FINAL REPORT

As Required By

THE ENDANGERED SPECIES ACT, SECTION 6

TEXAS

GRANT NUMBER E-1-8

ENDANGERED RESOURCES BRANCH

Project 59: Quantification of Piping Plover Habitat Loss in the Land Cut Area of the Laguna Madra

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FINAL REPORT

State: Texas **Grant Number:** E-1-8

Grant Title: Endangered and Threatened Species Conservation

Project Title: Quantification of Piping Plover Habitat Loss in the Land Cut Area of the Laguna Madre

Agreement Period: September 1, 1995 through August 31, 1996

Project Number: 59

Objective:

To evaluate the extent of piping plover habitat loss in the Land Cut area of Kenedy County, Texas using remote sensing data and by performing field analysis to substantiate results.

PREFACE

The attached report entitled "Key Residual Questions Associated with the Ecology of Piping Plovers and Snowy Plovers along the Texas Gulf Coast" by Curt Zonick resulted directly from this objective and is submitted in fulfillment of the Final Report requirement.

Prepared by: Lee Elliot Date: November 1, 1996

Approved by: _____ Date: December 1, 1996
Neil E. Carter
Federal Aid Coordinator

KEY RESIDUAL QUESTIONS ASSOCIATED WITH THE ECOLOGY OF PIPING PLOVERS AND SNOWY PLOVERS ALONG THE TEXAS GULF COAST.

A Final Report to the Texas Parks and Wildlife Department
covering preliminary work funded under Contract #336-0257 by:

Curt Zonick, National Audubon Society

Contract overview and history

The National Audubon Society is providing this report detailing research conducted on behalf of the conservation of Piping Plovers (*Charadrius melodus*) and Snowy Plovers (*C. alexandrinus*) along the Texas Gulf Coast as agreed to under TPWD Contract # 336-0257. The research supported by this contract began on May 1, 1996 and involved the preliminary investigations of 3 primary objectives:

1. The use of washover passes by Piping Plovers and Snowy Plovers.
2. The delineation and description of Snowy Plover breeding locations (historical and current).
3. The establishment of cooperative agreements that protect, enhance or restore habitat for Piping Plovers and Snowy Plovers.

Most of the research covered by this contract (conducted during the period covering May 1, 1996 through October 15, 1996) has focused on objectives 2 and 3. Preliminary work directed toward objective 1 began in July, however, most of the research addressing this objective will be conducted this winter and will be supported under another contract with TPWD.

OBJECTIVE #1. USE OF WASHOVER PASSES BY PIPING PLOVERS AND SNOWY PLOVERS

Background Information for Objective 1

Objective 1 focused on characterizing the use of washover pass habitat by Piping Plovers and Snowy Plovers throughout the year. Washover passes are zones on barrier islands where hurricanes and tropical storms have created gaps in the line of dunes and coastal prairie separating the Gulf beaches and the bayshore flats (Figure 1). In a recent report to Texas Parks and Wildlife Department and the U.S. Fish and Wildlife Service, I described washover passes as an important, and perhaps critical, habitat for both Piping Plovers and Snowy Plovers based upon my research at sites on Mustang Island, South Padre Island and Brazos Island (Zonick and Ryan 1994). During research I conducted between 1991 and 1994, I observed both species to congregate in large diurnal roosts in washover passes during the nonbreeding season (Zonick and Ryan 1994). I proposed that washover passes may serve as essential winter refugia for these species because

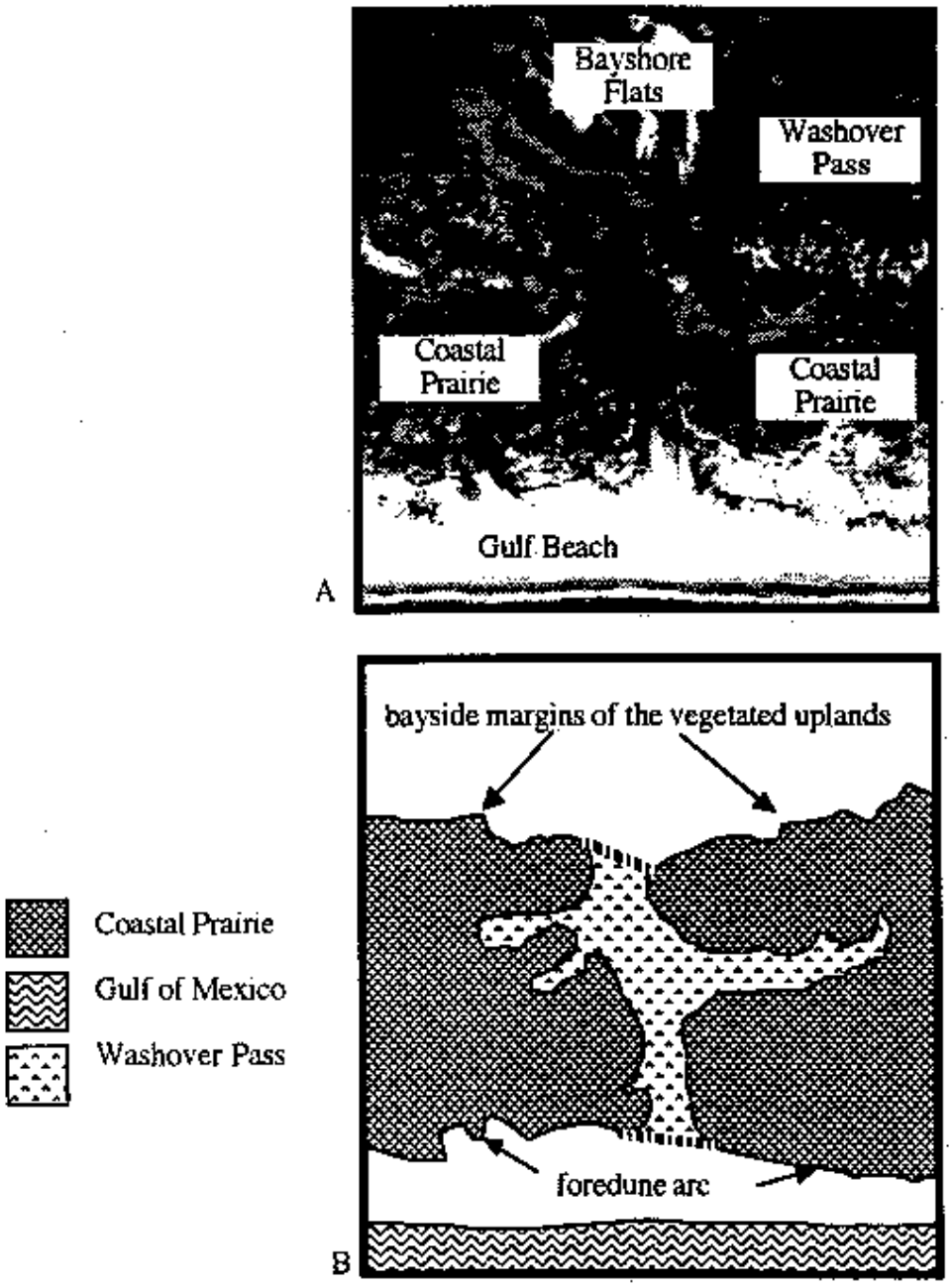


Figure 1. An aerial photograph (A) and a schematic drawing (B) of the same washover pass are presented to illustrate the habitat features that were used to define the boundaries of washover passes for this research. The "side" boundaries of the pass were delimited by the margins of the coastal prairie flanking the pass. The "front" and "back" boundaries of the pass (illustrated on the schematic drawing by hatched [▪▪▪▪▪▪▪▪▪▪▪▪] lines) were delimited by the approximate extensions of the foredune arc and the coastal prairie (vegetated uplands)/bayshore flat margin respectively.

diurnal roosting was often associated with harsh weather conditions when Piping Plovers and Snowy Plovers may have difficulty foraging. A standardized census program was lacking to support these observations, however, and the censuses that I began conducting in July of this year and will be continuing throughout the coming year will provide this missing information.

Methods for Objective 1

To address objective 1, I conducted diurnal censuses at 25 washover passes located on North Padre Island (2 passes), South Padre Island (21 passes), and Brazos Island (2 passes) beginning on 7/12/96. A single washover pass complex with 2 relatively unvegetated washover passes (Corpus Christi Pass, Newport Pass) exists near the juxtaposition of Mustang Island and North Padre Island (Figure 2). Fourteen well-defined washover passes occur on South Padre Island (SPI) between Mansfield Channel and the northern end of HWY 100 (Figure 3). In addition to these are 7 semi-relict washover passes that have been bisected by HWY 100, but still exhibit characteristics of a washover pass (i.e. the absence of densely vegetated coastal prairie between the beach and the bayshore tidal flats). Two large washover passes occur on Brazos Island north of Highway 4, which terminates at the Gulf shoreline (Figure 4).

For this research, I spatially delineated the boundaries of washover pass study sites using; as north and south boundaries, the coastal prairie margins bordering the washover pass; as an eastern boundary, the Gulf-side foredune arc; and as the western boundary, the bayside margin of the vegetated uplands (Figure 1). The washover passes were visited on a rotating schedule such that each pass was visited approximately every 2 weeks. During each visit, I censused all shorebirds present within the washover pass, as well as species from related families (primarily Ardeidae and Laridae). I also recorded a number of environmental variables, such as weather, bayshore tide levels, local disturbances (vehicles, humans, dogs), and the presence and amount of lakes and other forms of water within the washover pass. These data will support future analyses investigating the conditions that are related to the use of washover passes by plovers and other bird groups.

During another study I conducted in 1991-1994, I censused Piping Plover and Snowy Plovers within many of the same washover passes that I monitored for this research. A portion of the census data from that earlier study is reported here to describe previous sightings of plovers in washover passes along the Texas Coast.

Results for Objective 1

Mustang Island/North Padre Island

I documented the previous use (1991 - 1994) of Corpus Christi Pass and Newport Pass as feeding and roosting areas on many occasions, including those censuses reported in Table 1. Whereas the

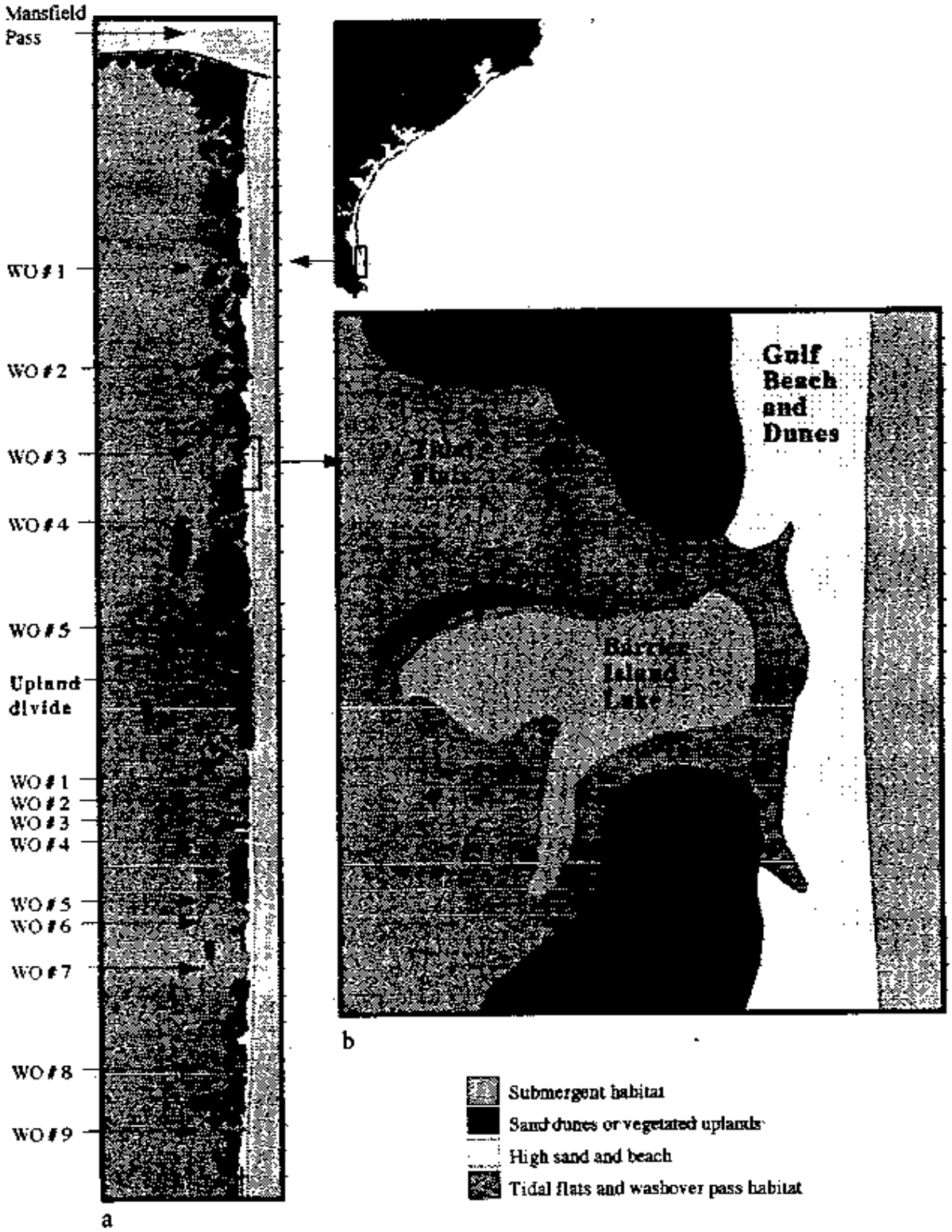


Figure 3. Schematic diagrams of the central and northern regions of South Padre Island (SPI) illustrating a) the location of the 14 washover passes in these 2 regions, and b) an enlarged figure of washover pass # 3 in the north region of SPI, which depicts the typical spatial relationships between the various habitat features that are found in most of the washover passes monitored for this study.

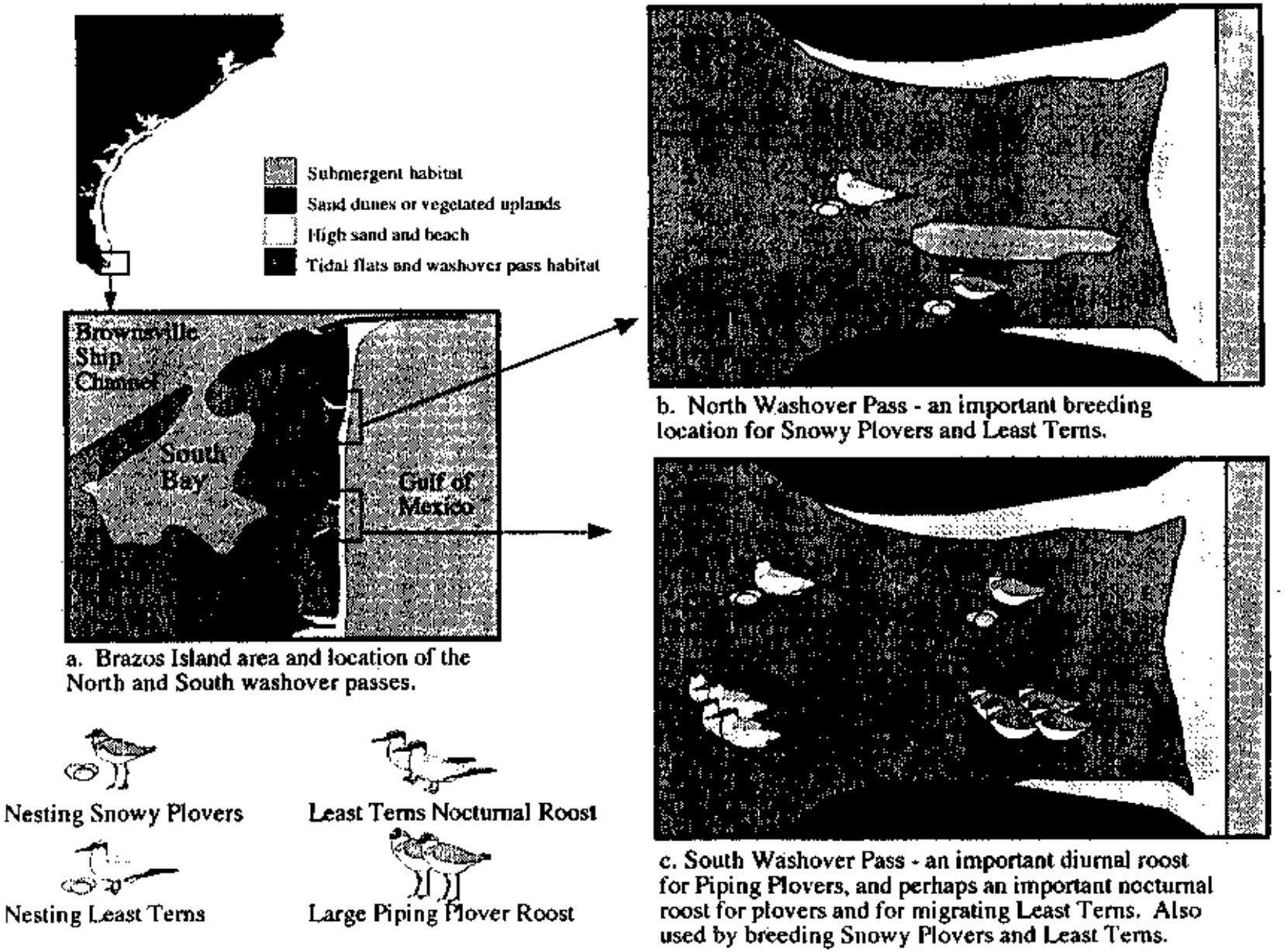


Figure 4. Schematic diagrams illustrating a) the locations of the 2 Brazos Island washovers I monitored as part of this study, and enlarged schematic maps of b) the North Washover Pass, and c) the South Washover Pass. Figures b) and c) illustrate some of the ways in which I have observed Piping Plovers, Snowy Plovers and Least Terns use these washover passes during the past 4-5 years.

NORTH PADRE ISLAND

Date	Washover Pass	# Piping Plovers	# Snowy Plovers
2/5/92	Newport	40	26
2/10/92	Newport	10	30
9/21/93	Newport + Corpus Christi Pass	21	42
9/24/93	Newport + Corpus Christi Pass	25	25
9/27/93	Newport + Corpus Christi Pass	14	28
1/12/94	Newport + Corpus Christi Pass	22	4
1/12/94	Newport + Corpus Christi Pass	19	36

SOUTH PADRE ISLAND

Date	Washover Pass	# Piping Plovers	# Snowy Plovers
2/4/93	Central Region	171	6

BRAZOS ISLAND

Date	Washover Pass	# Piping Plovers	# Snowy Plovers
2/10/93	South	254	4
2/26/93	South	153	4
3/16/93	South	149	0
3/31/93	South	82	1
10/8/93	South	74	18
1/24/94	South	68	18

Table 1. Selected census data collected during research conducted between 1991-1994 are presented in this table. These censuses document several large roosting flocks of Piping Plovers and Snowy Plovers that were previously observed to congregate within some of the washover passes that are being monitored as part of the current study.

use of these passes by plovers appeared to be correlated with conditions associated with passing north frontal systems (e.g. cold temperatures, high winds, high bayshore tides), the beach and washover pass habitat were not consistently censused separately during my previous research and, therefore, it was not possible to describe the environmental conditions associated with the use of washover pass habitat in a rigorous analysis of that dataset. The censuses that are being conducted for this project will support these analyses.

Beginning 7/12/96, I censused Corpus Christi Pass and Newport Pass 10 and 11 times respectively (Table 2, Figures 5 and 6) by the time this report was prepared. In general, plover populations were low, but only 2 of these censuses were conducted during "extreme conditions" that favor the use of washovers by plovers (e.g. extreme high tides, or winter cold fronts). On 9/30/96, the washover passes on North Padre were censused during the season's first cold front, and several groups of plovers were observed to use the washover passes (a total of 12 Piping Plovers and 41 Snowy Plovers were observed in both passes). On 10/8/96, during a census conducted under extreme high tides associated with Tropical Storm Josephine, 42 Piping Plovers and 35 Snowy Plovers were recorded to be either foraging or roosting in these washover passes (L. Elliott, Texas Parks and Wildlife Dept., pers. comm.). When the data from the 2 censuses performed during "extreme conditions" are pooled and compared to the censuses performed during "normal conditions", a substantial increase in plover use of washover passes is apparent during periods when conditions on other habitats are less ideal (Table 3). An important component of the research I will be conducting this winter will involve the description and quantification of parameters affected by events that cause plovers to use washover passes (i.e. during events that cause "extreme conditions" for plovers).

South Padre Island

I observed occasional flocks of Piping Plovers and Snowy Plovers to be resting in washover passes on SPI during the winters of 1991 - 1994. Among these was a roosting population of 171 Piping Plovers and 6 Snowy Plovers recorded on 4 February 1993 (Table 1).

Most of the washover passes on SPI had been censused 3 or 4 times at the time this report was prepared (10/15/96; Table 2, Figures 5 and 6). Most of the washovers supported very few plovers during the early portion of this study. The low abundance of plovers during August and September (data not shown) was not surprising, however, as only a small number shorebirds had begun to return from the breeding grounds at the time of the first few surveys, and the warm temperatures and low bayshore tides characteristic of the late summer period do not create the conditions expected to cause plovers and other birds to seek refuge in the passes. One set of censuses was conducted during "extreme conditions" that favor the use of washovers by roosting plovers (extreme high tides associated with Tropical Storm Josephine), and plovers were much more abundant during this census (Table 3).

Island	Region	Pass #	Piping Plovers	Snowy Plovers	shorebirds	waders	seabirds	N
North Padre	North	1	3.3	1.6	11	0	112	10
North Padre	North	2	3.3	9.3	25.5	0.5	151.5	11
South Padre	100	1	0.8	0.5	6.8	24.2	9.2	4
South Padre	100	2	0.7	0.7	4	1.3	0.7	3
South Padre	100	3	0.3	0	5.7	1.7	13.3	3
South Padre	100	4	0.3	0.3	2	0	0	3
South Padre	100	5	1	1	11.2	0.2	15	4
South Padre	100	6	0.2	0.2	2.8	0.5	0.5	4
South Padre	100	7	7	6.6	40.8	0	16.4	5
South Padre	Central	1	6.5	4.5	91.5	2.5	0	4
South Padre	Central	2	2	1.8	48	0.8	0.8	4
South Padre	Central	3	0	0	0	0	0	4
South Padre	Central	4	0.5	0.5	132.8	3.5	44.2	4
South Padre	Central	5	0.2	0.2	4.5	0.2	1.8	4
South Padre	Central	6	0.2	0	13	6	11.5	4
South Padre	Central	7	10.3	10.3	20.3	0	0.3	3
South Padre	Central	8	2.3	2.3	32	3.7	62.7	3
South Padre	Central	9	0	0	4	0.7	11.3	3
South Padre	North	1	1	1	17.5	2	0	2
South Padre	North	2	2	2	19.3	0	0.3	3
South Padre	North	3	7.3	7.3	108.3	0.3	1	3
South Padre	North	4	0.3	0.3	19.3	0	0	3
South Padre	North	5	2.7	2.7	67.7	2	182	3
Brazos	North	1	13.8	13.2	49.5	0.2	136.5	4
Brazos	North	2	6	5	119	2	116	4

Table 2. The mean numbers of Piping Plovers, Snowy Plovers, shorebirds (including Piping and Snowy Plovers), waders, and seabirds occuring in each washover pass are presented in this table.

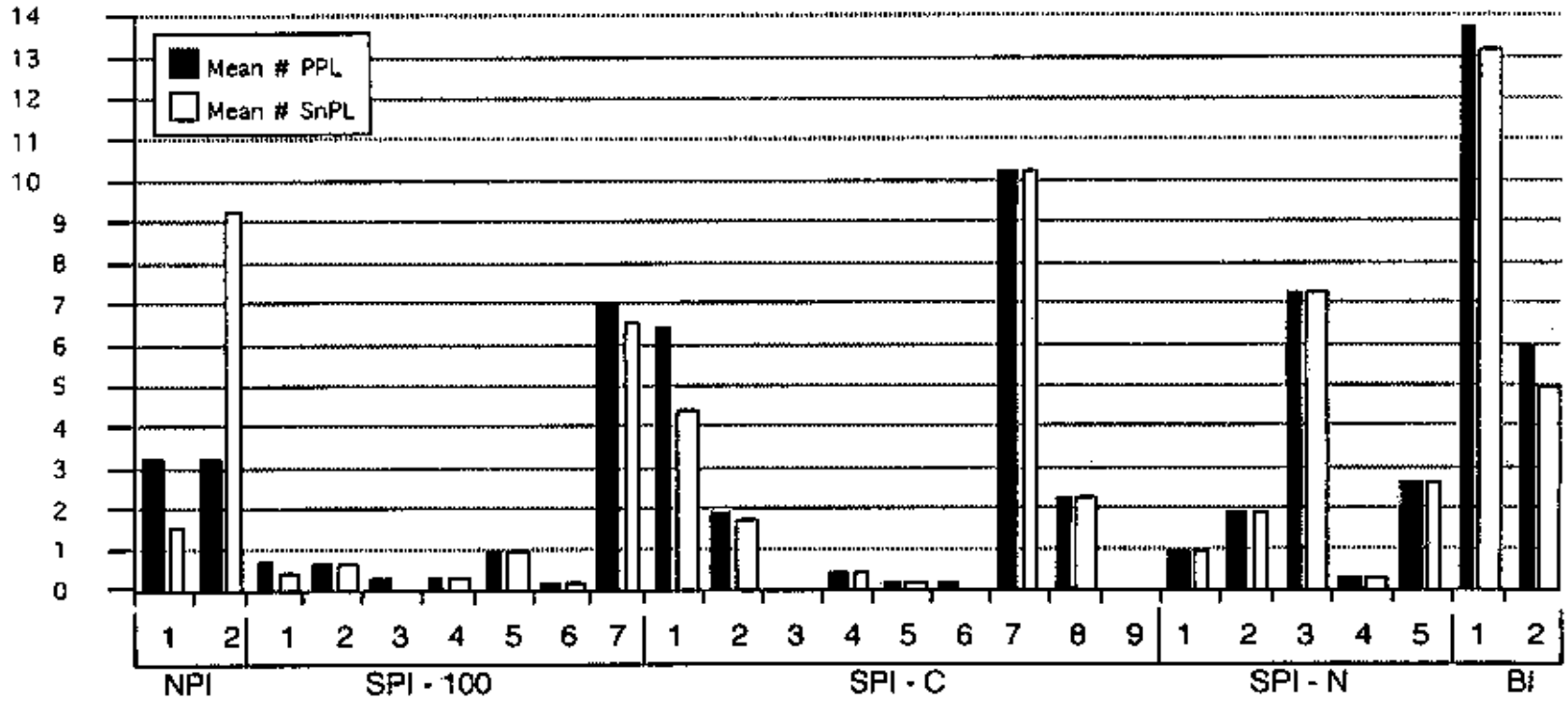


Figure 5. The mean numbers of Piping Plovers and Snowy Plovers observed in each of the washover passes are represented by black and white bars, respectively in this chart. Some washover passes had substantially larger populations of Piping Plovers and Snowy Plovers than did others. Among the passes with large plover populations were washovers #1 and #2 on North Padre Island (NPI), # 7 along HWY 100 on South Padre Island (SPI-100), #1 and #7 along the central region of South Padre Island (SPI-C), #3 along the northern region of South Padre Island (SPI-N), and both Brazos Island (BI) washover passes. The censuses have not been corrected for differences in area among the washover passes, however, and represent only 3-5 sample points per washover pass. The washovers will be mapped and their areas measured in the coming months, which will allow for a comparison of population density among the passes. Other factors, such as the presence of lakes in the washover passes, and the amount of human disturbance on the adjacent beach habitat and the width of the adjacent bayshore tidal flats will also be quantified and related to population densities.

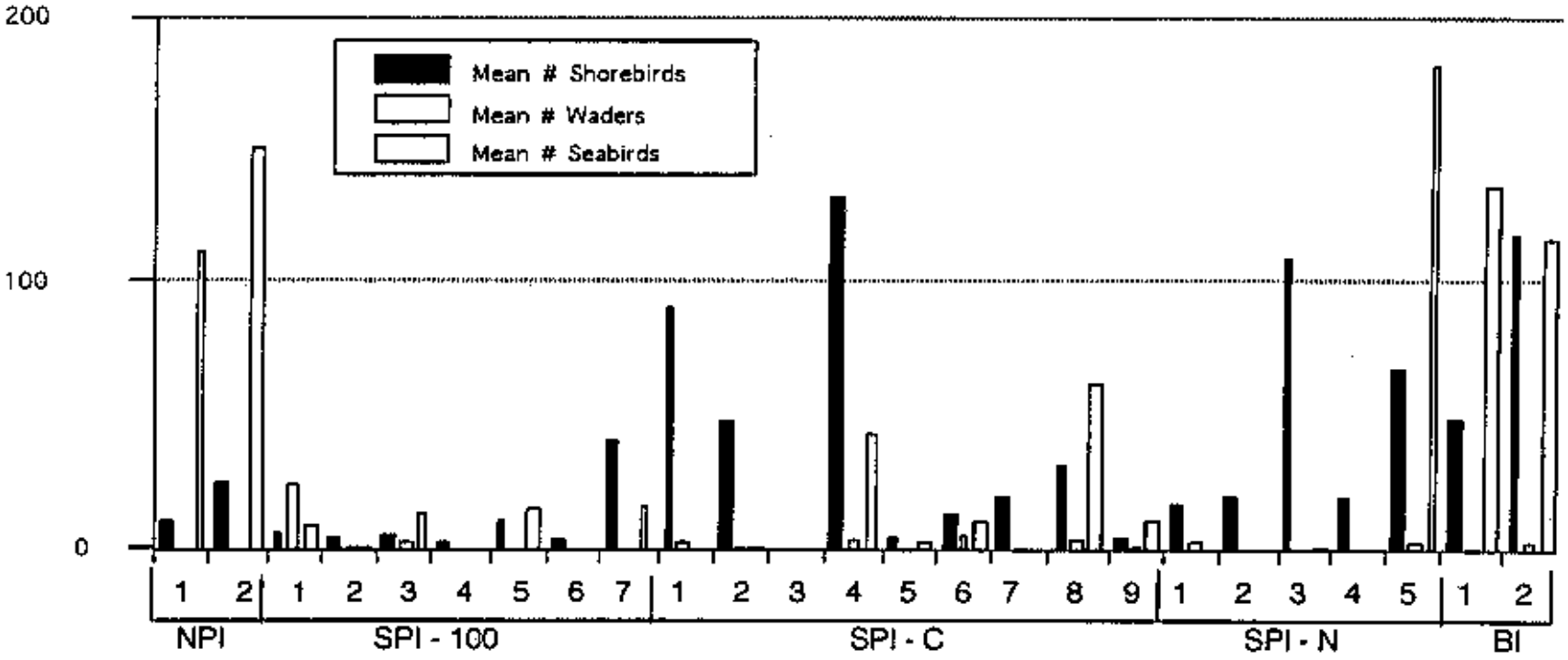


Figure 6. The mean numbers of shorebirds (including Piping and Snowy Plovers), waders (herons, egrets), and seabirds (gulls, terns, cormorants and pelicans) observed in each of the washover passes are represented by black, white and gray bars, respectively in this chart. Waders were found in many washover passes, but usually at very low numbers. Some washover passes had substantially larger populations of shorebirds and seabirds than did others. Among the passes with large populations were washovers #1 and #2 on North Padre Island (NPI), # 7 along HWY 100 on South Padre Island (SPI-100), #4 and #8 along the central region of South Padre Island (SPI-C), #3 and #5 along the northern region of South Padre Island (SPI-N), and both Brazos Island (BI) washover passes. The censuses have not been corrected for differences in area among the washover passes, however, and represent only 3-5 sample points per washover pass. The washovers will be mapped and their areas measured in the coming months, which will allow for a comparison of population density among the passes. Other factors, such as the presence of lakes in the washover passes, and the amount of human disturbance on the adjacent beach habitat and the width of the adjacent bayshore tidal flats will also be quantified and related to population densities.

	# Piping Plovers		# Snowy Plovers	
Island	**Normal Conditions[1]**	**Extreme Conditions[2]**	**Normal Conditions**	**Extreme Conditions**
North Padre	0.2 (7)	27.0 (2)	0.1 (7)	32.0 (2)
South Padre:				
HWY 100 Region	0.4 (3)	5.4 (1)	0.7 (3)	1.1 (1)
Central Region	0.5 (3)	7.2 (1)	0.9 (3)	11.8 (1)
Northern Region	2.9 (3)	2.0 (1)	1.3 (3)	7.8 (1)
Brazos Island	1.0 (3)	76.0 (1)	1.3 (3)	40.0 (1)

Table 3. The abundances of Piping Plovers and Snowy Plovers in washover passes on different Texas barrier islands are described on this table as they occurred during normal and extreme conditions (defined below). To simplify the comparison, census data from each barrier island (or in the case of South Padre Island, each geographical region of the island) were pooled. The abundance of Piping Plovers and Snowy Plovers increased substantially during extreme conditions in all cases but for the use of washover passes on the northern region of South Padre Island by Piping Plovers. There have not yet been enough censuses conducted to allow for meaningful statistical comparisons of these datasets, however, and therefore the relationship between washover pass use and environmental conditions must be viewed as a preliminary one that will be tested by future censuses to be conducted this winter and spring.

1. For the purposes of this table, "Normal Conditions" are loosely described as those where weather conditions are typical of periods *between* winter cold fronts (e.g. mild temperatures and southeasterly winds, no precipitation) and bayshore tidal flats are *at least partially emergent.*
2. For the purposes of this table, "Extreme Conditions" are loosely described as those where weather conditions are typical of periods *during* winter cold fronts (e.g. cooler temperatures, northerly winds) or when bayshore tidal flats are *completely inundated and unavailable to shorebirds.*

Brazos Island

I documented the previous use (1991 - 1994) of these 2 passes as feeding and roosting areas on many occasions, including those censuses reported in Table 1. A population of 172 Piping Plovers was also documented to use the north pass in the winter of 1989. This observation was used to support a jeopardy finding for the Playa del Rio Project (USFWS 1989).

Both of the washover passes had been censused 4 times at the time this report was prepared (Table 2, Figures 5 and 6). One set of censuses was conducted during conditions that favor the use of washovers by roosting plovers (high tides associated with Tropical Storm Josephine). Both species were much more abundant during this census than during the previous 3 censuses (Table 3).

In summary, the preliminary results of the censuses conducted this year, augmented by my observations of the periodic use of washover passes in 1991-1994, have begun to underscore the critical role washovers appear to play as refugia during periods of extreme high tides, winter cold fronts, and other phenomena that severely reduce the availability of other feeding habitat to plovers. During the coming year, I will be collecting data associated with a few key microclimatic variables (ground level wind speed, ground level air temperature, and sediment temperature and moisture) within a select number of washover passes and their adjacent beach and bayshore habitats. Whereas this work was not described in the research proposal, I believe these data will more strongly support an investigation into the reasons why plovers are selecting washover passes during periods of harsh weather.

Nocturnal Observations

Whereas the investigation of nocturnal ecology of Piping Plovers and Snowy Plovers was not an objective of this research, it is one of the major objectives of another study that I am conducting this winter. I have conducted some preliminary nocturnal research, and briefly summarize some of my observations below. Observations were made with a Noctron V light-intensifying spotting scope fitted with a 135 mm lens. The nocturnal ecology of Piping Plovers and Snowy Plovers will be discussed in much greater detail in a future report.

Piping Plovers and Snowy Plovers: Piping Plovers and Snowy Plovers were found to forage in near complete darkness during a 2 hour nocturnal observation session conducted in the south washover pass on Brazos Island on 10/9/96. Although there were no nearby sources of artificial lighting, and the moon had not yet risen, plovers were observed to forage well after nightfall. It was not possible to identify the prey they were pursuing due to limitations in the magnification and resolution of the night scope. However, the plovers appeared to be feeding visually based upon their foraging movements (all pursued prey with the characteristic look-run-peck motion that is

diagnostic of foraging plovers). During this same period of observation, a small group of plovers (8-10) was observed to congregate near the center of the washover pass and roost along with 10-15 Sanderlings. Although this group was not monitored continuously, and individual plovers were difficult to distinguish, the entire group appeared to remain in the same location throughout the 2 hour period.

Least Terns: The southern pass on Brazos Island was used by a large flock of Least Terns as a nocturnal roost during 2 other nocturnal censuses of this pass conducted this summer (8/14/96 and 9/3/96). On both occasions, the terns were observed to leave diurnal resting areas near the intertidal zone along the forebeach margin and congregate in the same general area in the rear portion of the southern washover pass. Although the flock flushed several times from the roost (for no observable reason) it always settled down in the same area. Observations with a night scope confirmed that the flock remained in this area for well over an hour after nightfall on both occasions.

OBJECTIVE 2. SNOWY PLOVER BREEDING DISTRIBUTION

Background Information for Objective 2

A comprehensive review of the historical breeding range and breeding ecology of the Snowy Plover is lacking. A better understanding of the historical breeding biology (range, habitat usage, etc) would provide a extremely useful baseline from which to appraise the health of the current Texas coastal population. The current breeding distribution is still poorly understood, as are the specific locations used by breeding Snowy Plovers along many stretches of the Texas coast, the habitat requirements of breeding Snowy Plovers along the central and upper Texas coast, and the factors that may threaten current breeding populations in these regions (e.g. predation, human disturbance).

Objective 2 focused on the preliminary characterization of 3 major aspects of Snowy Plover breeding ecology along the Texas Gulf Coast: A) historical breeding distributions, B) current breeding distribution (geographic range, habitat associations), and C) current breeding ecology (breeding period, threats to breeding populations, nest microhabitat features).

It must be noted here that many of the locations where I was able to locate Snowy Plover breeding populations occurred on private lands, and some of the landowners have asked that I refrain from reporting data that I collected on their property.

Objective 2A. Historical Snowy Plover Breeding Distribution

Methods for Objective 2A

To address Objective 2A I began compiling information describing past sightings of nesting Snowy Plovers in Texas Gulf Coastal counties. A portion of this effort has involved the pursuit of less readily available information (e.g. sightings from veteran birders, unpublished censuses or those published in reports with small circulations, compilations of the information recorded with bird skin collection, etc.)

Results for Objective 2A

Preliminary searches of available literature and museum records have begun to delineate the historical Snowy Plover breeding distribution in Texas. Oberholser (1974) describes the coastal breeding population of Snowy Plover as ranging "...from Galveston Bay to the Mouth of the Rio Grande...", being "...fairly common to uncommon..." along that region of the coast. A map accompanying the text from Oberholser (1974) indicates that breeding specimens had been collected from Bee, Nueces and Cameron Counties, and breeding sight records from Harris, Brazoria, and Aransas Counties. Most of the available literature, however, describe breeding Snowy Plovers only along the central and lower Texas Coast (Sennett 1888, Strecker 1912, Grisom and Crosby 1925a and 1925b, Packard 1951). According to Sennett (1888), Snowy Plovers bred in "Corpus Christi, Texas" in 1887, and were "... not uncommon; large series of adults and young were secured". Strecker (1912) describes the Snowy Plover as a "resident on the Gulf Coast from Galveston southward. More abundant in the winter than in the summer. Eggs in Baylor museum from eastern Refugio county." Griscom and Crosby (1925a) classified Snowy Plovers as "of uncertain status" in 1925, mentioning that birds classified as such "...have been observed so seldom in this region, that their status cannot be determined without further research.". The 7 other birds classified as "of uncertain status" by Griscom and Crosby (1925a) were the Avocet, Common Tern, Mexican Goshawk, Burrowing Owl, Texas Seaside Sparrow, Lark Sparrow, and Gray-breasted Martin. In a later publication that year, Griscom and Crosby (1925b) described Snowy Plovers as a species "...of which our local knowledge is very defective. It is known as a permanent resident at Corpus Christi, but the only record is that of Smith who states that he obtained on at Point Isabel on October 24, 1908."

A bird skin collection maintained at Welder Wildlife Refuge contains 2 female Snowy Plovers collected in 1924 that suggest the existence of a breeding Snowy Plover colony along the coastal bend "near Aransas Pass on mud flats". The birds were collected by R. Quillin, an amateur birder and egg collector (G. Blacklock, Ecoservices, Kingsville, TX, pers. comm.). Mr. Quillin provided labels on the skins reading "Many Plover: egg". This site may be referring to a large tidal flat located on the north end of Mustang Island along the Aransas Pass between Mustang and San Jose Islands, where I observed Snowy Plover breeding populations in 1994 and 1996.

Location	Coverage[1]	Activity[2]	Suitable Habitat[3]	Source of Information
Bolivar Peninsula	extensive	none	isolated; HF, LF, W	T. Eubanks, pers. comm., pers. obs.
Galveston Island	extensive	none	isolated; HF, LF, W, WA	T. Eubanks, pers. comm., pers. obs.
Follets' Island	none	no data	isolated; HF, LF, W	
Matagorda Peninsula	none	no data	irregular; HF, LF, W, WA	
Matagorda Island			isolated; HF, LF, W, WA	
beaches	'94, '96; extensive	none		pers. obs.
tidal passes	'94, '96; extensive	none		pers. obs
bayside lagoons/flats	'96; isolated	none		pers. obs
San Jose Island	none[4]	no data	partial; HF, LF, W, WA	
Mustang Island	'94, '96; extensive	isolated	irregular; HF, LF, W, WA	
North Padre Island			extensive; HF, LF, W, WA	
washover passes	'93; irregular	irregular		Chaney et al, 199#
bayside flats	'96; isolated	irregular		pers. obs.
South Padre Island			extensive; HF, LF, W, WA	
washover passes				
- *regions 100 and C*	'93, '94; extensive	partial		pers. obs.
- *region N*	'94; isolated	irregular		pers. obs.
tidal flats	none	no data		
Brazos Island			extensive; WA, HF, LF, W	
washover passes	'93, '94; extensive	irregular		pers. obs.
tidal flats	'93, '94; isolated	isolated		pers. obs.

Table 4. This table summarizes the approximate proportional use of Texas coastal barrier habitat by breeding Snowy Plovers based on observations during the past 4-5 years. The table presents estimates of the survey efforts on each of the barriers, as well as the proportion of suitable breeding habitat (as defined by the 4 habitat layers described in the Current Snowy Plover Breeding Distribution section of this report) on each barrier, and proportion of occupancy within suitable breeding habitat by breeding Snowy Plover populations in those areas that were surveyed.

1. Coverage: ~ proportion of area of suitable habitat that was surveyed; none (0%), isolated (~ 1- 10%), irregular (~ 11-25%), partial (~ 26 - 74 %), extensive (~ >75 %).
2. Activity: ~ proportion of surveyed habitat that was occupied by breeding Snowy Plovers; none (0%), isolated (~ 1- 10%), irregular (~ 11-25%), partial (~ 26 - 74 %), extensive (~ >75 %).
3. Suitable Habitat: ~ proportion of the land mass covered by the 4 habitat layers associated with Snowy Plover breeding activity on BEG maps of the area (see the Current Snowy Plover Breeding Distribution section of this report); none (0%), isolated (~ 1- 10%), irregular (~ 11-25%), partial (~ 26 - 74 %), extensive (~ >75 %).
4. Permission to access private property was requested but was not granted.

Location	Coverage[1]	Activity[2]	Suitable Habitat[3]	Source of Information
Upper Texas Coast[4]	none	no data	isolated; HF, LF, W	pers. obs.
Coastal Bend[5]	'96; isolated	irregular	irregular; HF, LF, W	pers. obs., G. Blacklock, EcoServices, Kingsville, TX, pers. comm.
Upper Laguna Madre[6]	'96; isolated	irregular	partial; HF, LF, W	pers. obs.
Land Cut[7]	'94, '95; isolated	isolated	extensive; HF, LF, W	pers. obs., G. Galbraith, Espey Houston & Associates, Austin, TX, pers. comm.
Lower Laguna Madre[8]	'93, '94; isolated	partial	partial; HF, LF, W	pers. obs.

Table 5. This table summarizes the approximate proportional use of Texas coastal mainland habitat by breeding Snowy Plovers based on observations during the past 4-5 years. The table presents estimates of the survey efforts on different mainland regions, as well as the proportion of suitable breeding habitat (as defined by the 4 habitat layers described in the Current Snowy Plover Breeding Distribution section of this report) in each region, and proportion of occupancy within suitable breeding habitat by breeding Snowy Plover populations in those areas that were surveyed.

1. Coverage: ~ proportion of area of suitable habitat that was surveyed; none (0%), isolated (~ 1- 10%), irregular (~ 11-25%), partial (~ 26 - 74 %), extensive (~ >75 %).
2. Activity: ~ proportion of surveyed habitat that was occupied by breeding Snowy Plovers; none (0%), isolated (~ 1- 10%), irregular (~ 11-25%), partial (~ 26 - 74 %), extensive (~ >75 %).
3. Suitable Habitat: ~ proportion of the land mass covered by the 4 habitat layers associated with Snowy Plover breeding activity on BEG maps of the area (see the Current Snowy Plover Breeding Distribution section of this report); none (0%), isolated (~ 1- 10%), irregular (~ 11-25%), partial (~ 26 - 74 %), extensive (~ >75 %).
4. For the purposes of this research, the Upper Texas Coast mainland habitat is defined as all wetland habitats occurring on the mainland within Jefferson, Chambers, Galveston, Brazoria, and Matagorda Counties.
5. For the purposes of this research, the Coastal Bend mainland habitat is defined as all wetland habitats occurring on the mainland within Calhoun, Refugio, Aransas, San Patricio, and Nueces Counties.
6. For the purposes of this research, the Upper Laguna Madre mainland habitat is defined as all wetland habitats occurring on the mainland within Kleberg and northern Kenedy Counties, extending south in Kenedy to the shoreline of the Upper Laguna Madre water mass.
7. For the purposes of this research, the Land Cut mainland habitat is defined as all wetland habitats occurring on the mainland within Kenedy County, between the upper and lower Laguna Madre water masses, extending eastward to the Gulf Intracoastal WaterWay.
8. For the purposes of this research, the Lower Laguna Madre Texas Coast mainland habitat is defined as all wetland habitats occurring on the mainland within lower Kenedy, Willacy, and Cameron Counties.

A 1980 study conducted by Texas A & M University describes an undated census by Gene Blacklock (now working for Ecoservices, Mr. Blacklock is a well regarded ornithologist specializing on Texas Coastal avifauna). Mr Blacklock's report documented the occurrence of a historical breeding population of Snowy Plovers at a location now recognized as the Suntide Dredge Material Placement Area owned by the Port of Corpus Christi Authority. At the time of Mr. Blacklock's survey, the Suntide Placement Area was a semi-natural wetland connected to the Nueces River.

The general lack of documentation describing Snowy Plover breeding activity along the northern Texas Coast, and the apparent absence of any large breeding populations along the Louisiana Coast (Louisiana Dept. of Conservation 1918, Lowery 1947 & 1955), coupled with the observations that I present in the "Current Snowy Plover Breeding Distribution" section of this report, suggests that Snowy Plovers may never have bred in large numbers along the Western Gulf of Mexico north of the Texas Coastal Bend. More research into the historical breeding range and ecology of Snowy Plovers will be conducted this winter, and will be summarized in a future report.

Objective 2B. Current Snowy Plover Breeding Distribution

Methods for Objective 2B

To address Objective 2B, I expanded upon research that I began in 1993. Aerial photographs and maps delineating habitat features were studied to identify locations within Texas' Gulf Coastal counties that appeared to exhibit suitable breeding habitat for Snowy Plovers (e.g. sparsely-vegetated sand and algal flats, washover passes). The areas 1) that appeared to offer the most promise for supporting breeding Snowy Plovers, 2) that were accessible, and 3) where permission could be obtained to enter the property, were visited and censused for Snowy Plovers and evidence of breeding activity (territorial behavior, nests, chicks, etc.). Several breeding sites were located on private properties, and there locations have been withheld from this report at the requests of the landowners.

Results for Objective 2B

Several of the locations that I identified as potential breeding sites prior to my surveys this summer were found to support breeding Snowy Plovers. I am in the process of mapping the locations of breeding sites that I have identified using the Bureau of Economic Geology Submerged Lands of Texas Maps as a base habitat layer (see below), but a brief summary of my census efforts on Texas' barrier island system and regions of the Texas mainland are presented in Tables 4 and 5. I am planning to have maps available for a report by the fall of 1997.

Although the central and upper coast has only been partially surveyed (see Tables 4 and 5), it appears that the large majority of the current Snowy Plover Texas Coastal breeding population exists along the Laguna Madre and the isolated wetlands and lagoons that border this large, hypersaline bay. I have been unable as yet to find any recent evidence of Snowy Plover breeding activity along the northern Texas Coast, however many areas have not been thoroughly censused. I will expand my breeding census efforts in 1997 to include the upper Texas Coast in order to address this gap in information. A working definition of Snowy Plover coastal breeding habitat is presented below. The habitat description is based in large part upon the breeding censuses that I conducted between 1993 - 1996, and by recent work by Jeff Rupert, a graduate student at the University of Texas Pan Am. Mr. Rupert has been conducting research on Snowy Plover breeding ecology at Laguna Atascosa National Wildlife Refuge since 1994. Together, we find Snowy Plover nesting habitat along the Texas Coast to be most accurately described as:

> - wind-tidal flats and other similar types of flats that exhibit scattered, sparse vegetation, and that are only rarely flooded, with preference given to flats and shorelines located nearby broad, shallow, pools of water.

This habitat description includes most washover passes, bayshore tidal flats and lagoons, many man-made impoundments and basins and some stretches of upper beach on a few barrier islands.

More specifically, we believe that Snowy Plover coastal breeding habitat is well delineated by 4 habitat layers (W, WA, LF, HF) presented on the Bureau of Economic Geology Submerged Lands of Texas Maps (e.g. Figure 7). High quality nesting habitat is not necessarily found throughout these habitat layers, but rather, near the juxtaposition of these habitats, especially the HF and W habitat layers. Whereas some inconsistencies have been observed with the use of this habitat description to predict Snowy Plover breeding activity (see Figure 7), this habitat description will undoubtedly increase the efficiency of our future efforts to map Snowy Plover nesting sites.

Objective 2C. Current Snowy Plover Breeding Ecology

Methods for Objective 2C

To address Objective # 2C, I recorded several microhabitat characteristics associated with Snowy Plover nests and nest locations. These analyses incorporate data collected in during the 1993, 1994 and 1996 breeding seasons. Parameters associated with nest site characteristics were recorded for as many nests as I was able to locate without unduly disturbing breeding colonies or compromising local breeding success by tracking through breeding congregations. Only a portion of the data that I collected in 1996 are incorporated into the analyses, however, as some data collected on private properties were excluded at the requests of private landowners.

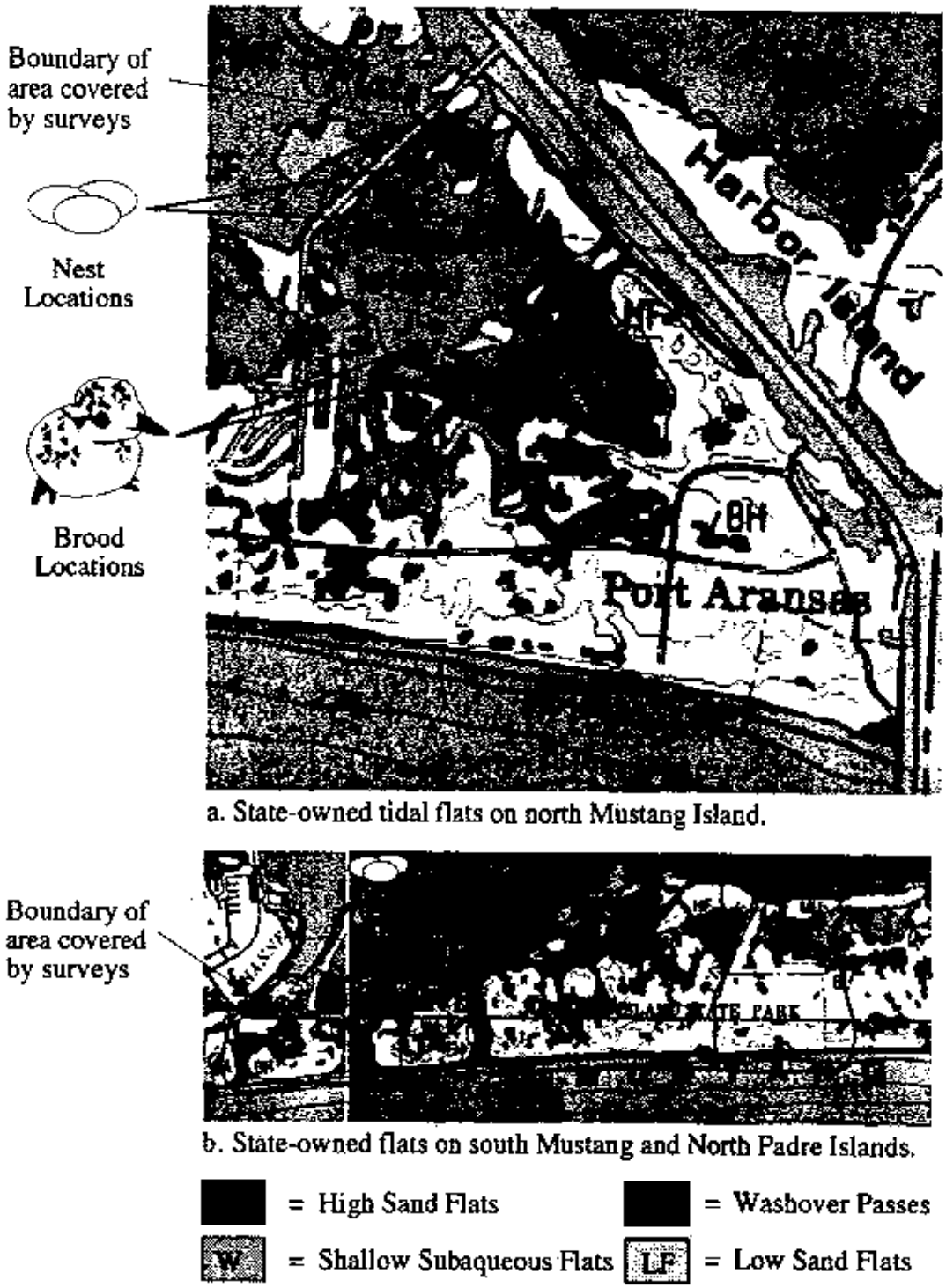


Figure 7. This figure illustrates 2 study areas as they are depicted by the Bureau of Economic Geology Submerged Lands of Texas maps (BEG maps). The figures are presented to illustrate both the association between Snowy Plover breeding activity and the 4 habitat layers on the BEG maps, and the variability in this association. These 2 areas exhibit similar landscape structure and habitat availability, but different levels of Snowy Plover breeding activity. The area shown in figure a) supported many Snowy Plovers (~ 10 pair), and at least 4 nests were laid in 1996. In contrast, the area shown in figure b) supported very few Snowy Plovers (1-2 pair), and only 1 nest was found, very late in the breeding season. The reduced breeding activity in the area in b) may be a result of higher human disturbance.

I extended a color-banding program that I began in 1993 to aid in the investigation of nest site fidelity and seasonal site fidelity.

Results for Objective 2C

All of the nests found during this study, and included in these analyses (i.e. not on private lands with landowners requesting confidentiality) were located within either high flat (HF) or washover pass (WA) habitat (Figure 8). Many of the nests, however, were located very close to the juxtaposition of one of these habitats and either the shallow pools (W) or low flat (LF) habitats as described in the Bureau of Economic Geology Submerged Lands of Texas maps. All of the nests described in this report were located within 750 meters of some form of standing water body, most often a shallow pool (Figure 9). All of the nests found in washover pass habitat were constructed on sandy substrate, and were lined with shell fragments (Figure 8). Although many of the nests found in high flat habitat were on mud or clay substrata, some were also found on a sand substrata (Figure 8). High flat nests were sometimes lined with materials other than shells, including stones, and small pieces of algal mat. Two of the nests were unlined, with the eggs deposited into an "unadorned" scrape in one case, and with the eggs deposited in a deer footprint in the other case (data not shown).

Table 6 describes data collected in association with 35 Snowy Plovers that were trapped and color banded. The table does not report data collected in association with plovers that were banded on private property, where landowners requested that data remain confidential. Six of the 35 plovers reported in Table 6 were resighted at least once, and 4 were resighted on more than one occasion. All of the plovers that were resighted were found very nearby the nesting site where they were captured and banded (data not shown). Although 2 of these birds nested the following year in the same general location where they were captured the previous year (i.e. exhibited some degree of nest site fidelity), there have not yet been enough resightings to determine whether nest site fidelity is a common trait among Snowy Plovers nesting along the Texas Coast. The fact that all of the resightings were very nearby the nesting site, however, suggests that at least some Snowy Plovers are non-migratory.

OBJECTIVE 3. COOPERATIVE AGREEMENTS

Background Information for Objective 3

Objective 3 focused on the development of cooperative agreements, especially with private landowners, leading to the monitoring, protection, restoration, or creation of habitat for Piping Plovers and Snowy Plovers (e.g. predator exclusion fences around Snowy Plover nesting areas, modifying commercial operations to minimize or prevent disturbance to nesting Snowy Plovers,

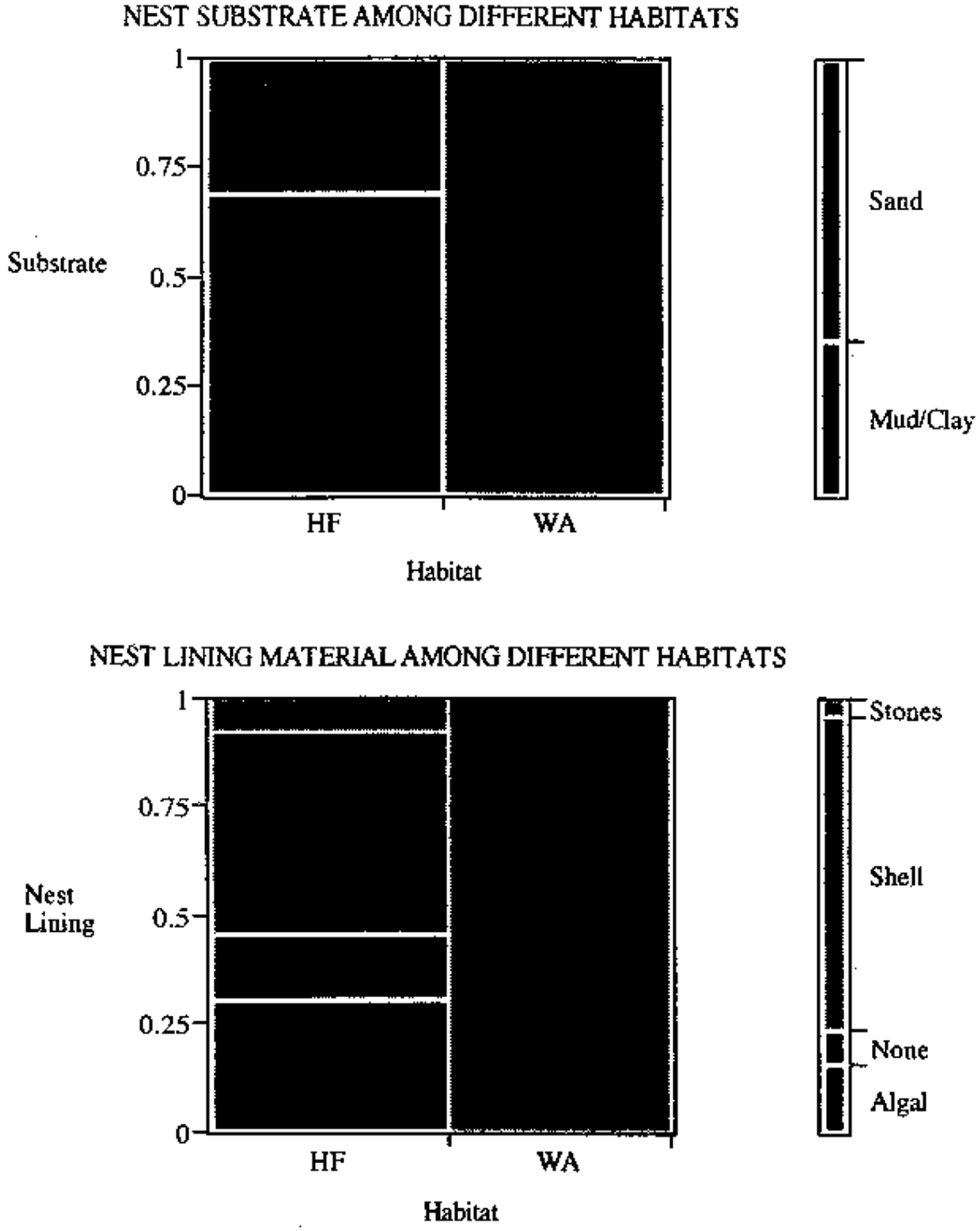
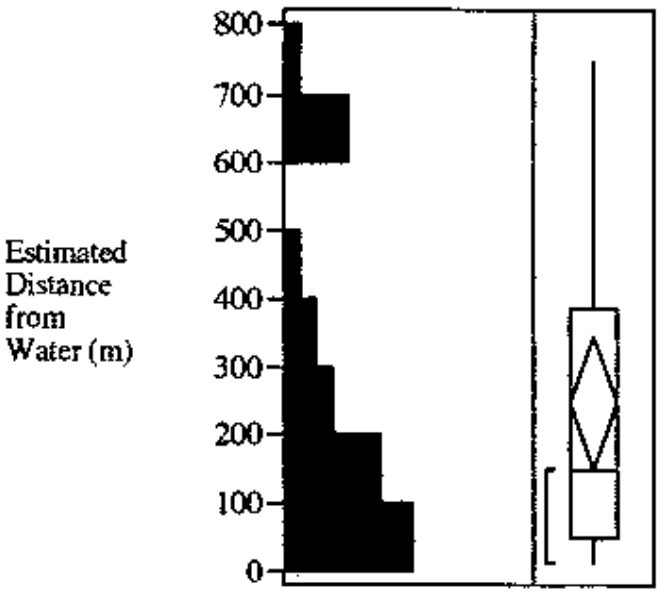


Figure 8. The graphs presented above illustrate the relative proportions of a) substrate and b) nest lining material associated with Snowy Plover nests in high flat (HF) and washover pass (WA) habitats. As described by graph a), all nests in WA habitat were constructed on sandy substrata, whereas most, but not all, nests in HF habitat were constructed on a dried mud or clay substrata. As described in graph b), all nests in WA habitat were lined with at least some shell fragments, whereas those in HF habitat were more variable. Although many HF nests were lined with shell fragments, some were instead lined with stone or algal mat pieces, or lacked lining altogether.



Quantiles

maximum	100.0%	750.00
	99.5%	750.00
	97.5%	750.00
	90.0%	650.00
quartile	75.0%	387.50
median	50.0%	150.00
quartile	25.0%	52.50
	10.0%	18.00
	2.5%	15.00
	0.5%	15.00
minimum	0.0%	15.00

Moments

Mean	250.0000
Std Dev	234.2052
Std Error Mean	46.8410
Upper 95% Mean	346.6744
Lower 95% Mean	153.3256
N	25.0000
Sum Weights	25.0000

Figure 9. The graph and tables above describe the spatial relationship between Snowy Plover nests and the nearest body of standing water. As the tables reveal, the average estimated distance between Snowy Plover nests and the nearest standing water was 250 meters and the median distance was 150 meters. Nests ranged from 15 meters to 750 meters from water. The graph above the tables displays a histogram of the dataset. To the right of the graph is an outlier plot identifying the Inter Quartile Range (52.5 - 387.5) and the shortest half of the dataset (the most densely packed 50% of the observations).

#	Date	Age	Location[1]	Habitat[2]	USFWS[3]	LT[4]	RT[5]	# resightings
1	4/21/93	Chick	SPI	WA	1A; 971-65401	FWS, -	-, -	0
2	4/21/93	Chick	SPI	WA	1B; 1351-57301	FWS, -	-, -	0
3	4/21/93	Adult	SPI	WA	1B; 1351-57302	FWS, -	For, -	1
4	4/21/93	Adult	SPI	WA	1B; 1351-57303	For, -	FWS, -	0
5	4/22/93	Adult	BI	WA	1B; 1351-57304	FWS, Fdg	-, WHWH	2
6	4/22/93	Adult	BI	WA	1B; 1351-57305	FWS, Fdg	-, WHYL	0
7	4/23/93	Adult	LANWR	HF	1B; 1351-57306	FWS, Fdg	-, WHOR	7[6]
8	4/23/93	Adult	LANWR	HF	1B; 1351-57307	FWS, Fdg	-, WHRD	7[6]
9	4/25/93	Chick	SPI	WA	1B; 1351-57308	FWS, Fdg	-, WHDG	0
10	4/25/93	Chick	SPI	WA	1B; 1351-57309	FWS, Fdg	-, DB	0
11	4/25/93	Chick	SPI	WA	1B; 1351-57310	FWS, Fdg	-, RD	0
12	4/26/94	Chick	SPI	WA	1B; 1351-57311	FWS, Fdg	-, YL	3
13	4/11/94	Adult	BI	WA	1B; 1271-45531	FWS, For	-, RDDB	0
14	4/11/94	Adult	BI	WA	1B; 1271-45532	FWS, For	-, ORDG	0
15	4/11/94	Adult	BI	WA	1B; 1271-45533	FWS, For	-, RDWH	0
16	4/11/94	Adult	SB	HF	1B; 1271-45534	FWS, For	-, ORDR	0
17	4/20/94	Chick	SPI	WA	1B; 1271-45535	FWS, For	-, RD	1
18	4/22/94	Adult	LANWR	HF	1B; 1271-45536	FWS, For	-, DGOR	0
19	4/24/94	Adult	SPI	WA	1B; 1271-45537	FWS, For	-, BKWH	0
20	4/25/94	Adult	SB	WA	1B; 1271-45538	FWS, For	-, LBWH	0
21	4/26/94	Adult	SPI	WA	1B; 1271-45539	FWS, For	-, WHBK	0
22	4/26/94	Adult	SPI	WA	1B; 1271-45540	FWS, For	-, DGRD	0
23	4/26/94	Adult	SPI	WA	1B; 1271-45541	FWS, For	-, RDDG	0
24	4/26/94	Chick	SPI	WA	1B; 1271-45542	FWS, For	-, BK	0
25	4/26/94	Chick	SPI	WA	1B; 1271-45543	FWS, For	-, WH	0
26	5/26/94	Adult	MI	HF	1B; 1271-45544	FWS, For	-, DBOR	0
27	5/26/94	Chick	MI	HF	1B; 1271-45545	FWS, Fdg	-, GY	0
28	5/26/94	Chick	MI	HF	1B; 1271-45546	FWS, Fdg	-, YL	0
29	5/13/96	Adult	MI	HF	1B; 1271-45547	FWS, ForRD	-, DGOR	0
30	5/13/96	Adult	MI	HF	1B; 1271-45548	FWS, ForRD	-, DGBK	0
31	5/15/96	Adult	CB	HF	1B; 1271-45549	FWS, ForRD	-, RDDB	0
32	5/13/96	Adult	CB	HF	1B; 1271-45550	FWS, ForRD	-, RDBK	0
33	5/13/96	Adult	CB	HF	1B; 1271-45551	FWS, ForRD	-, DGDB	0
34	6/14/96	Adult	CB	HF	1B; 1271-45552	FWS, ForRD	-, RDYL	0
35	6/14/96	Adult	CB	HF	1B; 1271-45553	FWS, ForRD	-, RDWH	0

Table 6. Data associated with Snowy Plovers that were color banded are reported in this table. This table does not report some data collected in association with plovers that were banded on private property.

1. Location: The banding locations are reported very generally; BI = Brazos Island, CB = Coastal Bend mainland, MI = Mustang Island, SPI = South Padre Island, SB = South Bay.

2. Habitat: The habitats WA and HF correspond to the "washover pass" and "high flats" habitats, respectively, as described on the Bureau of Economic Geology Submerged Lands of Texas maps (see the Current Snowy Plover Breeding Distribution section of this report).

3. USFWS: This column identifies the number on the aluminum U.S. Fish and Wildlife Service band. The size of the band is described to the left of the semicolon, and the band number is described to the right of the semicolon.

4. LT: This column describes the locations of the color bands and colored flags as they were placed on the plover's left leg. The bands appearing before the comma were placed on the upper left leg, whereas those to the right of the comma were placed on the lower left leg. Color codes are as follows; Flags - For = orange, Fdg = dark green; color bands - BK = black, DB = dark blue, DG = dark green, GY = gray, OR = orange, RD = red, WH = white, YL = yellow; FWS = USFWS aluminum band. Bands are described in order from top down (e.g. plover #29 received an orange flag over a red band on its lower left leg).

5. RT: This column describes the locations of the color bands and colored flags as they were placed on the plover's right leg. The bands appearing before the comma were placed on the upper left leg, whereas those to the right of the comma were placed on the lower left leg. Color combinations and positions are as described for the left leg (see footnote #4).

6. Some of these resightings were recorded by Jeff Rupert, University of Texas Pan Am.

creating beach zones that are closed to vehicular traffic, or are not maintained using beach-scraping or beach-raking techniques, but are still open to the public).

Methods

To address Objective # 3, I established working relationships with several private landowners in the Texas Coastal Bend whose property supports Snowy Plover breeding populations, including those described below. Cooperative strategies are being pursued to encourage these landowners to conserve, create or restore habitat for plovers.

Texas Department of Transportation. The Texas Department of Transportation agreed to allow me to erect protective fencing to divert vehicular traffic away from an active Snowy Plover nesting colony (Figure 10). The fencing was introduced after the establishment of the nesting colony, and may have been more effective had it been introduced earlier in the year before nesting had begun. The effort will be repeated in the spring of 1997, but the fence will be installed before the breeding season has begun, and the fencing will completely encircle the area of optimal nesting microhabitat.

Central Power and Light Company. A small nesting colony was discovered within the cooling pond complex at a Central Power and Light (CP&L) power plant in Flour Bluff (Figure 11). This complex provides the shallow pool of water (habitat layer W on the Bureau of Economic Geology Submerged Lands of Texas maps) that appears to be an consistent component of many Snowy Plover breeding sites. I am proposing management steps that might be taken to improve the pond complex for Snowy Plovers in the coming years, and CP&L has expressed their willingness to support those actions that are 1) either externally funded or are reasonably inexpensive and 2) do not conflict with the normal operations of the power plant (R. Allen, environmental consultant for CP&L, pers. comm.). Several options exist, including the 1) manual removal of branches and other organic debris in some areas of the emergent habitat, 2) the expansion of potential shoreline nesting habitat, which might be accomplished by introducing crushed shell material or another well-draining substrate, or 3) the introduction of electric fencing to exclude mammalian predators. The latter 2 of these options have been used with some success in Snowy Plover Colonies in Oklahoma (Koenen et al. 1996).

Cooperative agreements are being pursued with several other landowners (that prefers to remain anonymous) that will encourage habitat improvements and adaptive management strategies benefiting Snowy Plovers and Piping Plovers without penalizing the landowner for any resulting increases in the population.

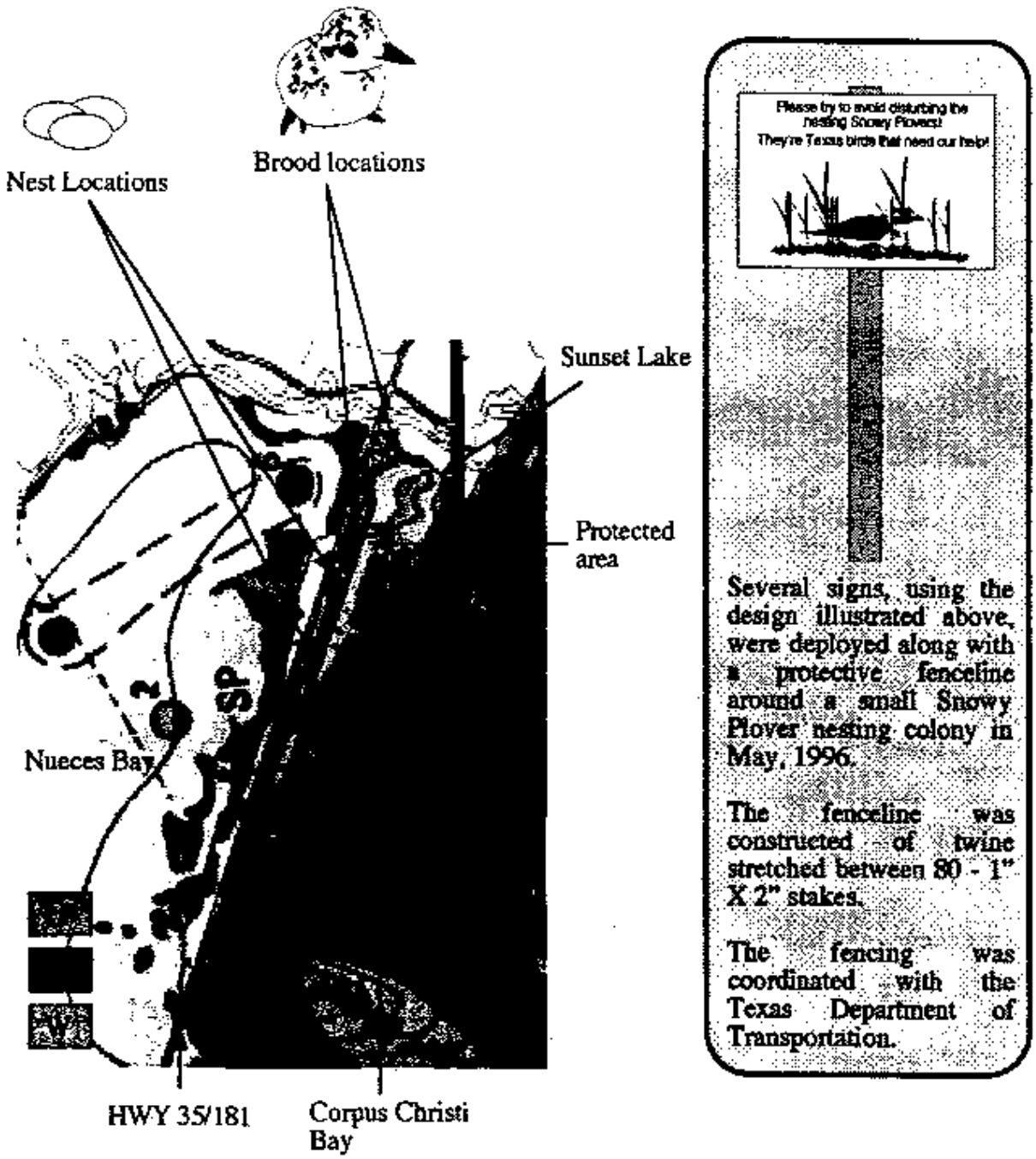
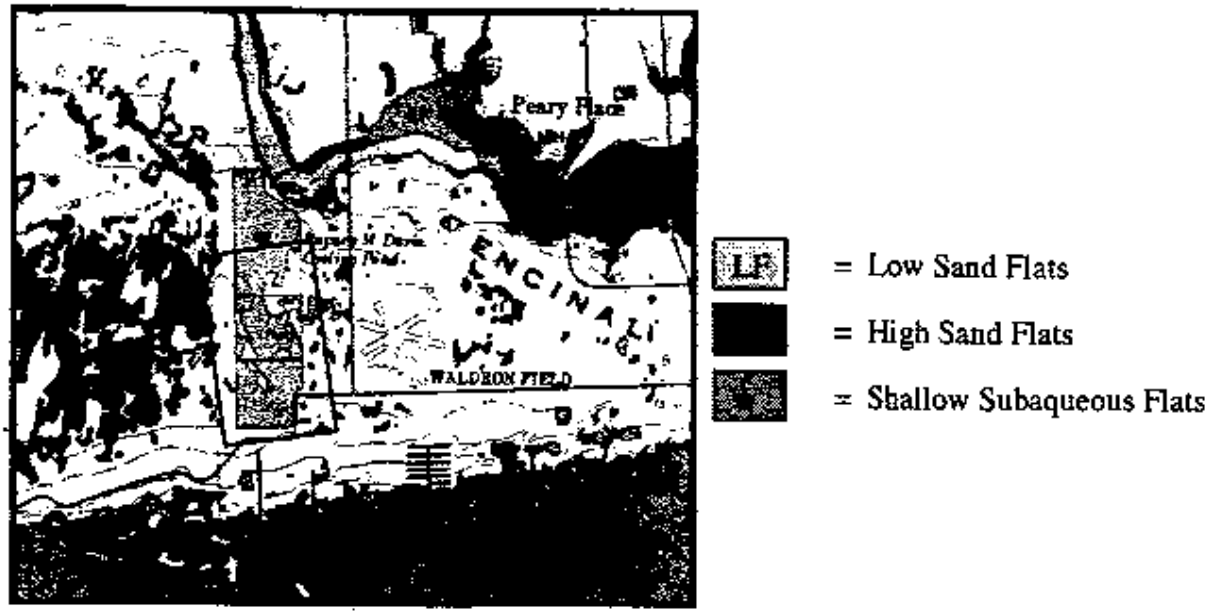
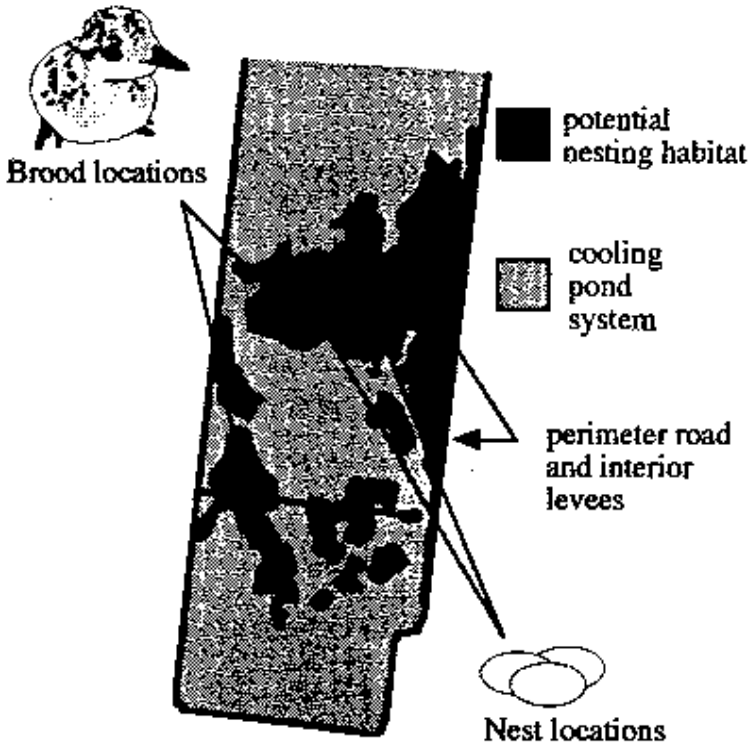


Figure 10. This figure illustrates a fencing project that was undertaken in May, 1996 to protect a small Snowy Plover nesting colony from vehicular traffic. The fencing was deployed with the help of an AmeriCorps student and an Audubon volunteer from Corpus Christi. Although the fencing did not exclude all vehicles (it only partially encircled the nesting area), it appeared to have reduced the amount of traffic through the nesting area - a gravel and shell embankment bordering the northbound lane of Highway 181/35 just south of Portland. One of the nests that was enclosed within the fence was later abandoned, however it is unlikely that the fencing caused the abandonment because it was erected very quickly, and an adult was observed to return to the nest and incubate the eggs several days after the fence line was erected. In the future, the fenceline will be erected in such areas before the start of the nesting season to reduce any possibility of disturbing nesting plovers, and the fenceline will completely encircle the area of nesting habitat.



a. Bureau of Economic Geology Submerged Lands map.

b. Aerial photo of complex.



c. Schematic of complex.

Figure 11. The figure above illustrates a) a portion of the 1983 Bureau of Economic Geology's "Distribution of Wetlands and Benthic Macroinvertebrates, Submerged Lands of Texas, Corpus Christi Area" map showing the wetland habitat types within the CPL cooling pond complex, b) an aerial photo of the inset from figure a) covering the eastern portion of the cooling pond complex, and c) a schematic diagram of the Eastern portion of the cooling pond complex illustrating potential Snowy Plover nesting habitat. The eastern portion of the cooling ponds exhibited the habitat that was most suitable for nesting snowy plovers.

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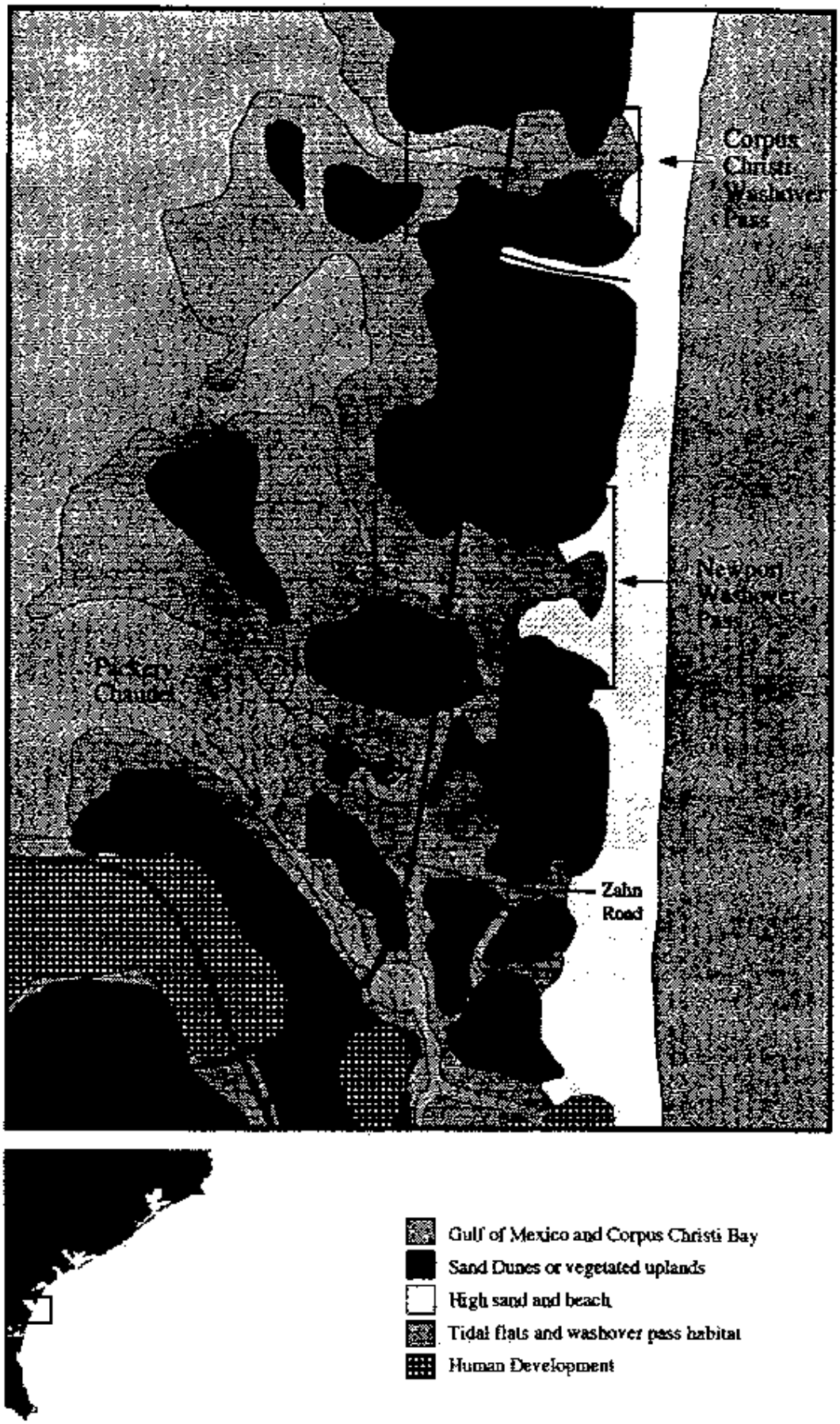

Figure 2. A schematic diagram of the juxtaposition of Mustang Island and North Padre Island is presented to illustrate the locations of the 2 washover passes from this coastal region (Corpus Christi Pass and Newport Pass) monitored during this study.