully, chicks must achieve rapid weight gain and growth, but exclusion from prey-rich beach areas, or increased avoidance behavior and reduced foraging time in response to disturbances, may extend the time needed for chicks to fledge (Pruner and Johnson 2010). Mechanical raking, an activity that is relatively common on Florida's beaches, can result in direct take of nests or young, separate young from adults, and/or diminish prey abundance on wintering and breeding beaches (Dugan et al. 2003). Researchers involved in regional monitoring of snowy plover breeding sites in Florida also convey alarm about the threat presented by the presence of dogs on beaches. Ordinances that allow dogs and weak enforcement of pet prohibitions can result in dogs flushing adults at greater distances and a slower return to nests than what is observed with disturbance by humans alone (Faillace 2010; Pruner and Johnson 2010). This is consistent with observations in California, where the presence of leashed and unleashed dogs has a deleterious effect on snowy plover breeding productivity, and is common even on beaches where such activity is prohibited (Lafferty et al. 2006; Rhulen et al. 2003; USFWS 2007) presumably due to lack of enforcement

In Florida, major threats to snowy plovers include habitat degradation, human related disturbance, and increased predator pressures throughout its range. Himes et al. (2006) found that 68% of sites in Florida that contained suitable habitat for snowy plovers experienced high levels of human disturbance. Yasué and Dearden (2009) offer an excellent overview of the direct, indirect, and cumulative impacts that increasing human activity and beach tourism have on populations of beach-obligate shorebirds such as plovers. The susceptibility of this species to human disturbance and development is underscored by population declines in the Southwest region. While most snowy plovers nest on public lands, these lands are generally managed for recreational use. Historically, limited public support for curtailing recreational use and a lack of regulatory infrastructure to protect beach-nesting birds from incompatible beach management practices have contributed to continued loss of suitable habitat and poor reproductive success (Wilson and Colwell 2010). Concerns have also been raised regarding the effect of beach replenishment projects on snowy plovers. It is unknown whether or not observed declines in abundance or total absence of the species is the result of sand renourishment impacts on substrate quality, prey abundance or other physical alterations to the habitat (Himes et al. 2006; Lott 2009; Nordstrom 2005).

Animals such as rats, raccoons, opossums, crows and coyotes, which are known predators of adult snowy plovers and eggs/chicks, respond positively to increased human presence and development. Predation from growing colonies of gulls can also be an issue for this species (Hunter et al. 2006). In Tampa Bay, for example, laughing gull colonies have increased from approximately 10,000 pairs to over 30,000 pairs since 2006 (Burney 2009). Additional emerging threats which are poorly understood but have generated concern are invasive species such as fire ants and carnivorous lizards.

With the majority of the breeding pairs occurring at relatively few sites in the Northwest region, the population is left more vulnerable to environmental perturbations such as hurricanes and oil spills. Impacts to snowy plovers from the 2010 oil spill and ongoing clean-up efforts have not been assessed.

Statewide Population Assessment – Findings from the Biological Review Group are included in Biological Status Review Information tables.

LISTING RECOMMENDATION

Staff recommends that the snowy plover be listed as a Threatened species because the species met criteria for listing as described in 68A-27.001(3) F.A.C. – limited geographic range combined with population declines and vulnerability to stochastic events; and limited population size combined with population decline.

SUMMARY OF THE INDEPENDENT REVIEW

LITERATURE CITED

American Bird Conservancy. 2007. Top 20 Most Threatened Bird Habitats. ABC Special Report. The Plains, VA. 48 pp.

American Ornithologists' Union. 1998. Check-list of North American birds. 7th ed. American Ornithologists' Union, Washington, D.C.

Brown, S.C., C. Hickey, B. Harrington and R. Gill (Eds.). 2001. The U.S. shorebird conservation plan, 2nd edition. Manomet Center for Conservation Sciences, Manomet, MA. Available online: http://www.fws.gov/shorebirdplan/USShorebird/downloads/USShorebirdPlan2Ed.pdf (Accessed 10/25/2010).

Burney, C. 2009. Florida beach-nesting bird report: 2005 – 2008. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL. Available online: http://www.flshorebirdalliance.org/pdf/2005-2008_FWC_BNB_Report.pdf (Accessed 10/20/2010).

Butcher, G.S., D.K. Niven, A.O. Panjabi, D.N. Pashley, and K.V. Rosenberg. 2007. Watchlist: the 2007 Watchlist for United States birds. Technical Report. American Birds 61: 18 – 25. Available online: http://web1.audubon.org/science/species/watchlist/techReport.php (Accessed 10/25/2010).

Clark, R.R. 1993. Beach conditions in Florida: a statewide inventory and identification of the beach erosion problem areas in Florida. Florida Department of Environmental Protection Beaches and Shores Technical and Design Memorandum 89-1, 5th Edition. 208 Pp.

Defeo, O., A. McLachlan, D.S. Schoeman, T.A. Schlacher, J. Dugan, A. Jones, M. Lastra, and F. Scapini. 2009. Threats to sandy beach ecosystems: A review. Estuarine, Coastal and Shelf Sciences 81: 1 – 12.

Dugan, J. E., D. M. Hubbard, M. D. McCrary, and M. O. Pierson. 2003. The response of macrofauna communities and shorebirds to macrophyte wrack subsidies on exposed sandy beaches of southern California. Estuarine Coastal and Shelf Science 58: 25-40.

Elliot-Smith, E., S.M. Haig, C.L. Ferland and L.R. Gorman. 2004. Winter distribution and abundance of snowy plovers in SE North America and the West Indies. Wading Group Study Bulletin 104: 28 – 33.

Faillace, C.A. 2010. Breeding snowy plovers (*Charadrius alexandrinus*) exhibit variable response to human disturbance on two islands in southwest Florida. M. Sc. Thesis, Rutgers, The State University of New Jersey, New Brunswick, NJ.

Fernald, E.A. and E.D. Purdum (Eds.). 1992. Atlas of Florida. University Press Florida, Gainesville, FL. Pp. 280.

Florida Department of Environmental Protection (FDEP). 2010. Critically eroded beaches in Florida. Bureau of Beaches and Coastal Systems, Division of Water Resource Management, Department of Environmental Protection, State of Florida. 75 Pp.

Florida Fish and Wildlife Conservation Commission (FWC). 2003. Florida's breeding bird atlas: A collaborative study of Florida's birdlife. Available online: http://myfwc.com/bba/docs/bba_LETE.pdf (Accessed 10/06/2010).

Florida Fish and Wildlife Conservation Commission (FWC). 2005. Florida's Widlife Legacy Initiative. Florida's Comprehensive Wildlife Conservation Strategy. Tallahassee, Florida, USA.

Florida Fish and Wildlife Conservation Commission (FWC). 2008. Wildlife 2060: What's at stake for Florida? Florida Fish and Wildlife Conservation Commission Special Report. 27 pp. Available online: http://myfwc.com/docs/RecreationActivities/FWC2060.pdf (Accessed 11/8/2010).

Forys, E.A. 2010. *Unpublished preliminary report*. Open-beach nesters on the central Gulf coast of Florida (2002 – 2010).

Funk, W.C., T.D. Mullins and S.M. Haig. 2007. Conservation genetics of snowy plovers (*Charadrius alexandrinus*) in the Western Hemisphere: population genetic structure and delineation of subspecies. Conservation Genetics 8: 1287 – 1309.

Gore, J.A. and C.A. Chase. 1989. Snowy plover breeding distribution. Final Performance Report. Florida Game and Fresh Water Fish Commission, Tallahassee, FL. 23 pp.

Gorman, L.R. and S.M. Haig. 2002. Distribution and abundance of Snowy Plovers in eastern North America, the Caribbean, and the Bahamas. Journal of Field Ornithology 73(1): 38 – 52.

Himes, J. G., N. J. Douglass, R. A. Pruner, A. M. Croft, and E. M. Seckinger. 2006. Status and Distribution of the Snowy Plover in Florida. 2006 study final report. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida, 27 pp. + 12 figs. + 12 tables + 5 appendices.

Hunter, W.C., W. Golder, S.L. Melvin, and J.A. Wheeler. 2006. Southeast United States regional waterbird conservation plan. U.S. Fish and Wildlife Service, Atlanta, Georgia, USA.

IUCN. 2009. International Union for Conservation of Nature and Natural Resources. The IUCN Red List of Threatened Species, Version 2010.3. Available online: http://www.iucnredlist.org/apps/redlist/details/144107/0 (Accessed 10/25/2010).

Küpper, C., J. Augustin, A. Kosztolanyi, T. Burke, J. Figuerola, and T. Szekely. 2009. Kentish versus snowy plover: phenotypic and genetic analyses of *Charadrius alexandrinus* reveal divergence of Eurasian and American subspecies. The Auk 126(4): 839 – 852.

Lafferty, K.D., D. Goodman, and C.P. Sandoval. 2006. Restoration of breeding by snowy plovers following protection from disturbance. Biodiversity and Conservation 15: 2217 – 2230.

Lamonte, K.M., N.J. Douglass, J.G. Himes and G.E. Wallace. 2006. Status and distribution of the Snowy Plover in Florida. 2002 study final report. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida, 20 pp. + 15 figs. + 14 tables + 7 appendices.

Lott, C.A. 2009. 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. ERDC/EL-09-13. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Nordstrom, K.F. 2005. Beach nourishment and coastal habitats: research needs to improve compatibility. Restoration Ecology 13(1): 215 – 222.

Nur, N., G.W. Page and L.E. Stenzel. 1999. Appendix D: Population viability analysis for Pacific coast snowy plovers. In Western Snowy Plover (*Charadrius alexandrinus nivosus*) Pacific coast population, draft recovery plan (May 2001) US Fish and Wildlife Service, Region 1.

Page, G. W., Lynne E. Stenzel, G. W. Page, J. S. Warriner, J. C. Warriner and P. W. Paton. 2009. Snowy Plover (*Charadrius alexandrinus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/154

Pruner, R.A. and S.A. Johnson. 2010. Ecology and conservation of snowy plovers in the Florida panhandle. Final report to the Florida Cooperative Fish and Wildlife Research Unit, U.S. Fish and Wildlife. RWO 240.

Rhulen, T.D., S. Abbott, L.E. Stenzel and G.W. Page. 2003. Evidence that human disturbance reduces Snowy Plover chick survival. Journal of Field Ornithology 74(3): 300 – 304.

U.S. Fish and Wildlife Service (USFWS). 2007. Recovery plan for the Pacific Coast population of the Western Snowy Plover (*Charadrius alexandrinus nivosus*). In 2 volumes. U.S. Fish and Wildlife Service, Sacramento, CA. xiv +751 pages.

U.S. Shorebird Conservation Plan. 2004. High Priority Shorebirds - 2004. Unpublished Report, U. S. Fish and Wildlife Service, 4401 N. Fairfax Dr., MBSP 4107, Arlington, VA, 22203 USA. 5 Pp.

Wilson, C.A. and M.A. Colwell. 2010. Movements and fledging success of snowy plover (*Charadrius alexandrinus*) chicks. Waterbirds 33(3): 331 – 340.

Yasué, M. and P. Dearden. 2009. Methods to measure and mitigate the impacts of tourism development on tropical beach-breeding shorebirds: the Malaysian plover in Thailand. Tourism in Marine Environments 5(4): 287 – 299.

Biological Status Review Information
Findings

Species/taxon: Snowy Plover / *Charadrius alexandrinus*
Date: 11/03/10
Assessors: Nancy Douglass, Beth Forys, Gary Sprandel

Generation length: ~ 3 years (Page et al. 2009/BNA Acct)

Criterion/Listing Measure	Data/Information	Data Type*	Criterion Met?	References
*Data Types - observed (O), estimated (E), inferred (I), suspected (S), or projected (P). Criterion met - yes (Y) or no (N).				
(A) Population Size Reduction, ANY of				
(a)1. An observed, estimated, inferred or suspected population size reduction of at least 50% over the last 10 years or 3 generations, whichever is longer, where the causes of the reduction are clearly reversible and understood and ceased[1]	Estimates from 1989 (at least 334 breeding adults), 2002 (at least 426 breeding adults), 2006 (at least 444 breeding adults), but surveys varied in methodology and effort making direct comparisons problematic. An estimate on size reduction cannot be inferred. Estimates are from pairs.	Estimated	NO	Gore and Chase 1989; Lamonte et al. 2006; Himes et al. 2006.
(a)2. An observed, estimated, inferred or suspected population size reduction of at least 30% over the last 10 years or 3 generations, whichever is longer, where the reduction or its causes may not have ceased or may not be understood or may not be reversible[1]	See (a)1.	Estimated	NO	See above.
(a)3. A population size reduction of at least 30% projected or suspected to be met within the next 10 years or 3 generations, whichever is longer (up to a maximum of 100 years) [1]	Quality of habitat is declining, productivity data is highly variant and appears to be below rates required for stability (panhandle = 2008 - 2010/avg 0.7 = 0.48 - 0.89 fledge/pair; southwest 2002 - 2010/avg 0.34; range 0.13 - 0.85 fledge/pair; Sanibel = 2003 - 2010 avg. 1.01; range 0.33 - 1.63 fledge/female), but cannot infer a projected 30% of decline.	Inferred/projected	NO	Forys 2010; Unpublished data from Raya Pruner (2008 - 2010), Brad Smith (2003 - 2010), Beth Forys (2002 - 2010).
(a)4. An observed, estimated, inferred, projected or suspected population size reduction of at least 30% over any 10 year or 3 generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction	See above.	Inferred/projected	NO	See above.

or its causes may not have ceased or may not be understood or may not be reversible.[1]				
[1] based on (and specifying) any of the following: (a) direct observation; (b) an index of abundance appropriate to the taxon; (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat; (d) actual or potential levels of exploitation; (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.				
(B) Geographic Range, EITHER				
(b)1. Extent of occurrence < 20,000 km^2 (7,722 mi^2) OR	Linear miles of statewide coastline = 2,276 miles x 1 mile width (beach range) = 2,276 sq miles. Generous overestimate which includes Atlantic coast and unsuitable habitat. Excessive estimate of beach width.	Estimated	YES	Fernald and Purdum, 1992.
(b)2. Area of occupancy < 2,000 km^2 (772 mi^2)	Combining total beach/surf zone and coastal strand habitats = 73.7 sq miles. Actual area of occupancy is less; this represents potential occupancy.	Estimated	YES	FWC 2005 "Florida's Wildlife Legacy Initiative"
AND at least 2 of the following:				
a. Severely fragmented or exist in ≤ 10 locations	Less than 10 locations. Two major breeding areas - panhandle and southwest, each of which consists of 2 - 4 locations that could be impacted by a single oil spill or hurricane/tropical storm.	Observed/Estimated	YES	Himes et al. 2006; Burney 2009
b. Continuing decline, observed, inferred or projected in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent, and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals	(iii) Quality of habitat is declining due to increased beach recreational pressures and associated management, 59% of beaches are eroded; intense population growth in the southwest region (particularly in the 1970s) has already resulted in decline in quality of habitat in that region. (v). Productivity data appears to be below rates required for stability (panhandle = 2008 - 2010/avg 0.7 = 0.48 - 0.89 fledge/pair; southwest 2002 - 2010/avg 0.34; range 0.13 - 0.85 fledge/pair; Sanibel = 2003 - 2010 avg. 1.01; range 0.33 - 1.63 fledge/female). We are projecting the number of mature individuals will decline based on the presented productivity rates.	Observed/Inferred/Projected	YES - iii, v	FWC 2008 ; Fernald and Purdum, 1992; American Bird Conservancy 2007 Threatened Habitats; DEP 2010; Clark 1993; FDEP 2010; Lafferty et al. 2006; Rhulen et al. 2003; Forys 2010; unpublished data from Raya Pruner (2008 - 2010), Brad Smith (2003 - 2010), Beth Forys (2002 - 2010). USFWS 2007
c. Extreme fluctuations in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals	No data to support this conclusion	None	NO	none
(C) Population Size and Trend				

Population size estimate to number fewer than 10,000 mature individuals AND EITHER	Most accurate estimate considered to be AT LEAST 444 breeding adults. Other surveys estimate at least 334 - 426 breeding adults.	Estimated	YES	Himes et al. 2006; Lamonte et al. 2006; Gore and Chase 1989
(c)1. An estimated continuing decline of at least 10% in 10 years or 3 generations, whichever is longer (up to a maximum of 100 years in the future) OR	No data to support this conclusion	None	NO	none
(c)2. A continuing decline, observed, projected, or inferred in numbers of mature individuals AND at least one of the following:	A continuing decline is inferred and projected based on productivity rates. Productivity data appears to be below rates required for stability (panhandle = 2008 - 2010/avg 0.7 = 0.48 - 0.89 fledge/pair; southwest 2002 - 2010/avg 0.34; range 0.13 - 0.85 fledge/pair; Sanibel = 2003 - 2010 avg. 1.01; range 0.33 - 1.63 fledge/female). We are projecting the number of mature individuals will decline based on the presented productivity rates.	Inferred/projected	YES	Forys 2010; Unpublished data from Raya Pruner (2008 - 2010), Brad Smith (2003 - 2010), Beth Forys (2002 - 2010).
a. Population structure in the form of EITHER	Florida population of breeding adults estimated to be at least 444.	Estimated	YES	Himes et al. 2006
(i) No subpopulation estimated to contain more than 1000 mature individuals; OR				
(ii) All mature individuals are in one subpopulation	All breeding adults considered to be in one subpopulation of approximately 444 adults.	Estimated	YES	Himes et al. 2006
b. Extreme fluctuations in number of mature individuals	No data to support this conclusion	None	NO	none
(D) Population Very Small or Restricted, EITHER				
(d)1. Population estimated to number fewer than 1,000 mature individuals; OR	Florida population of breeding adults estimated to be at least 444.	Estimated	YES	Himes et al. 2006
(d)2. Population with a very restricted area of occupancy (typically less than 20 km^2 [8 mi^2]) or number of locations (typically 5 or fewer) such that it is prone to the effects of human activities or stochastic events within a short time period in an uncertain future	No data to support this conclusion	None	NO	None
(E) Quantitative Analyses				
e1. Showing the probability of extinction in the wild is at least 10% within 100 years	Not available	None	NO	none

Initial Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met):
YES	B1(a) and (b)iii, v; B2(a) and (b)iii, v; C2(a)(i); C2(a)(ii); D1
Is species/taxon endemic to Florida? (Y/N)	NO
If Yes, your initial finding is your final finding. Copy the initial finding and reason to the final finding space below. If No, complete the regional assessment sheet and copy the final finding from that sheet to the space below.	
Final Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)
No Change - Meets the Criteria	B1(a) and (b)iii,v; B2(a) and (b)iii, v; C2(a)(i); C2(a)(ii); D1

1	Biological Status Review Information Regional Assessment Species/taxon:	Snowy Plover / Charadrius alexandrinus
2	Date:	11/3/10
3	Assessors:	Nancy Douglass, Beth Forys, Gary Sprandel
4		
5		
6		
7		
8	Initial finding	Supporting Information
9		
10	2a. Is the species/taxon a non-breeding visitor? (Y/N/DK). If 2a is YES, go to line 18. If 2a is NO or DO NOT KNOW, go to line 11.	NO
11	2b. Does the Florida population experience any significant immigration of propagules capable of reproducing in Florida? (Y/N/DK). If 2b is YES, go to line 12. If 2b is NO or DO NOT KNOW, go to line 17.	DO NOT KNOW
12	2c. Is the immigration expected to decrease? (Y/N/DK). If 2c is YES or DO NOT KNOW, go to line 13. If 2c is NO go to line 16.	
13	2d. Is the Florida population a sink? (Y/N/DK). If 2d is YES, go to line 14. If 2d is NO or DO NOT KNOW, go to line 15.	
14	If 2d is YES - Upgrade from initial finding (more imperiled)	
15	If 2d is NO or DO NOT KNOW - No change from initial finding	
16	If 2c is NO or DO NOT KNOW- Downgrade from initial finding (less imperiled)	
17	If 2b is NO or DO NOT KNOW - No change from initial finding	NO CHANGE
18	2e. Are the conditions outside Florida deteriorating? (Y/N/DK). If 2e is YES or DO NOT KNOW, go to line 24. If 2e is NO go to line 19.	
19	2f. Are the conditions within Florida deteriorating? (Y/N/DK). If 2f is YES or DO NOT KNOW, go to line 23. If 2f is NO, go to line 20.	
20	2g. Can the breeding population rescue the Florida population should it decline? (Y/N/DK). If 2g is YES, go to line 21. If 2g is NO or DO NOT KNOW, go to line 22.	
21	If 2g is YES - Downgrade from initial finding (less imperiled)	
22	If 2g is NO or DO NOT KNOW - No change from initial finding	
23	If 2f is YES or DO NOT KNOW - No change from initial finding	
24	If 2e is YES or DO NOT KNOW - No change from initial finding	
25		
26	Final finding	NO CHANGE

APPENDICES

Appendix 1: Biological Review Group Members' Biographies
Appendix 2: Summary of Public Comment
Appendix 3: Information and Comments Received from Independent Reviewers

Appendix 1. Brief biographies of the members of the Biological Review Group for the snowy plover.

Nancy J. Douglass received her B.S. in Wildlife and Fisheries Biology from the University of Vermont and her Masters of Environmental Management from Duke University. She has over 23 years of experience working in the wildlife profession, 20 of which have been with the Florida Fish and Wildlife Conservation Commission as a regional biologist. Her area of expertise is nongame wildlife but she is most recognized for her expertise in seabird and shorebird conservation.

Elizabeth A. Forys received a M.S. in Environmental Science/Ecology from the University of Virginia and a Ph.D. in Wildlife Ecology and Conservation from the University of Florida. She is currently a professor at Eckerd College in St. Petersburg, Florida. She has over 30 publications on endangered species theory and management and 8 specifically on shorebirds and seabirds including American oystercatchers, black skimmer, least terns, and snowy plovers in Florida. For the past 10 years Beth has helped coordinate a project that monitors, maps, and protects beach and roof-top nesting birds throughout west-central Florida.

Gary L. Sprandel has a B.S. degree in Computer Science from Colorado State University with coursework in wildlife biology. He has worked as a geoprocessor for the Kentucky Department of Fish and Wildlife Resources since 2005 on a variety of projects including the State Wildlife Action Plan, public hunting area mapping, survey databases, habitat mapping, and species distribution mapping. From 1992-2005 Gary worked for the FWC as a database manager on many projects including data collection and analysis for wintering shorebird surveys, support of breeding shorebird and seabird surveys, and species and site ranking databases. Gary has over a dozen published papers on Florida's bird life.

Appendix 2. Summary of letters and emails received during the solicitation of information from the public period of September 17, 2010 through November 1, 2010.

Email from Ann B. Hodgson, Gulf Coast Ecosystem Science Coordinator, Audubon of Florida, Florida Coastal Islands Sanctuaries, (ahodgson@audubon.org, 410 S. Ware Boulevard, Suite 702, Tampa, Florida 33619) dated October 29, 2010. Dr. Hodgson provided a copy of the following report:
Hodgson, A. and A. Paul. 2010. Twenty-Five Years after Basis I: An Update on the Current Status and Recent Trends in Bird Colonial Waterbird Populations of Tampa Bay, in: Cooper, S.T. (ed.). 2010. Proceedings, Tampa Bay Area Scientific Information Symposium, BASIS 5: 20-23 October 2009. St. Petersburg, FL. 538 pp.

Appendix 3: Information and comments received from independent reviewers**.**