

# SNOWY PLOVER BREEDING DISTRIBUTION

## FINAL PERFORMANCE REPORT

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*Nongame Wildlife Section  
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**Project:** Survey and Monitoring

**Study:** Snowy Plover Breeding Distribution

**Period Covered:** 1 September 1988 - 31 August 1989

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**Abstract:** Surveys of breeding populations and nesting habitat of the snowy plover (*Charadrius alexandrinus*) were conducted from January to August, 1989 along the Gulf Coast of Florida and Alabama. Conservative estimates based upon observations of adults, nests, and families of plovers indicate at least 167 breeding pairs of snowy plovers were in Florida in 1989. At least 30 more pairs are predicted to have been present in Alabama and Mississippi, making an estimated total of 200 pairs along the eastern Gulf Coast.

Nearly all nests were located where the level of human activity was relatively low. Public lands with long, undeveloped beaches contained the most nests; only 22 pairs of plovers were found in South Florida, where undeveloped stretches of beach are rare. Of 85 nests sampled, most were near the front dune (mean distance = 10.5 m) and close to vegetation (mean distance = 1.4 m). Nests found after midsummer storms were more likely to be located in openings in the dune or behind the dunes. The fates of 83 nests were determined, and eggs hatched in 42% of nests. Storms, vehicles, predators, and humans accounted for the known causes of nest failure.

More information about breeding biology, nesting success, and long term population trends is needed to assist in the conservation of snowy plovers. Immediately, continued and increased protection from human disturbance on public lands would be beneficial. In most areas, nesting success and the number of pairs present could be increased by reducing or altering vehicle traffic, concentrating human activities, and posting nesting areas against trespass.

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## INTRODUCTION

Snowy plovers and other closely related species breed on coastal sand beaches and interior alkali flats of temperate and subtropical portions of the world. In North America there are 2 subspecies (American Ornithologists' Union 1957). The western snowy plover (*C. a. nivosus*) breeds along the Pacific Coast from Washington to Baja, Mexico, as well as in the interior of the Great Basin and in the Salton Sea Basin. The Cuban snowy plover (*C. a. tenuirostris*) breeds along the Gulf Coast from Mexico to South Florida and on larger islands in the Caribbean. Snowy plovers also breed in the

Great Plains, and that population also appears to be *tenuirostris* (C. Chase, pers. observ.). In Florida and Alabama, snowy plovers occur only along sand beaches on the Gulf Coast (Howell 1932, Sprunt 1954, and Imhof 1976). Most of these birds breed along the northwest coast of Florida, with scattered nesting south to Marco Island, Collier County (Fig. 1).

Throughout its range in the Southeast, the snowy plover's requirements for breeding habitat place it in conflict with humans. The sand beaches that the birds prefer for nesting are also highly desirable recreational resources for humans. Unfor-

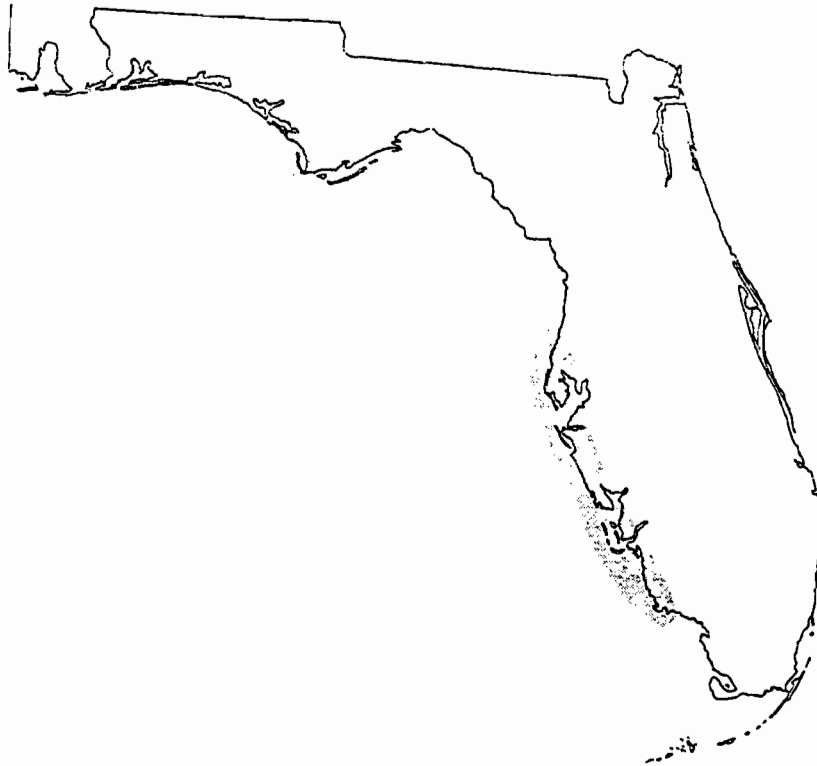


Figure 1. Approximate range of breeding snowy plovers in Florida and Alabama.

Unfortunately, snowy plovers do not tolerate much disturbance near their nests, and they typically avoid or abandon beaches that are frequented by people. This loss of nesting habitat has led to an apparent decline in the number of snowy plovers breeding in the Southeast (Imhof 1976, Woolfenden 1978). Consequently, the snowy plover has been classified as an endangered species in Alabama (Imhof 1978) and as a threatened species in Florida (Wood 1989). The United States Fish and Wildlife Service is reviewing the status of the species.

The recognized status of the snowy plover in Florida is primarily based on anecdotal evidence from numerous amateur and professional ornithologists (Howell 1932, Sprunt 1954, Woolfenden 1978, and seasonal reports and Christmas bird counts published in Audubon Field Notes/American Birds 1947-1988). No systematic survey of snowy plovers in

Florida has been conducted, nor has their breeding biology or habitat use been examined in detail. In 1988, during winter surveys for piping plovers (*Charadrius melodus*), 215 snowy plovers were found in Florida (J. Nicholls, Auburn Univ., pers. commun.). Additional records of incidental observations of snowy plovers in Florida are maintained by several groups including the Florida Natural Areas Inventory in Tallahassee, the Western Hemisphere Shorebird Banding Project (Florida cooperator: Ted Below, Naples), and the Manomet Bird Observatory in Manomet, Massachusetts.

The purpose of this study was to survey potential breeding habitat within Florida and Alabama, to count breeding pairs and nests, to determine nest site characteristics, and to learn about the breeding biology and reproductive success of snowy plovers along the eastern Gulf Coast.

## Review of Breeding Biology

Most of what is known about the breeding biology of snowy plovers in North America has come from work on the populations in California, the Great Basin region, and the southern Great Plains (Boyd 1972; Chase and Loeffler 1978; Chase 1979; Chase and Johnson 1979; Page and Stenzel 1981; Page et al. 1983, 1985; Purdue 1976; Warriner et al. 1986). Little detail is known about the breeding biology of the birds along the eastern Gulf Coast (Sprunt 1954). Pacific Coast populations have quite different breeding systems from those in the interior of North America due, at least in part, to the abbreviated breeding season in the Interior. The information on breeding biology given below is primarily based on populations along the Pacific Coast.

Snowy plovers nest from mid-March through mid-July with the peak of egg laying in April and May. Breeding pairs can form during the winter, though most form in the spring on territories established by the male. Once a pair has settled on a territory, they defend it and the nest from intruders and predators.

All territorial pairs attempt to breed (at least laying 1 clutch of eggs). After 5-30 days of courtship, the female picks 1 of several scrapes made by the male and lays her eggs, usually 3. The nest scrapes may be bare or contain a small amount of shells, pebbles, or debris. Some small objects such as shells or beach debris are typically nearby, though the nest can be completely in the open. Nests are usually located above the storm tide line but in front of the primary dune line. Incubation lasts approximately 27 days and chicks fledge 28-30 days after hatching. In California, the female usually abandons the brood within a week of hatching and often renests with another male. The male remains with the chicks 30-47 days. Pairs usually renest if the clutch is lost, and approximately 50% of the birds renest after successfully fledging chicks. Clutches are usually replaced within 1 week of loss. In the Interior, breeding pairs remain together until chicks fledge and rarely, if ever, do adults attempt second broods. The breeding system in Florida has not been described.

After the breeding season, snowy plovers tend to aggregate in small flocks. Birds may remain near the breeding areas or may migrate long distances. Some birds remain loosely paired throughout the year.

## METHODS

Nonsystematic surveys were initiated in January 1989 to locate wintering snowy plovers and to search areas where birds had previously been reported. Beginning in mid-March, systematic searches were conducted of the northwest coast of Florida, specifically along all Gulf-front beaches of the mainland and the barrier island beaches and along the bayside shoreline of all islands and peninsulas. Once an area was identified as being regularly used by plovers, it was surveyed every 7-10 days. Outside of Northwest Florida, only areas where suitable habitat occurred or where birds had been previously reported were surveyed. These areas were surveyed only 1-3 times.

Because we were able to determine more accurate estimates of the total number of breeding birds at the regularly surveyed locations, those observations are referred to as censuses. Areas with few or no birds were searched less frequently, and at most once or twice a month. Observations at these sites are termed surveys.

Although their frequency and regularity differed, surveys and censuses were conducted in the same manner. All potential breeding habitat was searched by observers on foot or off-road vehicle. When plovers were observed from a vehicle, the observer conducted further observations and searches on foot.

Birds observed during the surveys were grouped as follows:

1. *Nesting pair* - a pair of birds that actively defended a scrape containing 1 or more eggs.
2. *Family* - 1 or 2 adults with unfledged chicks.
3. *Territorial pair* - a pair of birds that

actively defended an area when in the presence of other plovers or the observer. Pairs with nest scrapes but no eggs are included here since most scrapes do not result in nests.

4. *Territorial Single* - usually unmated males holding territories, although mated birds would be recorded here if 1 of the breeding pair was absent during our survey.
5. *Loose* - birds not exhibiting clear breeding behaviors. By July many of these are fledged juveniles. Non-territorial birds observed feeding along the beach would fall in this category.

We recorded only nests with eggs or chicks, not empty scrapes. Nest locations were marked with surveyors' flags and identified with an alphanumeric code. Initial contents of each nest were recorded and the site was revisited until the fate of the eggs or chicks was determined. For each nest, we recorded a general and specific location as well as a physical description of the site and nest, including the distance from the nest to the primary dune line and the high tide line. We also measured the distance from each nest to the nearest vegetation, bay or freshwater source, occupied building, designated public access, and crab hole. The height, density, and type of vegetation; slope of beach; objects in or near nest; human activity; and location relative to the dune line were also recorded. During the early part of the season our efforts focused on locating all areas with breeding plovers and searches for nests were less intensive than during the second half of the season.

Whenever possible, chicks were caught and marked with 3 plastic leg bands and 1 U.S. Fish and Wildlife Service metal band. Some adults were caught on nests and marked. Families and color-banded fledglings were noted on subsequent surveys.

To facilitate both field work and presentation of results, we grouped observations by local geographic areas (Figs. 2-5). The boundaries of each area were determined by the presence of suitable habitat,

human access and use, and administrative boundaries of land management agencies. Certain small areas, such as Philips Inlet and East Pass, were distinguished from adjacent areas because they represented unique combinations of good habitat and relatively low human interference. Data recorded at each area included size of area, number and density of breeding pairs, and whether the area was surveyed irregularly or censused on a regular basis.

The number of breeding pairs rather than number of nests was used to indicate population size because the well-camouflaged nests are difficult to find and because the same pair can breed more than once per season. Few adults were individually marked. Therefore, we calculated the number of breeding pairs based upon the following assumptions: (1) that all birds attempt to renest if their clutch fails, (2) that adults with families do not attempt to breed again until after chicks fledge (at least 30 days), and (3) that pairs maintaining a territory are attempting to nest. Based upon these assumptions, we used the number of nesting pairs, territorial pairs, and families observed in each geographic area to calculate the highest number of possible breeding pairs for a 30-day period. This was then used as the number of breeding pairs estimated to use that area in 1989.

The actual number of pairs was likely higher, particularly in areas with large concentrations of birds, because it is not likely that all of the birds breeding later in the season also nested earlier in the season. Some of the later pairs may be birds that moved in from elsewhere or birds that did not have mates earlier in the season. Unfortunately, without marked birds it is impossible to determine which birds have nested and how often they nested. Therefore, we chose a conservative estimate of the minimum number of pairs present in the 1989 breeding population based upon the greatest number of breeding pairs possible in each study area during any 30 day period of the season. For example, if 10 pairs were estimated for Area X in the

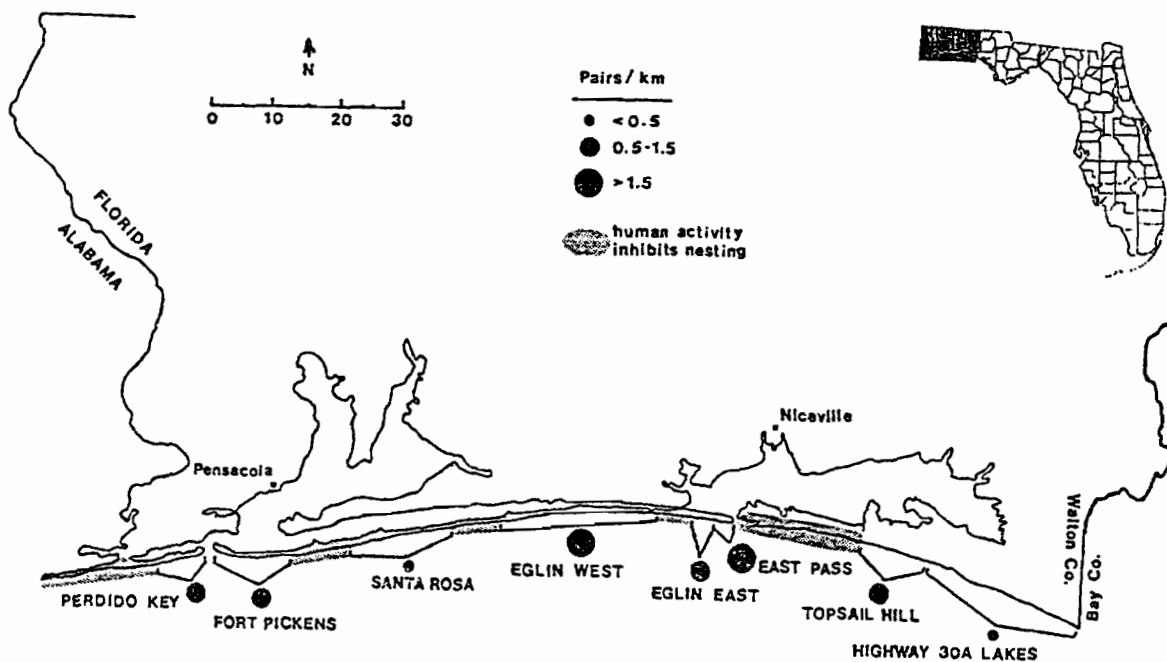


Figure 2. Distribution and density of nesting snowy plovers along the Gulf Coast of Florida, from Perdido Key east to the Bay-Walton county line.

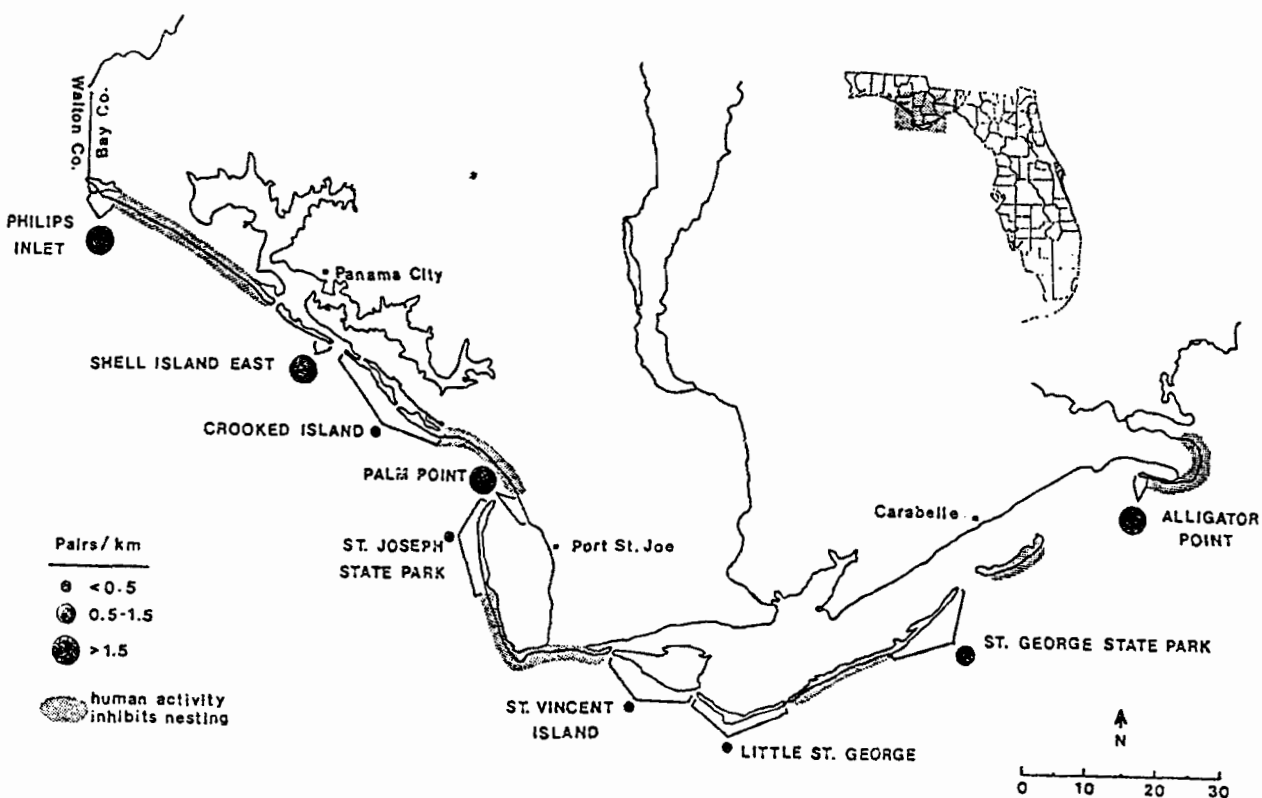


Figure 3. Distribution and density of nesting snowy plovers along the Gulf Coast of Florida, from the Bay-Walton county line east to Alligator Point.

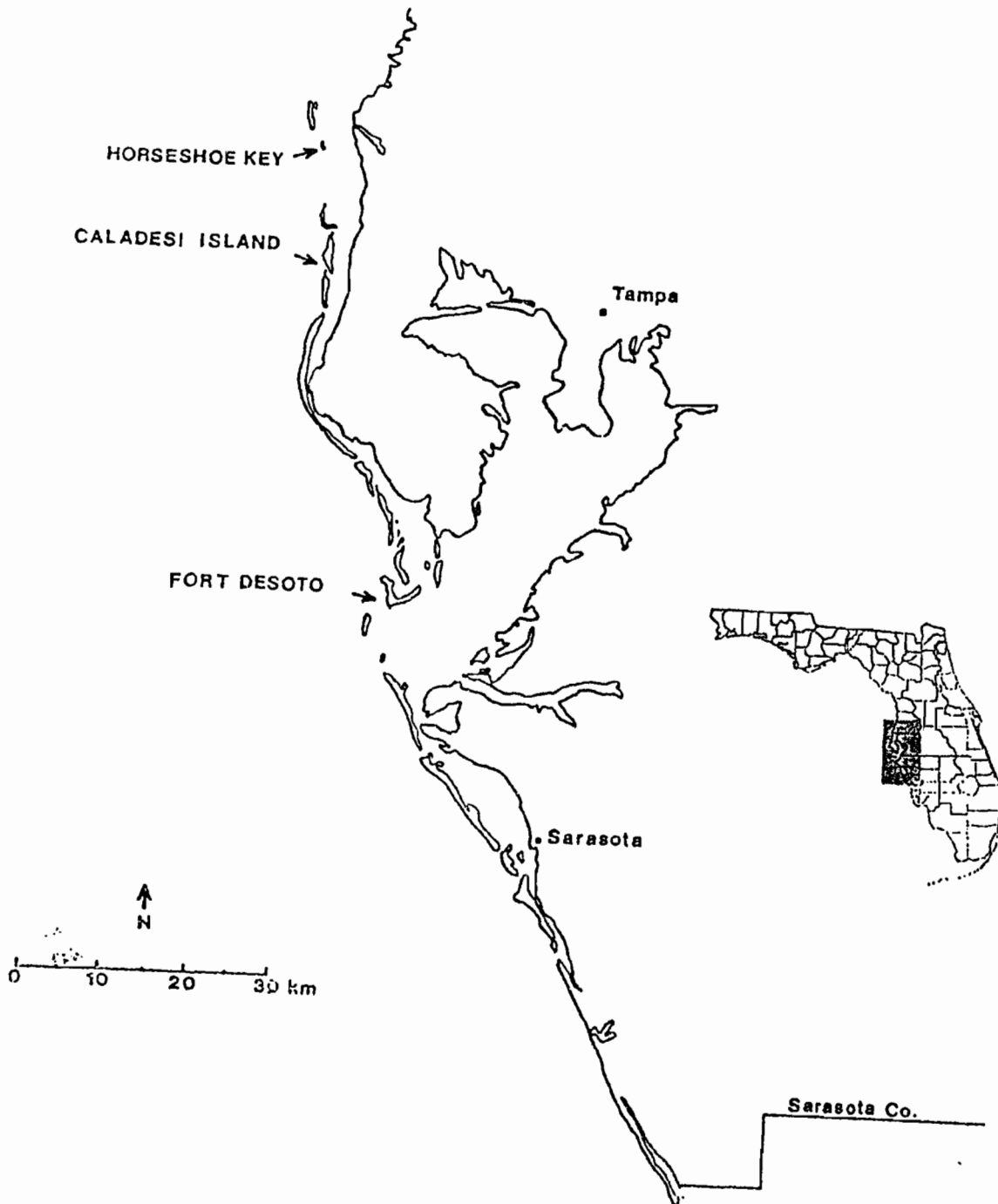


Figure 4. Distribution of nesting snowy plovers along the Gulf Coast of Florida, from New Port Richey south to the Sarasota-Charlotte county line. Arrows denote nesting sites; all other potential nesting habitat is used intensively by humans.

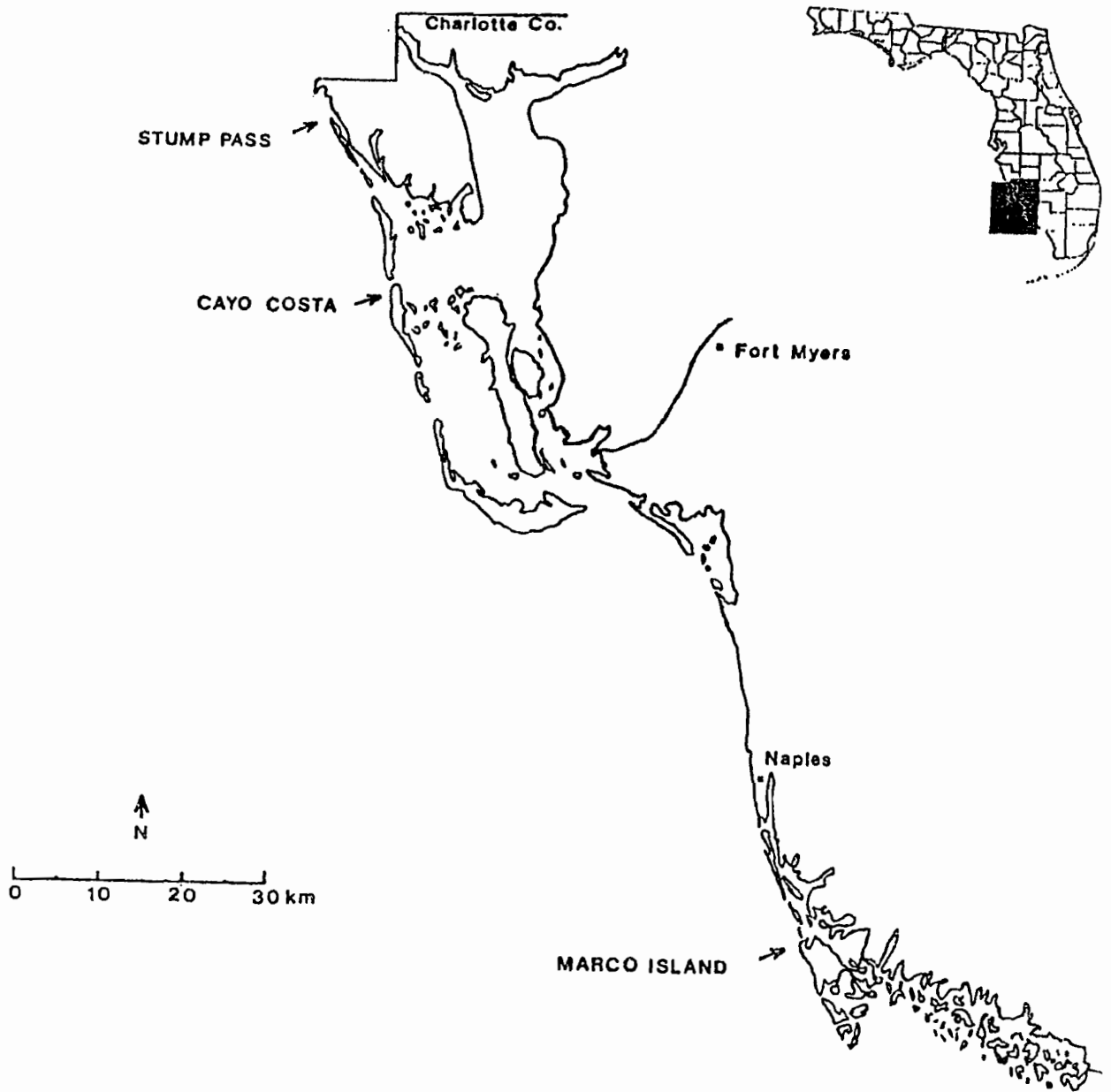


Figure 5. Distribution of nesting snowy plovers along the Gulf Coast of Florida, from the Sarasota-Charlotte county line south to Marco Island. Arrows denote nesting sites; all other potential nesting habitat is used intensively by humans.



early part of the season, 15 pairs in mid-season, and 8 pairs later, we reported the breeding population as 15 pairs: the maximum for any period, but the minimum possible for the area for the entire breeding season.

## RESULTS

### Breeding Chronology

The first nesting snowy plovers were located during the last week of March. However, many birds had been paired and defending territories since the beginning of surveys in January 1989. The first peak in nesting occurred during the last week of April and the first week of May (Fig. 6). Severe storms occurred along the coast of Northwest Florida on 19-21 May with winds of 42 kph and 17.1 cm of rain, on 7-9 June with winds of 58 kph and 12.6 cm of rain, and on 15-16 June with 59 kph winds and 8.2 cm of rain. The storms covered a majority of the open sand beach habitat with aquatic vegetation (i.e., beach wrack) and most nests with eggs were lost, as were most flags noting nest locations. By the middle of July most of the beach wrack had been partly covered by blowing sand and some plovers began to nest on the sand-covered wrack. Some of the broods that hatched before the storms occurred did survive, perhaps because the chicks were able to hide among the dunes.

The loss of nests due to storm tides and heavy rains accounted for the low number of nests and new broods found from the end of May until the middle of June (Fig. 6). During the second week of June the next peak of hatching began. The higher number of pairs observed in June than in early May indicates that not all nests were the result of renesting attempts.

Incubation lasted 25-27 days ( $n = 30$  nests). Fledging occurred approximately 29-30 days ( $n = 26$  nests) after hatching, and both parents remained with broods through 14 days in 82% of the broods examined. After that time, about half of the broods were observed with only 1 adult. Whether the second adult had actually left or was simply absent at the time of observation is unknown.

Females were seen guarding broods as often as males; therefore, it is not likely that females abandoned broods as frequently as in California (Warriner et al. 1986). Because no adults were banded until mid-summer, it was difficult to determine if birds renested after fledging a first brood. Nevertheless, several birds apparently reared second broods. In 4 instances, birds with unique natural markings were observed nesting again after successfully fledging a brood. Three other adults were observed incubating eggs or caring for new chicks while marked, fledged chicks remained near the adults. Birds that lost nests or broods were believed to have attempted new nests rather quickly after the loss because, in most cases, the number of pairs present did not change dramatically, although their activities shifted from 1 site to another within a study area.

Densities of breeding pairs of snowy plovers in Northwest Florida are shown in Figs. 2-3; single, isolated breeding pairs were not mapped. Table 1 compares numbers of pairs and densities for the areas used frequently by plovers. Two areas, Philips Inlet and East Pass, had very high densities of nesting plovers, but both were small in size. Philips Inlet is a point of suitable nesting habitat adjacent to a freshwater inlet that is isolated by development on both sides. East Pass, on the other hand, is an area of high quality habitat located on a point adjacent to a saltwater pass and a mostly undeveloped beach that offers less suitable plover habitat. The 2 areas should not be considered similar, other than each had several plover pairs within a small area. Comparisons of the density of breeding pairs among areas must be made cautiously because Philips Inlet and East Pass are not as linearly distributed as the other study areas.

### Population Size and Distribution

Below are summaries from the 1989 breeding season of each area we considered as potential breeding sites for snowy plovers. The following information is provided for each area: location, linear area, habitat description, number of pairs observed, public access and use, and pertinent com-

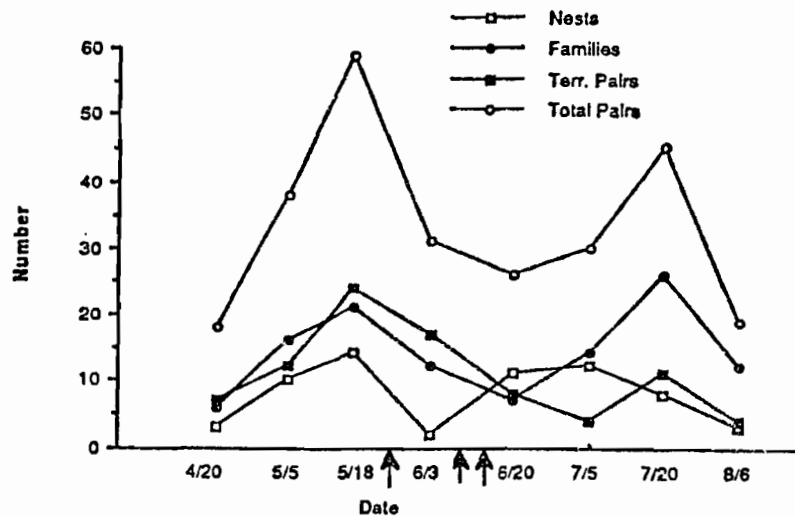


Figure 6. Chronological comparison of the number of snowy plover nests, families with unfledged chicks, and territorial pairs observed during the 1989 breeding season at the most intensively surveyed areas: Fort Pickens, Eglin West, Eglin East, East Pass, Topsail Hill, and St. George State Park. Arrows denote dates of severe storms.

Table 1. Minimum number and density of territorial pairs of snowy plovers breeding along the Gulf Coast of Florida in 1989. (See figures and text for area locations and discussion of variation in minimum population size.)

Study area	Number of pairs	Length of beach (km)	Density (pairs/km)
Northwest Florida			
Perdido Key East	5	7.2	0.7
Fort Pickens	9	11.6	0.8
Santa Rosa	4	17.4	0.2
Eglin West	38	21.1	1.8
Eglin East	6	6.1	1.0
East Pass	9	1.0	9.0 <sup>a</sup>
Topsail Hill	8	6.3	1.3
Highway 30A Lakes	8	27.0	0.3
Phillips Inlet	4	0.8	5.0 <sup>a</sup>
Shell Island East	4	2.4	1.7
Crooked Island	5	21.4	0.2
Palm Point	6	3.1	1.9
St. Joseph State Park	6	14.8	0.4
St. Vincent Island	5	14.6	0.3
Little St. George Island	4	15.6	0.3
St. George Island State Park	17	14.5	1.2
Alligator Point	3	1.9	1.6
Additional isolated pairs	4	---	---
<b>Total</b>	<b>145</b>		
Southwest Florida	22	---	---

<sup>a</sup>See text for comments on comparing densities of areas of small size.

<sup>b</sup>Length of habitat and density were not calculated for isolated pairs or small groups in South Florida because the area used and the number of birds were too small to be meaningful when extrapolated to a larger area.

ments regarding nesting success. Locations in Northwest Florida are listed first, starting at the Alabama-Florida border and running east to Phipps Preserve on Alligator Point, Franklin County. Only 22 of 167 pairs of birds found during this study were located outside this area. Areas along the coast of peninsular Florida are presented next, followed by a summary of breeding sites in Alabama and Mississippi.

*Northwest Florida. --*

1. Alabama border east to end of road in Gulf Islands National Seashore on Perdido Key, Escambia County; 14.4 km. This area had been developed with homes and buildings and remaining open areas were heavily used by humans. There were no freshwater inlets to provide breaks in the beach or additional habitat for snowy plovers. No breeding birds were observed during 2 surveys.
2. Perdido Key. Eastern portion of Perdido Key, Gulf Islands National Seashore, Escambia County; 7.2 km. This area consists of moderately wide beaches accessible only by foot. Human use was low except at the west end near the parking lot; most people observed were near the tide line. Consequently, patrols by park rangers with vehicles likely comprise the greatest disturbance by humans. The east end is not suitable for nesting as it is steeply cut by wave action. Most nesting birds at Perdido Key were located in open areas between the dunes, and these openings were numerous here. No surveys were conducted until after the storms at the end of May. At least 5 pairs bred here; 9 nests were found and at least 4 hatched. Most of the birds were found in the middle section of this area.
3. Fort Pickens. Western unit of Gulf Islands National Seashore on Santa Rosa Island, Escambia County; 11.6 km. This area consists of moderate to wide beaches with frequent openings between low dunes. These open pockets were used by most of the birds nesting in this area during the latter half of the season. Several freshwater seeps and ponds were present in this area and the bay is approximately 1 km from the Gulf. Early counts yielded few birds, but after the mid-summer storms 5-8 pairs moved here and initiated nesting. A total of 9 territorial pairs were scattered throughout the area, except at the heavily used western tip. Most of the area was little used because visitors concentrated along the beach at access points near the few parking lots. A tornado touched down near the park entrance on 8 June and destroyed a least tern (*Sterna antillarum*) nesting area, 2 snowy plover nests, and the park's entrance station.
4. Pensacola Beach, Escambia County; 2.4 km. Heavily developed with extremely high human use. No plovers were observed during 3 surveys.
5. Santa Rosa. Central Unit of Gulf Islands National Seashore on Santa Rosa Island, Escambia County; 17.4 km. Compared to the Fort Pickens area there are fewer openings in the dune line and the dunes are steeper with heights of 1-3 m. Freshwater is limited to a few small ponds, and the bay is less than 1 km from the Gulf. Human use is high because there is no entrance fee for this portion of the Seashore and people can park along the road throughout this area and easily access the beach. Only 4 pairs of plovers bred here.
6. Navarre Beach, east end of Gulf Islands National Seashore to west end of Eglin Air Force Base, Santa Rosa Island, Escambia County; 7.5 km. Intensively developed and no breeding birds were observed during 3 surveys.
7. Eglin West. Western end of Eglin Air Force Base, Santa Rosa Island, Santa Rosa and Okaloosa counties; 21.1 km. This area uniformly contains dunes 1-3 m tall with few breaks. There is some open shallow fresh water behind the dune line and the bay is less than 1 km from the Gulf. Human access is restricted on this military base; even base personnel access the beach at only a few points. Only at the 2 ends do

many people walk into the area. The greatest number of birds and some of the highest densities were recorded here. At least 38 pairs bred here and it is possible that as many as 20 other pairs also bred. Birds appeared evenly spaced throughout this area except near the 2 ends where people entered. Productivity was also high here and little nest predation was noted. The only nest in this study that was away from the beach was found here, in the middle of the island on a flat spoil pile adjacent to a freshwater pond.

8. East end of Eglin West to John C. Beasley County Park, Okaloosa County; 4.4 km. Heavily developed area with high human use. No plovers were observed in this area during 2 surveys.
9. Eglin East. John C. Beasley County Park to NCO Club, Eglin Air Force Base, Okaloosa County; 6.1 km. The habitat is similar to Eglin West; beaches are moderately wide, dunes stand 1-3 m above the tideline, and few open areas exist between the dunes. There is little fresh water nearby. This portion of Eglin Air Force Base is fenced, but public access is allowed at several points. The area receives much higher human use than Eglin West but less than any of the Gulf Islands National Seashore areas. At least 6 pairs of plovers nested here and produced at least 4 broods.
10. East Pass. NCO Club to East Pass, Eglin Air Force Base, Okaloosa County; 1.0 km. This point is one of the most unusual in North Florida and it contained the greatest density of snowy plovers in the state. The area consists of high (2-7 m) dunes surrounded first by an uneven, sparsely-vegetated area (20-50 m wide) and then by a wide (100-200 m) sand beach on the Gulf side and a sandy/rocky flat on the East Pass side. Fresh/brackish water and feeding areas were available along the edge of the Pass. Snowy plovers nested adjacent to and even partly within the high dune area. To the west of the high dune area was an area of wide, low dunes interspersed with flat low areas that plovers used during the latter half of the breeding season. During the first half of the breeding season, most plovers nested in front of the primary dune line as they did at most other locations. When least terns and several pairs of snowy plover began nesting in April, the breeding area was posted against trespass and fenced off from public access. The combination of a wide area recessed from the shoreline, fenced boundaries and access corridors that restricted human activity, and the protected flat areas between dunes provided snowy plovers with a high quality breeding area. At least 9 pairs of birds bred here, hatching 14 broods and fledging at least 27 chicks. This was the highest productivity of any of the censused areas.
11. Destin to Miramar Beach, Okaloosa and Walton counties; 16.5 km. This area ranges from lightly to heavily developed. All of it received heavy human use and no plovers were found during 4 surveys.
12. Topsail Hill. East end of Four Mile Village west to the freshwater inlet where Highway 30A parallels shore, Walton County; 6.3 km. This area is only developed at each end. The dunes were moderately high, beaches were relatively wide, and fresh water was readily available. Birds nested throughout the area but were somewhat concentrated near the freshwater outlets. Human use was light to moderate and limited vehicle use on the beach was permitted. At least 8 pairs of plovers bred here.
13. Highway 30A Lakes. From the point where 30A turns east parallel to shore to the last buildings before Philips Inlet at Powell Lake on the Bay-Walton county line, Walton County; 27.0 km. This area has single family homes and condominiums and most of the beach receives moderate human use. However, several freshwater lakes connected intermittently with the Gulf. Most plovers found here bred along the edges of these inlets. The inlets effectively increase the flat dune area and

were often away from the most heavily used areas. Eight pairs of birds bred here.

14. Philips Inlet. Undeveloped area at western border of Bay County; 0.8 km. This freshwater inlet is unique because it has been protected from human disturbance in recent years due to the presence of a least tern colony. The colony is posted before the breeding season each year and, though there are large numbers of people nearby, the large irregular point on the east side of the inlet is able to support a tern colony. Four pairs attempted to breed here. Only 2 broods were fledged over the entire breeding season. The west side is too narrow to protect the birds and is overrun with people on weekends.
15. Hollywood Beach to east end of St. Andrews State Recreation Area, Bay County; 24.4 km. Intensively developed and used area. Three pairs of plovers were found at freshwater inlets during our 3 surveys here. All 3 nests were disturbed by people and were destroyed or abandoned.
16. Shell Island West, western portion of Shell Island, Bay County; 8 km. Most of this area is under the administration of the Florida Department of Natural Resources as part of St. Andrews State Recreation Area. The western half of the area contains narrow beach with little available breeding habitat and fresh water. The beaches widen to the east, but they were intensively used by people during the summer. No birds were observed during 1 survey.
17. Shell Island East. Eastern 2.4 km of Shell Island, Bay County; 2.4 km. Administered by Tyndall Air Force Base. The separation of Shell Island into 2 areas is somewhat arbitrary but is based on where the beaches became relatively wide and where the first plovers were found. The eastern end contained a broad, open interdune area with many small pockets of habitat among low dunes. Two pairs nested in these pockets and 2 others nested near a protected least tern colony on the eastern end. Plovers were observed feeding at 2 tidal flats adjacent to the tern colony. The eastern end of Shell Island, particularly the last 500 m, which is wide and flat, was washed over during a May storm and the plover and tern nests were destroyed. No further evidence of breeding was found, possibly due to increased human use in June and July from recreational boaters that frequently landed at this site. At least 2 pairs of birds found later in the season at the western end of Crooked Island likely moved over from this area.
18. Crooked Island. West end of Tyndall Air Force Base to west end of Mexico Beach, Bay County; 21.4 km. Compared with other areas with high plover densities, Crooked Island appears to provide ideal plover habitat, yet only 5 pairs bred here and 2 of these pairs may have moved over from Shell Island late in the season. The beaches on Crooked Island were wide with frequent pockets in the low dunes, fresh water was common, good foraging sites were available locally, and human use was limited over much of the area. While predators were abundant, they appeared no more so than at Gulf Islands National Seashore or Eglin Air Force Base. All nests found were on or near the several points and washover areas with large open sand flats. The most obvious human disturbance was from the regular sea turtle survey and occasional boats landing at the points.
19. Mexico Beach west to the freshwater inlet 3.1 km west of Palm Point, Bay and Gulf counties; 12.2 km. The beach here was relatively narrow (less than 10-25 m wide) and was frequented by many people. No plovers were observed here.
20. Palm Point. From 3.1 km west of Palm Point to Palm Point, Gulf County, 3.1 km. This is another anomalous area. Compared with other areas, this beach did not seem to contain good breeding habitat, but 6 pairs of plovers attempted to nest here. This area was

narrow (<35 m) but there were several small open areas between the low dunes. This was the only area surveyed where any numbers of breeding plovers were present on a beach that fronted a bay and not the Gulf directly. Human activity was moderate here and occasionally dogs were observed. The 6 pairs that tried to breed here had the shortest internest distance of any area (mean = 65 m). Productivity was fairly low with only 3 nests hatching. Human disturbance from the west was limited by a large freshwater inlet that was difficult to cross, but at the east end access from the highway was convenient and human use was high. Plovers were observed feeding immediately adjacent to nests along the shoreline. Perhaps a nearby, abundant source of food and adequate habitat made this area particularly attractive to the plovers in spite of the disturbance from humans.

21. St. Joe Bay, shoreline from Palm Point east to tip of St. Joe Peninsula, Gulf County; 40.6 km. One pair of birds successfully bred at Highland View just west of Port St. Joe. This small area of dredge-spoil was the only suitable nesting habitat, other than Palm Point, on St. Joe Bay. The remaining shoreline in this area was vegetated to the water.
22. St. Joseph State Park. Tip of St. Joe Peninsula southeast to the park boundary, Gulf County; 14.8 km. This area was similar to Crooked Island in that the habitat appeared to be good but few breeding birds (6 pairs) were found. St. Joe Peninsula had little available fresh water, and several stretches of beach had steep dune faces that are inaccessible for brood cover. Human disturbance was minor and mainly resulted from boat visitation at the northwest tip, patrols by park vehicles, and activity at beach access points near Eagle Harbor. Most birds were concentrated on the wide sand flats at the west end, with the rest at an area approximately 4-5 km southeast of the tip.
23. St. Joe Peninsula east to Indian Pass, including Cape San Blas, Gulf County; 26.7 km. The habitat here ranged from good to excellent with large open beaches and nearby fresh water and foraging areas. However, vehicles were allowed on beaches in Gulf County and there was heavy use of the area by humans, with and without vehicles. Plovers have been reported nesting on Cape San Blas in past seasons, but no territorial pairs were observed during our surveys, perhaps due to the intensive disturbance by humans. A large tidal pond that covered much of the Cape in 1989 greatly reduced the amount of open sand flats and possibly inhibited breeding plovers.
24. Mainland shoreline from St. Vincent Sound east to tip of Alligator Point in Alligator Harbor, Franklin County; 99.4 km. This area, including the bay side of the barrier islands, contained suitable habitat only along a 2 km section at Carrabelle Beach. Carrabelle Beach received high human use and no birds were observed there during 3 surveys. At least 1 pair of snowy plovers bred there in the past (B. Stedman, Gulf Islands Natl. Seashore, U. S. Natl. Park Serv., pers. commun.).
25. St. Vincent Island. St. Vincent National Wildlife Refuge, Franklin County; 14.6 km. The habitat here was suitable for breeding plovers: wide open beaches and low dunes along parts of the island, numerous freshwater seeps, and very few people. At least 5 breeding pairs were observed during 2 surveys. Most of the birds were observed within a kilometer of each end, though no apparent habitat differences between the ends and the middle of the island were observed. Perhaps, because St. Vincent Island ranges from 1-7 kilometers in width, only birds nesting at the ends of the Island can afford to fly to feeding areas in the bay. The dune line is also quite shallow (often less than 20 m wide) with thick forest directly behind it and may not offer suitable cover for protecting broods.
26. Little St. George Island. Franklin County; 15.6 km. The western half of this island had relatively wide beaches, low dunes with numerous flat open-

ings, and some intermittent freshwater ponds. Nevertheless, only a few birds (4 breeding pairs) were observed here during 2 visits. Nests were located on the dune edge during the early portion of the breeding season and, as on most other areas, back in recessed pockets in the dunes in the later half of the season.

27. West end of St. George Island to the beginning of St. George Island State Park, Franklin County; 17.6 km. Many single-family dwellings and moderate human use, including dogs on the beach, reduced the suitability of this area. No birds were observed breeding during 2 surveys.
28. St. George State Park. St. George Island State Park, Franklin County; 14.5 km. This area had good habitat throughout, but received relatively high use by people. No plovers were found breeding near any of the public access areas or near the eastern point where vehicles were allowed on the beach. At least 14 pairs nested here, and about half the nests hatched.
29. Dog Island, Franklin County; 11.2 km. Only the 2 ends and a short (2 km) section in the middle of the island were suitable for breeding. The rest of the island was used intensively by humans or had only narrow beaches backed by trees. No birds were observed by Nature Conservancy personnel this season, or during 2 surveys conducted for this study. In the past, as many as 4 pairs have nested here.
30. Phipps Preserve on Alligator Point, Franklin County; 1.9 km. This is the eastern-most breeding site in Northwest Florida. The habitat appeared to be good with wide flat beaches, low dunes with openings, and easy access to foraging areas. Unauthorized use by people, and especially their dogs, may limit use of this area by plovers. Storms washed over the point several times and young hatched from only one nest. The 3 pairs that attempted to nest each made several nesting attempts before abandoning the area in June. The Nature Conservancy, which administers this site, has records of snowy plovers occasionally nesting here in past years.
31. East end of Phipps Preserve to Bald Point, Franklin County; 12.9 km. Beaches along the eastern half of this area have been eroded by storms and hurricanes and are very narrow (10 m). The western half of this area contains relatively good beach habitat for breeding plovers, but experiences intensive use by people. No plovers were observed in this area.

*Big Bend and South Florida. --*

1. The area from Alligator Point, Franklin County east and south to Tarpon Springs, Pinellas County was surveyed twice during the breeding season. St. Marks National Wildlife Refuge and the islands in Apalachee Bay, Wakulla County, and Cedar Key and associated offshore keys, Levy County were surveyed 2 additional times. No breeding snowy plovers were found, although records indicate snowy plovers occur here in the nonbreeding season. There are a few small beaches (less than 50 m long) scattered through the area, but most of this coast supports salt marsh or a forested shoreline.
2. The area from Tarpon Springs, Pinellas County, south to the south end of the Sunshine Causeway, Manatee County, was surveyed 3 times during the breeding season. These surveys covered the entire coast including the offshore islands of Anclote Key and associated sandbar islands. Egmont Key, south of St. Petersburg was not surveyed directly. On the day it was scheduled to be counted there was a regatta and the shoreline was completely covered with boats and people. Even though birds have bred on Egmont Key in the past, it is likely that few, if any, were present this year. The entire area was intensely developed, and the only available nesting habitat was found at the following locations:

- 2a) Anclote Key State Park had a narrow, 4 km-long beach on the south side and a smaller (1 km) beach on the west end. Although many people visited the park on weekends and no birds were observed, the habitat appeared capable of supporting a few pairs of plovers.
- 2b) Horseshoe Key was a small sandbar island with grassy vegetation in the center (3 km along the south and west edge). Three pairs of plovers were observed nesting in June. Many people visited this island by boat, especially on weekends, but the site was still able to support a colony of 30-40 pairs of black skimmer (*Rynchops niger*) as well as the plovers.
- 2c) Honeymoon Island State Park yielded the highest winter counts of snowy plovers of the entire state for the last 2 winters (Nicholls 1988; C. Chase, pers. observ.) and has had plovers breeding in the past. The park management did not protect the shorebird nesting areas this year and no nests or territorial pairs were observed, although a few non-territorial plovers were observed during the summer.
- 2d) At Caladesi State Park and adjacent Dunedin Pass only 1 pair of plovers was observed breeding during the early breeding season. This was the earliest (26 March) nesting attempt recorded in Florida in 1989. The plovers nested on the newly-filled area at Dunedin Pass. The area supported large numbers of shorebirds feeding on the tidal flats, including snowy plovers (as many as 9 observed). In July, a least tern colony on the north end of Clearwater Beach (approximately 250 m south of Dunedin Pass) was posted and fenced. Four pairs of plovers nested here during June and July. The high quality breeding habitat, a nearby feeding area, and protection from disturbance made this an important nesting area for

snowy plovers in South Florida. Only the Gulf side of Caladesi State Park had beach habitat suitable for nesting, and it was overrun with people on weekends. The pass was muddy and flooded at high tide; most people avoided it. The status of the pass is in contention, and it may be reopened in the future.

- 2e) Fort DeSoto State Park received heavy recreational use and no birds were located except at the very northern end, on a sandbar island. Even though this sandbar area was accessible and used by people, 3 pairs of plovers successfully bred there this year. During the survey, numerous people were on the feeding tidal area between the sandbar and the island and dogs were observed chasing plovers. The northern tip had good habitat for plovers with wide beaches, low sparsely-vegetated interior, and adjacent feeding areas; however, human activity limited use by plovers.

No plovers were observed along the Sunshine Causeway. They have been recorded nesting in the past, but highway construction this season apparently precluded any use. The small islands south of St. Petersburg were covered with mangrove and were not suitable for nesting.

3. Bradenton, Manatee County, south to Marco Island, Collier County. A single survey was conducted during the first week of June. Only areas identified as having possible habitat or where birds had been recorded in the past were checked. Local observers were questioned about current use of the area by plovers and all sites with recent observations were searched. The majority of this area was heavily developed and not suitable as breeding habitat for plovers. The points of land at saltwater passes were the typical sites available for plovers; virtually all other undeveloped areas have mangrove growing to the water's edge and were not suitable for



plovers. Unfortunately, the plovers rarely nested on the available points because, with the exception of Cayo Costa State Park and the sandbar at Marco Island, these points were intensively used by people, especially on the weekends. Specific locations within this area are described below.

- 3a) Anna Marie, Longboat, Lido, Siesta, Casey, Venice, and Manasota keys are all developed. The passes between were developed or covered with mangrove, providing no suitable habitat for plovers. Charlotte Beach State Recreation Area on the south end of Manasota Key had several kilometers of beach and the point was fairly wide, but no birds were observed or reported. Many people used this area, especially on weekends. Stump Pass separated Manasota Key and Don Pedro Island. One pair of plovers bred in May on the north end of Don Pedro at the pass (B. Millsap, Fla. Game and Fresh Water Fish Comm., pers. commun.) and is included in our 1989 estimates (Table 1) although no birds were observed during our survey. Abundant footprints and trails indicate frequent human use. The south end of Don Pedro Island had a similar point at Gasparilla Pass. No birds were observed during the survey, though there was adequate habitat for a pair of plovers to breed. Residents walk their dogs on the beach all along Don Pedro Island, precluding any extensive use by plovers. Gasparilla Island was developed and the beaches were heavily used; no plovers were observed.
- 3b) Cayo Costa State Park. This park was accessible only by boat or commercial ferry. There was a 1 km stretch of sandbar that has attached to the main body of the island and currently provides excellent habitat for plovers and terns. The central area had been roped off and was protected by park personnel. Inside the sandbar was a tidal feeding area. Five breeding pairs of plovers were observed in this area along with a large colony of least terns and a pair of American oystercatchers (*Haematopus palliatus*). This site contained the only suitable nesting habitat on Cayo Costa Island; the rest of the island was covered with mangrove to the shoreline. The sandbar was a transitional habitat; the area will likely vegetate as the tidal flat fills in, though new sandbars will then typically form.
- 3c) North Captiva, Captiva, Pine, and Sanibel islands are either intensively developed or support mangrove instead of sand beach. Estero Island is heavily developed except for a small spit extending from the Holiday Inn. One family of plovers was reported from this spit but was not observed during the survey (T. Below, Natl. Audubon Soc., pers. commun.). The Barefoot Beach State Reserve and Delnor-Wiggins Pass Recreation Area had some beach habitat, especially at the ends, but both areas were heavily used by people. No plovers were observed here.
- 3d) South from Naples, the shoreline was covered with mangrove except for small sandy points on some islands. The only potential habitat, and the southernmost plover nests recorded on this survey, was a small sandbar less than 1 km long on the north end of Marco Island. This area received strong protection from the National Audubon Society warden of Rookery Bay Aquatic Preserve, Mr. Ted Below. There were 5 pairs breeding here along with a large colony of least terns. Even though the area was posted, fenced, and patrolled, people wandered through the colony. This area was quite similar to the Cayo Costa State Park sandbar and will likely be as transitional in nature.
- 3e) The only suitable habitat south of Marco Island was in the Florida

Keys, where some small isolated sand beaches were present. Observers among the National Audubon Society staff at Tavernier reported no sightings of plovers in the Keys during the summer and this area was not surveyed. No snowy plovers have been recorded nesting on the Atlantic coast of Florida and this area was not surveyed.

Breeding south of Tampa was completed by the beginning of July. There were no catastrophic storms early in the season as in Northwest Florida; instead there was a continuing drought. Whether or not plovers stopped breeding due to very hot dry conditions is not clear. However, in past years breeding has ended in the beginning of July (T. Below, Natl. Audubon Soc., pers. commun.). All breeding snowy plovers east and south of Northwest Florida occurred in isolated, small, and often transitional, habitats. Even though they occasionally bred in areas with a fair amount of human use, nesting plovers were successful only when protected by fencing or patrols or when they nested in the rough salt grass (*Distichlis spicata*) edges away from the sandy beaches, as at Fort DeSoto and Horseshoe Key.

#### Alabama and Mississippi Distribution

We surveyed from the Florida border to the west side of Gulf Shores. The beach was highly developed and no plovers were observed. We did not visit Fort Morgan during the breeding season but the habitat here was similar to that at the eastern end of Perdido Key, and we expect similar densities of nesting plovers. Plovers have regularly nested in this area in the past (J. Fulton, Bon Secour Natl. Wildl. Refuge, U.S. Fish and Wildl. Serv., pers. commun.; Imhof 1976, 1978). Dauphin Island is developed on the east end, and vehicles can reach to the west end of the island. Plovers have nested here and on nearby Sand Island in the past (Imhof 1976, 1978).

The only additional nesting habitat for snowy plovers along the eastern Gulf Coast is on the barrier islands off of Mississippi. We observed 2 pairs on Horn Island late in the 1989 breeding season, and they have

been reported in the past from Horn and West Ship islands (Toups and Jackson 1987).

#### Nesting Habitat

Parameters describing snowy plover nests and the associated habitat were measured for 85 nests in Northwest Florida (Table 2). More nests were examined after the severe mid-season storms than before. However, more time was available to search for nests later in the season, so the number of nests present was not necessarily greater after the storms.

All but 1 of the nests observed were located on sand and consisted of small scrapes approximately 4-5 cm in diameter and less than 2 cm deep. Nests were typically lined with small shells and debris (Table 2) and, invariably, shells, bits of stick, dead vegetation, or other debris were within 10 cm of the nest. One pair of birds even nested on a flat-topped log 20 cm in diameter. About half of the nests were within 10 m of active ghost crab (*Ocyropode quadrata*) holes (Table 2) and the crabs apparently preyed on the nests, especially during the early nesting season.

Early season nests ( $n = 23$ ) were most commonly located within 15 m of the primary dune line and more than 30 m from the high tide line. Nests were seldom found in pockets or openings in the dunes until after the May/early June storms when the majority of nests were located in pockets (Table 2). This was most noticeable at East Pass and Perdido Key where there were large open flats in the secondary dune area. At least 4 pairs of birds nested in these areas at East Pass. Of the 45 nests behind or between the primary dune line, 13 were in flat areas within the interior of the dune complex and out of view of the Gulf. Most of the interior nests were also found after the storms (Table 2).

No young fledged from a nest located closer than 30 m to the high tide line. Three of 5 nests near the tide line were preyed upon by herons or mammals that searched the beaches nightly. Two nests close to

Table 2. Characteristics of 85 nests of snowy plovers from Northwest Florida.

Variable measured	Range	Mean	Number of nests	% of total nests
Distance (m) to				
High tide	0-250	61.5		
Primary dune line	0-60	10.5		
Nearest vegetation	0-22	1.4		
Nearest vegetation >10 m	0-2.5 <sup>a</sup>	0.4		
Nearest house	150->10000	-		
Designated public access	50->10000	-		
Elevation above beach (m)	0-4	0.19		
Slope of ground (%)	0-3	0.5		
Type of vegetation near nest				
Grass			35	41
Forb			26	31
None within 1 m			24	28
Nest lined with shell or debris			79	93
Nest <1 m from vegetation or debris			85	100
Nests located between or behind dunes:				
Nest in a dune pocket/opening				
Early nests <sup>b</sup>			1	1
Late nests			31	36
Entire season			32	38
Nest in interior, behind dunes				
Early nests			2	2
Late nests			11	13
Entire season			13	15
Total			45	53
Nest located near crab hole				
Nest <10 m from hole			43	51
Nest >10 m from hole			42	49
Nests located with water in view				
Excluding interior nests			68	94
All nests			68	80

<sup>a</sup>Does not include 6 nests located >10 m from vegetation.

<sup>b</sup>Early nests (n = 23) were found before storms that began 7 June; 62 late nests were found after that date.

the tide line washed away in a high tide. All known active nests located in front of the primary dune line were washed away or covered during the storms at the end of May and beginning of June. Throughout Northwest Florida, beaches were washed over and covered with beach wrack, and in many areas aquatic vegetation such as *Sargassum* and *Thalassia* was piled >50 cm deep.

Seventy-two percent of nests were

within 1 m of vegetation and 39% were immediately adjacent to or touching a clump of vegetation. The distance from nests to vegetation did not differ before and after the storms. Only 6 nests (7%) were located more than 10 m from any vegetation or elevated dune and these were all located on points at the ends of peninsulas. The vegetation associated with nests included the grasses *Uniola paniculata*, *Panicum amarum* var. *amarulum*, and *Schizachyrium maritimum* and the forbs *Ipomoea*

*stolonifera*, *Hydrocotyle bonariensis*, and *Cakile* spp. Most of the forbs were less than 10 cm high but the grasses averaged 45 cm in height (range = 8-80 cm). Nests were never located in dense vegetation, though they were often at the edge of a dune with relatively dense sea oats. Nests sites were always open on at least 2 sides with clear visibility for >10 m. Excluding the 13 nests within the interior of the dune systems, all but 4 nests had a clear view of the Gulf (Table 2). Even nests back in dune pockets were situated so that the Gulf was visible from the nest site.

Over 85% of nests were located on small rises (<5-10 cm in most cases) that elevated them slightly above the surrounding area; but only 4 nests (5%) were located on dunes more than 1 m above the surrounding beach or flat. The small rises were most typically caused by wind blown sand aggregating around the base of a plant. Slopes were visually estimated and 89% of nests ( $n = 76$ ) were on slopes of <1%.

No nests were located on beaches within 150 m of houses and none were within 50 m of designated public access points (e.g., parking lots and boardwalks). No nests were found on any intensively used beach or on any area where the public frequently drove vehicles on the beach. At least 3 nests were destroyed by patrol vehicles, but these vehicles apparently do not use most areas frequently enough to cause birds to abandon an area.

Snowy plovers were observed on the edges of tern colonies at East Pass, Gulf Islands National Seashore, Shell Island, Philips Inlet, and Phipps Preserve in Northwest Florida, and at Dunedin Pass, Cayo Costa State Park, and Marco Island in South Florida. These include all but 1 of the ground-nesting least tern colonies observed on barrier islands or peninsulas within the study area. No snowy plovers were observed at tern colonies located at sites away from the beach, on causeways leading to barrier islands, or on roofs. In previous years, least terns and snowy plovers have also nested together at St. George State Park; however, this year only the snowy plovers were observed nesting in that area along the beach.

## Productivity

We found 117 snowy plover nests in Northwest Florida in 1989 and were able to determine the fate of 83 of them. The other 34 nests should not necessarily be considered losses, because it is possible that many hatched and the parents moved the chicks far from the nest prior to our next observation. Hatching success of the 83 nests of known fate was 42% ( $n = 35$ ). Of the failed nests, 13 were destroyed by storms, 7 by predators, 5 by humans, and 3 by patrol vehicles. Three other nests were abandoned after patrol vehicles drove near them and 4 nests with eggs were abandoned for unknown reasons.

Sixteen other nests disappeared for unknown reasons (i.e., eggs were missing well before the time that chicks should have hatched). Many of these vacant nests may have been preyed upon by ghost crabs. Crab tracks were noted at some empty nests, but no shells of plover eggs were found at these nests. Evidence of predation of eggs at 7 nests by ghost crabs, fish crows (*Corvus ossifragus*), raccoons (*Procyon lotor*), or striped skunks (*Mephitis mephitis*) included broken egg shells and/or tracks of the predators. Foxes, particularly the red fox (*Vulpes vulpes*), may also be important predators, but we found no evidence that they had taken eggs or chicks. All of these predators were common along beaches of Northwest Florida and undoubtedly preyed upon plover eggs and young.

After-hatching productivity is not possible to determine from the data collected this year. However, several observations are worthwhile. A great blue heron (*Ardea herodias*) was observed eating plover chicks, and fish crows swooped at chicks but were never observed capturing them. When disturbed by predators or humans, parents led chicks into the dune area, often >30 m back into the vegetation. Once the disturbance ceased, adults returned chicks to the beach. If the presence of humans prevented parents from returning chicks directly to the beach, they often led the chicks several hundred meters parallel to the shore to a less disturbed site. We observed 2 broods that apparently remained

in the dunes through the entire day and only returned to the beach at dusk after humans left. At freshwater inlets, which were frequently used by people, adult plovers often took their broods upstream 100-200 m and fed along the freshwater shoreline. These observations suggest that snowy plover chicks are less likely to be lost due to human disturbance than are eggs. However, it is not known what stress effects result from continually moving chicks in and out of the dunes or what effect disruption of feeding may have on young plovers.

Chicks were observed on the beaches with parents until fledging. After fledging, some stayed with parents for the remainder of the summer while others dispersed throughout the area. Fledged chicks that were marked often were not observed again on surveys for several weeks. These birds were most likely feeding at local tidal flats and bay-side feeding areas during the surveys.

## DISCUSSION

### Population Size and Distribution

At least 167 pairs of snowy plovers bred along the Gulf Coast of Florida in 1989. Approximately 30 additional pairs could be expected from Alabama and Mississippi, based upon available habitat and past records. Thus, a reasonable estimate for the size of the snowy plover population along the eastern Gulf Coast is approximately 200 breeding pairs.

Without individually marked birds, it is not possible to determine how many pairs re-nested after clutches failed and how many raised more than 1 brood. The method we used for determining the maximum number of pairs present during a particular portion of the breeding season produces a conservative estimate. A more accurate estimate of population size could be obtained if nest success and the frequency of re-nesting were known.

Because we observed some re-nesting and second broods have also been observed in California, it is tempting to use population

parameters from California (Warriner et al. 1986) to calculate population size in Florida. However, 2 important differences between these populations convinced us not to adapt the California parameters to the Florida population. First, female snowy plovers in Florida remained with broods longer (2-5 weeks) than females in California (<1 week). In fact, many females in Florida remained with their broods until they fledged. Secondly, the California population has a skewed ratio of 1.4 males to each female, but in Florida we detected no difference in the sex ratio among adult snowy plovers. Thus, female plovers in Florida may switch mates less often and stay with their brood longer than females in California.

On the Pacific Coast it is rare to find incubating birds after the middle of July. However, in Northwest Florida in 1989 there was a second peak of laying during the third week of July and clutches were initiated until 8 August. The storms earlier in the season may have been responsible for the extended nesting season.

It is important to note that these productivity estimates are not based on the entire population but only on the nests we located. While we believe that these figures are representative of the population, it may be that nests not located were more successful because the parents were more secretive and kept their nests better hidden.

Nesting habitat was described and quantified for 85 nests. However, the nest site characteristics we described (Table 2) may not be good predictors of nest site requirements for snowy plovers in Florida for several reasons. We did not actually test which factors influenced birds nesting at a site. Several interrelated factors likely affect selection of a nest site, and the relative importance of each factor may vary with changes in the other factors. Available food, cover for unfledged birds, and low numbers of people and predators are clearly important to nesting success. However, some nest site characteristics changed as the breeding season progressed. For example, nests were located further back from the beaches later in the season (Table 2). This behavior may have been a

response to the severe storms that destroyed many nests in front of the primary dunes. However, similar behavior has been noted elsewhere (Page et al. 1983, 1985; C. Chase, pers. observ.) and may be typical for the species. In any case, this demonstrates how little is known about nesting habitat requirements of the snowy plover and why it is not appropriate to develop overly specific predictions of habitat use or recommendations for habitat management from 1 season's data.

Snowy plovers often nested near least tern colonies, possibly because the tern colonies were posted before breeding commences and people generally avoid those areas. It is known that both species have similar habitat preferences (Chase and Johnson 1979, Boyd 1972, Massey 1974). However, these associations may be due in part to the protection afforded most tern colonies, the protection indirectly provided to the snowy plovers by the aggressive terns, or similar habitat preferences.

Of the 83 nests we knew the fate of, 42% hatched; this estimate of hatching success must be interpreted carefully for 2 reasons. First, this number may be lower than actual hatching success for the population if many of the nests we did not find were those of more secretive birds who hid their nests well from observers and predators. Second, the disruptive effects of the severe storms in 1989 may be an unusual influence on the population. Such storms, and the resulting extensive washover and deposition of dense vegetation or wrack on the beach, are unusual (C. Zimmerman, Gulf Islands Natl. Seashore, U. S. Natl. Park Serv., pers. commun.). It is highly unusual for such storms to greatly affect the entire northwest coast, as they did in 1989. In addition to reducing productivity, the storms may have also influenced the length of the breeding season. Anecdotal reports from past seasons suggest that snowy plovers in Florida typically stop breeding in early July, with few unfledged chicks observed after mid-July. Only additional studies can determine whether or not the extended breeding season observed in 1989 is typical.

Snowy plovers, like most shorebirds, are strongly philopatric. This tendency to

return to past breeding areas coupled with a history of occasional storms and disturbances may explain the somewhat localized breeding distribution of snowy plovers. This might also explain why few birds were found in some apparently good habitat, such as Crooked Island, while many were found in some seemingly poorer habitat, such as Eglin West.

### Recommended Conservation Actions

The lack of data from previous years obviously precludes any discussion of trends in population size. Nevertheless, the small number of pairs we observed and their strong association with areas that are protected from human disturbance suggest that this species deserves strong conservation action. Several management actions should be taken to protect nesting areas and improve nesting success.

1. By far the most important variable that could be manipulated by public land managers or private owners is human disturbance. Access to beaches should be concentrated as much as is practical. Snowy plovers are likely to be absent along any stretch of beach that is easily reached by people. However, if human use is focused at specific locations, snowy plovers will use the remaining available habitat. Alternatively, nesting areas within areas of high human use could be fenced or roped and posted against trespass. This works well in protecting least tern colonies and, as noted earlier, snowy plovers often indirectly benefit.
2. Pets, particularly dogs, disturb nesting plovers as much as, or more than, their owners. Dogs are likely to flush plovers off their nests, repeatedly chase them, and catch and kill chicks. Adoption and enforcement of regulations prohibiting dogs on beaches, even when leashed, would help protect nesting plovers. This is needed most along beaches adjacent to private lands. The effect of predation by house cats on plover nests is unknown, but these efficient predators should also not be allowed to run free.

3. Vehicles not only cause birds to flee their nests, but they have a great potential for crushing eggs or chicks. Therefore, reducing vehicle traffic on beaches would likely benefit snowy plovers. In areas such as Cape Sans Blas in Gulf County, Florida, where isolated, but suitable, habitat exists, reductions in the number of vehicles that use the beach would undoubtedly improve nesting success. However, even changes in beach use by authorized vehicles may be important. We observed 3 clutches that had been crushed by vehicles during routine patrols or sea turtle surveys. Another 3 nests were abandoned after near misses by patrol vehicles because the tire tracks disrupted the habitat adjacent to the nest. Obviously these vehicles must use the beach, but impacts to the snowy plovers could be reduced greatly if (1) vehicles drove below the high tide line when possible, and (2) vehicles never drove near vegetation on the beach or between vegetation and the front dunes. Most plover nests were within 1 m of vegetation and nearly all were within 3 m. Therefore steering vehicles clear of vegetation, including isolated plants, would greatly reduce the probability of destroying a nest.
  
4. The other major factor in human disturbance is the development of beach-front land for human use. This disturbance is less easily controlled but has the most permanent impact. The difference in number of snowy plovers between public lands with undeveloped beaches and private beaches lined with buildings is striking (Figs. 2 - 5). Without the large stretches of public lands along the northwest coast, the snowy plover population in Northwest Florida would be greatly reduced, as it is in South Florida. In Alabama, the best remaining snowy plover habitat is, similarly, on the undeveloped public land along the Fort Morgan peninsula. In Northwest Florida, only 2 long stretches of undeveloped beach remain in private ownership where they are susceptible to development: Topsail Hill and Palm Point (west to Mexico Beach). Both areas currently support plover nest habitat that will be lost if the land is

developed. Plovers sometimes nest near developed lands, if they are adjacent to freshwater inlets. The configuration of these inlets changes frequently in response to water levels and winds, so that plovers consistently have open, sparsely vegetated habitat available for nesting. The fluctuation of sand and water also impedes construction of buildings near the inlets. The relative isolation from buildings, availability of habitat, and presence of nearby feeding areas make freshwater inlets attractive and productive areas. If such areas are protected from human disturbance, such as at Philips Inlet, they can be valuable nesting sites for snowy plovers and other beach nesters, such as terns. Unfortunately, the dynamic conditions that make these areas attractive also mean that nests here are highly susceptible to natural disturbances. Like freshwater inlets, points at the tips of islands or peninsulas can also be productive nesting sites (Fig. 2-3). However, the same caveats apply. Human disturbance must be minimized, and natural disturbances such as winds or high tides will occasionally be devastating to the nesting birds.

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