COLLIER COUNTY
COMMUNITY DEVELOPMENT AND
ENVIRONMENTAL SERVICES DIVISION

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COLLIER COUNTY
SEA TURTLE PROTECTION PLAN

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Prepared by
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ABSTRACT

Collier County was responsible for the daily survey of 22.1 miles (35.6 km) of beach for sea turtle activities during the 2000 sea turtle season (May through October). The Collier County Natural Resources Department (NRD) surveyed 15.4 miles (24.7 km) of beach including Barefoot, Vanderbilt, Park Shore, and Marco Island. The NRD documented 467 nests during the Year 2000, a decrease from 591 nests in 1999. Under contract to Collier County, the Conservancy of Southwest Florida (CSWF) documented 68 nests on the 5.6 mile (9.0 km) Naples Beach. Delnor Wiggins Pass State Recreation Area reported 17 nests on the one mile beach within the park.

Evaluations of emergences on renourished beaches showed an initial decrease in nesting success following the renourishment with gradual increases thereafter. The nesting success is significantly higher on natural beaches than renourished beaches. The data shows it is not until 4 years after renourishment that the ratio of nests to false crawls returned to that of natural beach areas.

During the 2000 nesting season, 2.7% (15) of the documented nests were disoriented (approximately 895 hatchlings), a decrease from 4.6% (27) disoriented nests in 1999. Storms inundated 25% of the nests (140) and 5% (27) of the nests were washed away. Fifteen percent (81) of the nests were depredated, an increase from 12% (71) in 1999. Raccoons (*Procyon lotor*), gray foxes (*Urocyon cinereoargenteus*), fire ants (*Solenopsis invicta*), and unknown predators were the most prevalent predators of sea turtle eggs and hatchlings. A total of 38,391 hatchlings were estimated to have reached the Gulf of Mexico from Barefoot, Delnor Wiggins, Vanderbilt, Park Shore, Naples, and Marco Island beaches.

The number of strandings in Collier County in 2000 (108) was significantly higher than 28 in 1999 and represents a 415% increase from the past five year average of 26 per year. Seventy-four loggerheads (*Caretta caretta*), 29 Kemp's ridleys (*Lepidochelys kempi*), 3 green turtles (*Chelonia mydas*), 1 hawksbill (*Eretmochelys imbricatai*), and 1 unidentified turtle were recorded as stranded on Collier beaches from January through December, 2000.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
ATV	All Terrain Vehicle
CCCL	Coastal Construction Control Line
CITES	Convention of International Trade in Endangered Species of Wild Fauna and Flora
CSWF	Conservancy of Southwest Florida
DNA	Deoxyribonucleic Acid
DNR	Department of Natural Resources
FDACS	Florida Department of Agriculture and Consumer Services
FPL	Florida Power and Light
FWC	Florida Fish and Wildlife Conservation Commission
GPS	Global Positioning System
HWL	High Water Line
IUCN	International Union for the Conservation of Nature and Natural Resources
NAD	North American Datum
NERR	National Estuarine Research Reserve
NMFS	National Marine Fisheries Service
NOV	Notice of Violation
NRD	Collier County Natural Resources Department
P&R	Collier County Parks and Recreation Department
PSA	Public Service Anouncement
SRA	State Recreation Area
STSSN	Sea Turtle Stranding and Salvage Network
TED	Turtle Exluder Devices
USFWS	United States Fish and Wildlife Service

SECTION I

INTRODUCTION

Sea turtles have inhabited the earth for millions of years. They are believed to have evolved from marsh dwelling species that existed between the Upper Triassic and the Jurassic periods (190 –135 million years ago). Fossil records indicate an early transition from the marsh into the marine environment. By the Cretaceous period (65 million years ago) four families of sea turtles were distributed throughout the oceans of the world (Pritchard, 1979). Today marine turtles are limited to two families; Cheloniidae (six species) and Dermochelyidae (one species) (National Research Council, 1990).

Sea turtles are air-breathing reptiles that emerge from the sea and deposit their eggs on tropical and subtropical beaches around the world. The loggerhead sea turtle (*Caretta caretta*) is the most abundant sea turtle species nesting in Collier County. Loggerheads, named for their disproportionately large head, emerge on Florida's beaches from May through August to lay their eggs. Clutches, containing an average of 100 eggs, incubate for approximately two months before hatchlings, less than two inches in length, emerge and head to the water. Within 12 to 30 years these turtles will reach sexual maturity and return to the beach to lay eggs every two to four years. It is estimated that only one hatchling in 1,000 will survive to repeat this cycle.

All but one species of sea turtle [Australian flatback (*Natator depressus*)] is listed as endangered and/or threatened by one or more of the following agencies: U.S. Fish and

Wildlife Service (USFWS), Florida Fish and Wildlife Conservation Commission (FWC), and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Furthermore, the loggerhead sea turtle is classified by the International Union for the Conservation of Nature and Natural Resources [IUCN (although without statutory authority)], as a 'vulnerable' species (Groombridge, 1982). Extensive exploitation by man for food, leather, decorative pieces, cosmetics and other uses, as well as incidental catch by commercial fisheries have drastically decreased populations of all remaining sea turtle species.

Coastal development and natural erosion have significantly reduced the number of suitable nesting beaches. Developed beaches used by nesting sea turtles can become hazardous to emerging hatchlings. Human disturbances on nesting beaches include: human activity, artificial lighting, erosion induced by shoreline hardening with seawalls, rock revetment, beach renourishment, vehicular traffic on or near the beach, beach raking, pollution, shading of beaches by large buildings and exotic vegetation, beach furniture and recreational accessories, as well as egg and hatchling predation associated with human activities (Carr and Ogren, 1960; Daniel and Smith, 1947; Dickerson and Nelson, 1989; Mann, 1978; Mortimer, 1987; Mortimer and Portier, 1989; Moulding and Nelson, 1988; National Research Council, 1990; Nelson, 1988; Nelson, 1991; Nelson and Dickerson, 1989; Nelson *et al*, 1987; Raymond, 1984b; Salmon and Wynekin, 1990; Schmeltz and Mezich, 1988; Witherington, 1990; Witherington, 1991; Witherington and Bjorndal, 1991). Sea turtles have encountered some or all of these problems on many of Florida's beaches, including Collier County. As human activity and development on

nesting beaches increases, a more complete understanding of the plight of the sea turtle must be developed so that remedial actions can be taken.

Collier County is responsible for surveying 22.1 miles (35.6 km) of beach for sea turtle activities. The Natural Resources Department (NRD) monitored 15.6 miles (24.7 km) of shoreline on Barefoot, Vanderbilt, Park Shore, and Marco Island Beaches. The remaining 5.6 miles (9.0 km) of beach in the City of Naples is subcontracted to the Conservancy of Southwest Florida (CSWF). Delnor Wiggins Pass SRA surveys approximately 1 mile of beach within the park boundary. The surveyed beaches not included in this report are Keewaydin Island (monitored by the CSWF), Cape Romano Complex (monitored by the NRD), Cannon and Sea Oat Islands (monitored by Florida Department of Environmental Protection), and the Ten Thousand Islands National Wildlife Refuge (monitored by the USFWS).

The purpose of the Collier County Sea Turtle Protection Program is to protect nests and collect data on sea turtle nesting and hatching activities in order to fulfill permit requirements for beach raking and beach renourishment. Protecting sea turtle nests also allows beachfront property owners to obtain permits for certain activities seaward of the State Coastal Construction Control Line (CCCL) during nesting season.

This report details the methods established by the NRD based on Florida Department of Environmental Protection monitoring guidelines (FDEP, 1996). The report includes an analysis of sea turtle emergences, effects of beach renourishment, historical trends, nesting and hatching, depredation, disorientations, beach lighting, strandings, and public awareness. Program research and management recommendations are also provided.

SECTION 2

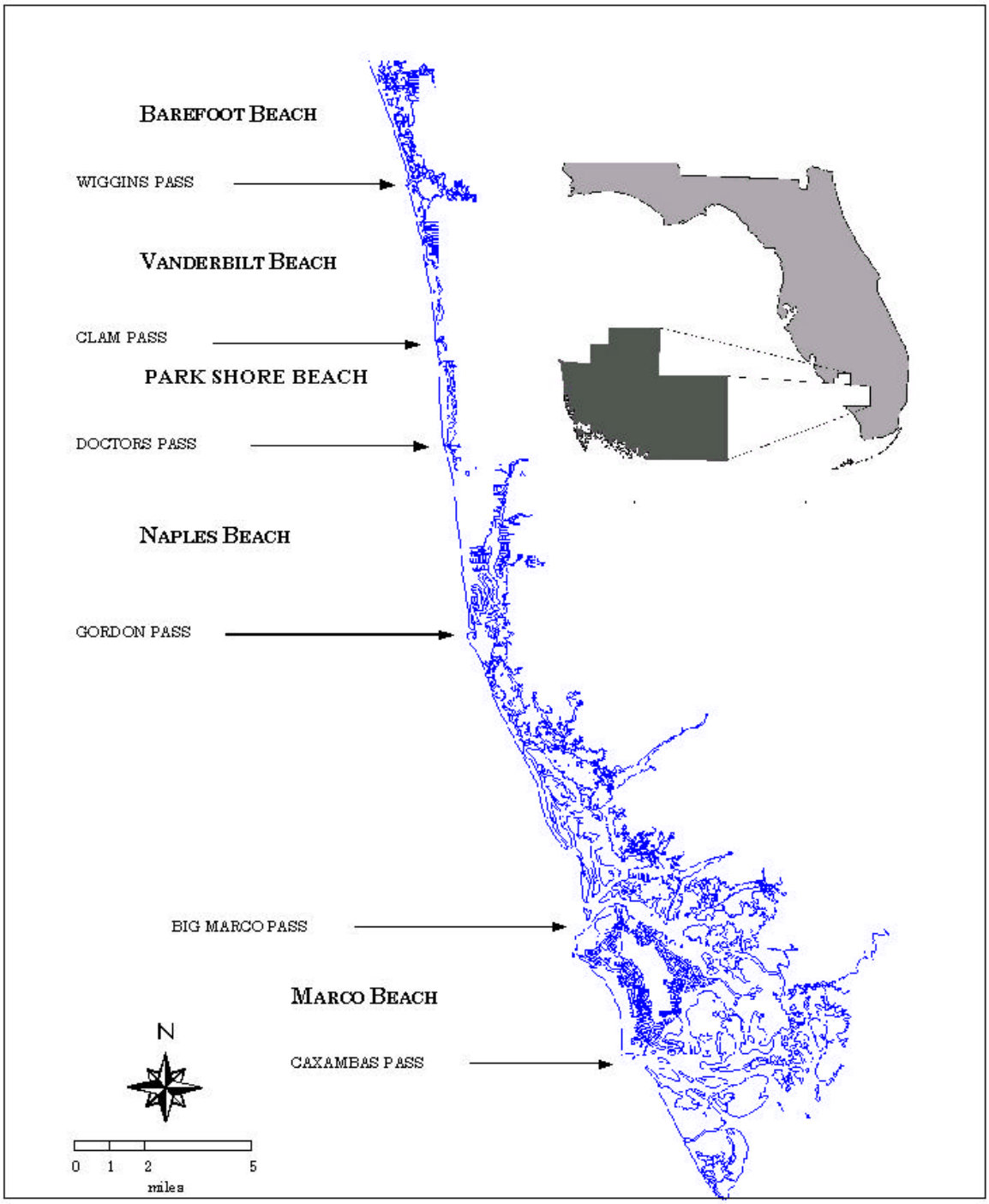
SEA TURTLE MONITORING PROGRAM

2.1 STUDY AREA

Collier County, Florida is the southern terminus of the southwest barrier island chain that begins at Anclote Key in Pasco County, 175 miles (282 km) to the north. The Collier barrier island coastline extends 37 miles (60 km) from the Lee/Collier County line, southward to Cape Romano. The beaches comprise a wide variety of physiographic types including a coastal headland, barrier beach ridge, barrier islands, migrating overwash ridges and a coastal cape. Ten major barrier beach units are recognized in the County, separated by nine tidal passes. Five of the ten coastal barrier units are surveyed daily (May 01 – October 31) for sea turtle activities including, Barefoot, Vanderbilt (including Delnor-Wiggins Pass State Recreation Area), Park Shore, City of Naples, and Marco Island Beaches (Figure 2.1.1).

Since 1990, beach renourishment activities have occurred in Collier County. The following sections outline the year (1990 – 2000), DNR location, and sand source (mechanical, hydraulic, or upland) for each renourishment event. Mechanical sand is excavated from a pass, stockpiled and placed onto the beach. Hydraulic sand is transported by pipe from an offshore sand source with seawater as a transport medium. Upland sand is trucked from an inland quarry source and spread onto the beach.

Figure 2.1.1. Collier County Surveyed Beaches, 2000.



2.1.1 Barefoot Beach

The northern most beach unit in Collier County, Barefoot Beach, encompasses approximately three linear miles (4.8 km) of barrier beach, from the County line south to Wiggins Pass (DNR monument R-01 to R-16). The Barefoot Beach unit is surveyed for sea turtle activities as part of the Wiggins Pass Inlet Management Plan and to assist in the permitting process for the maintenance of Wiggins Pass. Table 2.1.1.1 summarizes the renourishment history of Barefoot Beach since 1990.

Table 2.1.1.1. Barefoot Beach Renourishment History.

Year	DNR Location	Sand Source	Cubic Yards	Linear Feet of Beach
1990	R-13 to R-14	Hydraulic	33,460	1000
1991	250' North R-13 to 30' North R-15	Hydraulic	34,010	2,264 ft
1998	R-12.5 to R-13.5	Hydraulic	11,980	913 ft

2.1.2 Vanderbilt Beach / Delnor Wiggins Beach

The Vanderbilt Beach coastal barrier unit includes 4.7 miles (7.6 km) of beach from Wiggins Pass south to Clam Pass (DNR monument R-17 to R-41A). The northern most mile of the Vanderbilt Beach unit, Delnor Wiggins Pass State Recreation Area (R-17 to R-22.5) is surveyed for sea turtle activities by park staff. The data from Delnor Wiggins is included in this report. Vanderbilt Beach is surveyed for sea turtle acitivities as part of permit requirements for beach restoration and beach raking. Table 2.1.2.1

summarizes the renourishment activity of Vanderbilt Beach and Delnor Wiggins Pass State Recreation Area since 1990.

Table 2.1.2.1. Vanderbilt Beach and Delnor Wiggins Renourishment History.

Year	DNR Location	Sand Source	Cubic Yards	Linear Feet of Beach
1994	R-18 to R-19 (Delnor Wiggins Pass SRA)	Hydraulic	35,250	1,000 ft
1995	R-19 to R-20 (Delnor Wiggins Pass SRA)	Hydraulic	46,580	1,000 ft
1996	100' North R-22.5 to R-29 R-29 to 50' South of R-30.5 R-40 to R-41 (N of Clam Pass)	Hydraulic Upland Mechanical	322,800 3,000 4,500	7,490 ft 1,588 ft 1,000 ft
1998	R19 to R20 (Delnor Wiggins Pass SRA)	Hydraulic	19,550	1,000 ft
2000	R-18 South 850 ' (Delnor Wiggins Pass SRA)	Hydraulic	16,960	850

2.1.3 Park Shore Beach

The Park Shore coastal barrier unit extends 3.2 miles (5.1 km) south from Clam Pass to Doctors Pass (DNR monument R-41A to R-57). Clam Pass Park is approximately 2,000-ft (610 m) from the pass to the Naples Cay development (R-42 to R-44). Park Shore Beach is monitored for sea turtle nesting activities as part of beach renourishment and beach raking permit requirements. Table 2.1.3.1 summarizes the renourishment history of Park Shore Beach.

Table 2.1.3.1. Park Shore Beach Renourishment History.

Year	DNR Monument	Sand Source	Cubic Yards	Linear Feet of Beach
1995	Clam Pass to R-43.5	Mechanical	4,500	2,889 ft
1996	Clam Pass to R-42.5	Mechanical	6,000	1,788 ft
	350’ South R-50 to 350’ North R-54	Hydraulic	90,700	3,589 ft
1997	Clam Pass to R-42.5	Mechanical	6,000	1,788 ft
	350’ North R-48 to 350’ South R-50	Mechanical	8,000	2,751 ft
1998	Clam Pass to 143’ North R-45	Mechanical	8,000	4,208 ft
1999	Clam Pass to 270’ North R-42	Mechanical & Hydraulic	3,500	310 ft
	430’ South R-42 to 250’ South R-43.5	Hydraulic	26,500	1,365 ft

2.1.4 City of Naples

The City of Naples unit encompasses approximately 5.6 miles (8.8 km) of shoreline from Doctors Pass south to Gordon Pass (DNR monument R-57A to R-89). The Naples Beach is monitored for sea turtle activities by the Conservancy of Southwest Florida, contracted by the County, as part of the Beach Renourishment Program permit requirements. Naples Beach monitoring results are included in this report and also in an annual report by the Conservancy of Southwest Florida. Table 2.1.4.1 summarizes the renourishment history of Naples City Beach.

Table 2.1.4.1. Naples Beach Renourishment History.

Year	DNR Location	Sand Source	Cubic Yards	Linear Feet of Beach
1996	Doctors Pass to 350' north of R-78	Hydraulic	759,150	18,253 ft
	R-69A to R-72	Upland/Hydraulic	55,000	2,438 ft
1998	R-69A to R-72	Upland	8,820	2,438 ft
	R-75 to 400' South R-76	Upland/Hydraulic	6,696	1,213 ft
1999/ 2000	500' north of R-63 to R-64 (Naples Beach Club)	Upland	8,036	1,500 ft.
	Doctors Pass to R-58	Upland	6,804	1,000 ft.
2000	R-88 to R-89	Upland (Big Island)	6,000	1,000 ft.

2.1.5 Marco Island Beach

The Marco Island coastal barrier unit encompasses 5.6 miles (8.8 km) of beach, from inside Big Marco Pass [Hideaway Beach (DNR monument H16 to H1)] south to Caxambas Pass (DNR monument R-131 to R-148). Marco Island is a highly developed beach with high-rise condominiums and hotels. Marco Island has been monitored for sea turtle activities since 1990 as part of the permit requirements for beach renourishment and raking. Table 2.1.5.1 summarizes the renourishment history for Marco Island.

Table 2.1.5.1. Marco Island Beach Renourishment History.

Year	DNR Monument	Sand Source	Cubic Yards	Linear Feet of Beach
1990	H-3 to H-7 (Hideaway) R-136A to R-138A R-142A to R-148	Hydraulic Hydraulic Hydraulic	70,000 284,600 715,400	2,063 ft 2,189 ft 5,533 ft
1997	130’ South H-9 to 45’ South H-11 370’ South H-1 to 131’ South -H3 (Hideaway) R145A to R148	Upland Upland Upland	1,000 4,000 80,000	1,345 ft 1,636 ft 1,781
1998	H9 to H11 (Hideaway) 400’ South H1 to H2 (Hideaway)	Upland Upland	15,000 10,000	1,250 ft 900 ft
1999	H1 to H3 (Hideaway) R148 to Caxambas Pass	Upland Upland	3,528 9,000	985 ft 625 ft
2000	200’ NE of H1 to H3 (Hideaway)	Upland (B.I.) Hydraulic	3,600 2000	950 ft

2.2 METHODS AND MATERIALS

2.2.1 Reconnaissance Surveys and Beach Zoning

Pre-season reconnaissance surveys of the monitored beaches were conducted in April. Aerial reconnaissance surveys were conducted by helicopter in addition to ground truthing. The objective of the survey was to develop daily monitoring strategies, note the condition of the beaches, and zone the beaches for management purposes.

Wooden stakes were marked with the corresponding DNR monument numbers and placed within the dune area at approximately 500-ft (152 m) increments from the Lee/Collier County line south through Marco Island. Beaches were measured along the high tide line using a Rolatape survey wheel.

As required by the FWC for purposes of beach renourishment, eleven Onset Pro Hobo Temperature Recorders were placed at a depth of 45cm approximately 10 feet from the vegetation line on Vanderbilt, Park Shore, and Naples Beach. These instruments recorded the sand temperature every hour from May 15 to September 15. The recorders were retrieved early in September to avoid losing them during Hurricane Gordon.

2.2.2 Daily Monitoring

Prior to beach raking, daily surveys for emergence activity was performed along the high water line (HWL) utilizing All-Terrain-Vehicles (ATVs) with low pressure tires. Upon discovery of an emergence, staff visually determined if the emergence resulted in a nest or a false crawl (non-nesting emergence). Nests and false crawls were sequentially numbered and mapped on 1:100 or 1:200 scale aerial photographs. Characteristics and measurements of the emergences were recorded on data sheets for evaluation (Fig.

2.2.2.1 and Fig. 2.2.2.2). A GPS unit was taken to each beach weekly so that every emergence location could be recorded for mapping.

All nests were marked with stakes, flagging tape, and a sign to provide protection and facilitate evaluations. Four, 36-inch (91 cm) wooden stakes were placed in the corners of the disturbed area. Yellow "caution" or "restricted area" ribbon was then placed around the stakes and a "sea turtle nest" sign (Figure 2.2.2.3) was affixed to alert, and direct, beach rakers and the public away from the nests.

Nests laid in areas known for high predation were covered with a protective screen. Nest screening was applied on undeveloped portions of Barefoot, Vanderbilt and Park Shore Beach. Screening involved anchoring a "self-releasing", 4-ft by 4-ft (1.2m X 1.2m) wire mesh screen over the clutch with metal tent stakes. The screen openings (2" X 4") were large enough to allow the natural escape of hatchlings, but were small enough to prevent depredation. Screened nests were observed on a daily basis for evidence of predation. If a raccoon disturbed the sand under the screen, the sand was replaced, the area flattened out, and the event recorded. If fire ants were observed, they were gently swept off the nest.

Figure 2.2.2.1. Sea Turtle Nesting Form, 2000.

Nesting & Hatchling Data Form 2000

NEST #_____

GPS REF #_____

Nesting Data

Date_____ Species_____

Did You Verify?: Yes or No

DNR Location: _____

Establishment_____

Renourished* or Natural

Distance(ft) from:

MHW_____ Vegetation / Structure_____

Structure Type: _____

Scarp: No or Yes : Height_____ : Sloped or Vertical

Length_____ Crawl over scarp: Yes or No

Site material: ____% Sand _____% Shell _____% Vegetation

Nest cover: Full sun Partial shade Total shade

Relocated: Yes or No

If Relocated, Why:_____

Screened / Caged: No or Yes Date:_____

Investigator_____

Egg Chamber Data

A. Hatched eggs (1+2+3) ☐

1. Emerged _____2. Alive_____3. Dead_____

B. Unhatched eggs (4+5+6) ☐

4 Undeveloped_____5.Dead embryo_____6.Dep._____

C. Pipped eggs (7+8) ☐

7. Dead _____ 8. Alive _____

D. Total Eggs (A+B+C) ☐

E. Hatching Success (A / D) ** ☐

F. Emergence Success (1 / D)** ☐

Nest Material: _____% Sand ____% Shell _____ % Root

*Include total depredated from the back of this page.
** To be completed in office

Renourishment Data*

Year of Renourishment: _____

Type of Sand: Upland Hydraulic Mechanical

Eggs deposited in renourished sand: Yes or No

Sand sample taken from chamber: Yes or No

Embryo Stages

30 _____ **29** _____ **28**_____

27 _____ **26** _____ **25**_____

24 _____ **23** _____ **22**_____

21 _____ **< 21** _____

Undetermined _____

Emergence Data

Expected Date_____Actual_____

Incubation_____Date excavated_____

Clutch Depth(in)_____Width_____

Investigator_____

Disoriented Hatchlings: _____ Date: _____

Dead _____ # Alive _____ Source _____

DEP Form filled out? Yes or No

Crawl Diagram
* Draw scarps!

Figure 2.2.2.2. False Crawl Form, 2000.

Crawl # _____ GPS Ref _____

Date: _____ Species _____

Pitting: No or Yes Egg Cavity: No or Yes

Of Egg Cavities _____ Depths _____

DNR Location: _____

Establishment: _____

Natural Upland Hydraulic Mechanical

Renourishment Year _____

Feet From : MHW _____ Vegetation / Structure _____

Structure Type: _____

Site Material: Sand Shell Vegetation

Scarp: No or Yes : Height _____ : Sloped or Vertical

Scarp Length: _____ Crawl over scarp Yes or No

Investigator: _____

Describe Any Possible Reasons For False Crawl:_____

_____

_____

Crawl Diagram:

Crawl # _____ GPS Ref _____

Date: _____ Species _____

Pitting: No or Yes Egg Cavity: No or Yes

Of Egg Cavities _____ Depths _____

DNR Location: _____

Establishment: _____

Natural Upland Hydraulic Mechanical

Renourishment Year _____

Feet From : MHW _____ Vegetation / Structure _____

Structure Type: _____

Site Material: Sand Shell Vegetation

Scarp: No or Yes : Height _____ : Sloped or Vertical

Scarp Length: _____ Crawl over scarp Yes or No

Investigator: _____

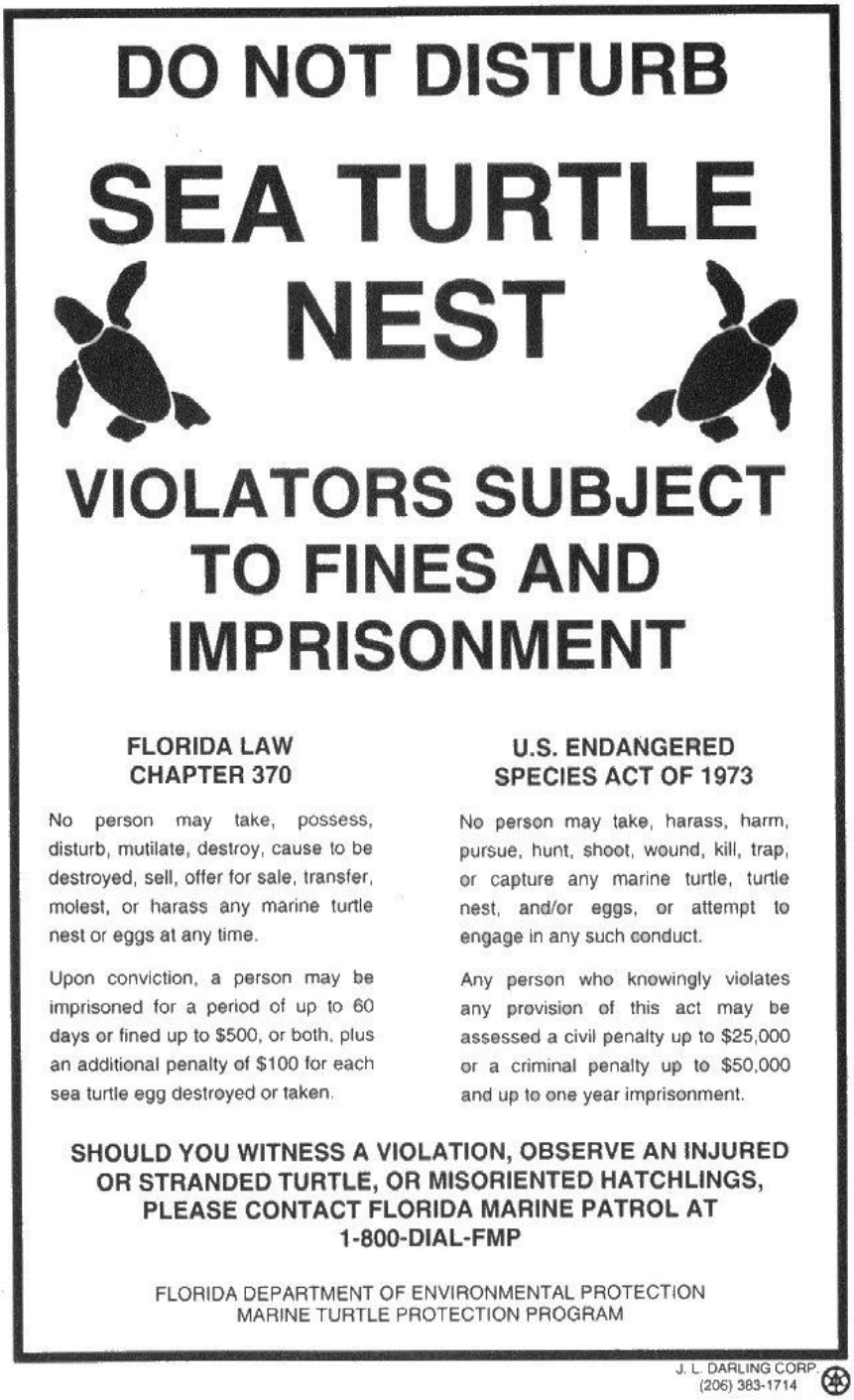
Describe Any Possible Reasons For False Crawl:_____

_____

_____

Crawl Diagram:

Figure 2.2.2.3. Sea Turtle Nesting Area Sign.



2.2.3 Nest Monitoring and Evaluation

Daily monitoring for hatched nests began as the first nest approached its expected hatch date (approximately 50 days). All nests were observed for signs of hatching, such as an obvious depression in the sand or hatchling tracks around the nest. Nests were excavated for success evaluations approximately 72 hours following signs of the first emergence or, in the case of unhatched nests, 70 days from deposition or 80 days if the nest was inundated with water.

Excavation included removing all contents from the egg cavity by hand. The depth of the egg cavity was measured and recorded. Data from the nest evaluations are recorded on Natural Resources Department "Nesting Data Forms" (Figure 2.2.2.1). Empty shell contents accounted for live hatchlings that escaped from the nest, live turtles found within the nest, and dead turtles found within the nest. Unhatched eggs included undeveloped eggs, dead embryos, and eggs depredated prior to hatching. Pipped eggs referred to hatchlings (dead or alive) that puncture the shell but did not fully emerge out of the shell. Unhatched eggs were opened and inspected to determine the stage of development at the time of death. If live hatchlings were found in the nest, they were either released immediately or transferred to a bucket of moist sand for night release, depending on the presence of predatory birds in the area. Hatchling releases were conducted according to FWC guidelines (FDEP, 1996).

Nests were also inspected for evidence of fire ants. If fire ants are noticed, the information is recorded. The collection of fire ant data aids in quantifying and determining the extent of ant predation on hatchlings in Collier County.

2.2.4 Data Analysis

Sea turtle emergence and hatchling data were compiled using the relational database, Microsoft Access. Maps were produced using AUTOCAD, ArcCAD, and Microsoft Publisher. Shoreline and monument points were based on North American Datum (NAD) 1927 and then converted to NAD 1983, Florida State Plane Coordinate East Zone. Shoreline data and emergence locations were collected with a Trimble GeoExplorer Global Positioning System (GPS). Sand temperature data was downloaded and analyzed using Boxcar Pro 3.51 software. Graphs and plots were created using Microsoft Excel.

Data were compared for all monitored beaches through single factor analysis of variance (ANOVA) testing. Relationships between beach characteristics were analyzed using t-test; Mann-Whitney Rank Sum test in the case of Normality Test failure. Significance determinations were made at the $P<0.05$ probability level. Data was analyzed with IBM compatible PCs utilizing Microsoft Excel and Microsoft Access.

Data was analyzed at each study area for factors relating to both nest and hatching characteristics. Nesting factors included nests per emergences (nest success), emergence per mile (e/mi.), and nest placement characteristics. Factors relating to hatching success included cavity depth, incubation duration, egg counts, inundation, and depredation. Linear regression analysis was used to search for any factors directly affecting hatching success. Plots were prepared showing comparisons between and within study areas. Comparisons among beach types were based on emergences, historical trends, seasonal timelines, emergence distributions, egg counts, clutch characteristics, crawl distances and predation.

2.3 RESULTS AND DISCUSSION

2.3.1 Emergences

The first adult sea turtle emergence was recorded on April 29, 2000 and the last on August 10, 2000. A total of 1,113 emergences (552 nests and 561 false crawls) were identified along the 22.1 miles (35.6 km) of the daily surveyed shoreline. A breakdown of emergence activity for each beach is listed in Table 2.3.1.1. Maps showing emergence location by beach are included in the Appendix.

Table 2.3.1.1. Collier County Nests and False Crawls, 2000.

	Barefoot	Delnor Wiggins	Vanderbilt	Park Shore	Naples	Marco	Total
Total Nest	96	17	167	154	68	50	552
Total False Crawls	85	32	136	186	70	52	561
Total Emergences	181	49	303	340	137	102	1,113
Nesting Success	53%	34%	55%	45%	49%	49%	50%

A comparison of nests and false crawls for each beach segment is given in figure 2.3.1.1. Table 2.3.1.2 gives a breakdown of emergences per mile on each beach. Park Shore Beach recorded the most sea turtle activity with an average of 101 emergences per mile. Marco Island received the least activity with an average of 18 emergences per mile.

Figure 2.3.1.1 Sea Turtle Emergences in Collier County, 2000.

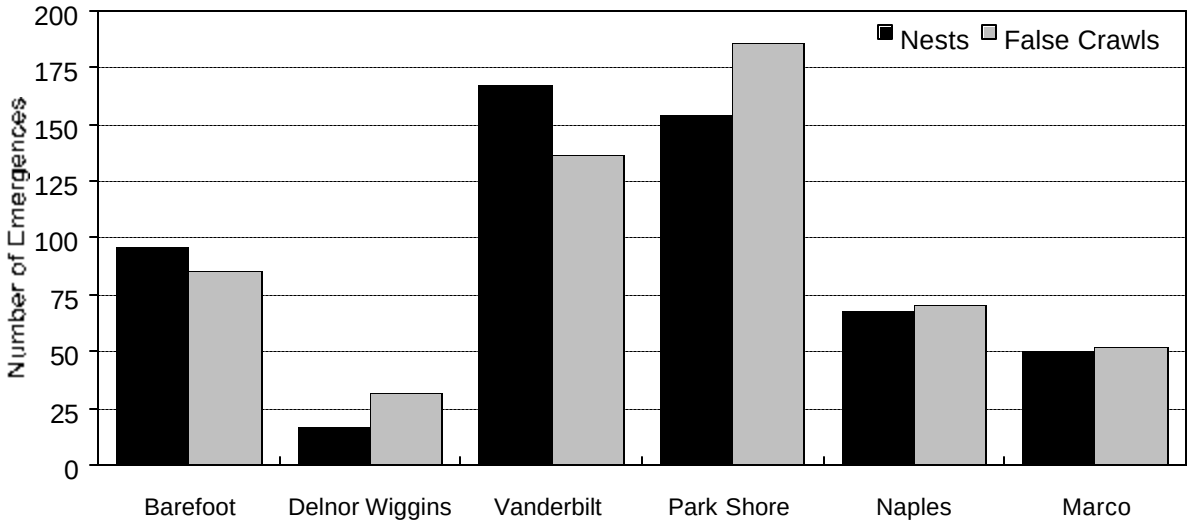


Table 2.3.1.2. Emergences, 2000.

	Barefoot	Delnor Wiggins Pass	Vanderbilt	Park Shore	Naples	Marco
Beach Length (mi.)	3.1	1.2	3.5	3.2	5.6	5.6
Emergences / mi.	59	41	87	108	25	18
Nests / mi.	31	14	48	49	12	9
False Crawls / mi.	28	27	39	59	13	9

The above table shows a large variety of emergences per mile and nests per mile between the beaches. This variation is difficult to explain since nest-site selection by the female turtles is still poorly understood. Some important factors include, but are not limited to, beach compaction, artificial lighting, human activity, structures on the beach, and scarps.

Above normal beach compaction can impede nest excavation contributing to the rejection of a nesting site, thus increasing the number of false crawls and false digs on renourished beaches (Raymond, 1984a; Nelson, 1991). The "presence" of lights in beach areas has been found to "sharply reduce" the number of sea turtles that emerge to nest (Witherington, 1991). Human activities on the beach can also contribute to the disruption of nest site selection by adult sea turtles (LeBuff, 1990; Kraus, 1992). Obstacles in the paths of emerging turtles may contribute to the failure of a nesting attempt. These obstacles include, but are not limited to, scarps, beach furniture, seawalls, boardwalks, stairs, fences, pilings, groins, sand castles, sand pits, and Australlian Pine trees.

Abandoned nesting attempts are a common occurrence for loggerheads and have been recorded at all nesting beaches (Dodd, 1988). Raymond (1984b) reported that on natural beaches 46% to 49% of emergences resulted in false crawls. The 561 false crawls in Collier County represent 50% of the total emergences. However, when the six locations are analyzed individually (Table 2.3.1.1), Delnor Wiggins and Park Shore exceed the expected percentage with 65%, and 55% of emergences resulting in false crawls, respectively.

It is possible that a limited number of false crawls occur from the female's instinctive preferences for a specific site. These are false crawls not provoked by human

disturbance and interference, but by physical factors such as temperature, sand composition, and possibly other unknown characteristics. The abnormal false crawl ratio on Park Shore may include several causes such as human disturbances, seawalls, scarps, non-beach compatible sand, stairs, boardwalks, fences, and lights. Although there are well established dunes along much of the beach, beach property lights precludes the protective benefit dunes create in blocking the light. The above normal false crawl ratio for Delnor Wiggins Pass SRA cannot be fully explained, however some causes may include scarps, human activity at night, and dredging noise and lights.

2.3.2 Effects of Beach Renourishment

Figure 2.3.2.1 compares the 2000 nests and false crawls per mile on natural and renourished beach areas on the combined beaches of Barefoot, Vanderbilt (including Delnor Wiggins Pass SRA), Park Shore, Naples, and Marco Island. The data shows a nesting preference for natural (non-renourished) beach over renourished beach. There is a significant difference ($p=0.09$, $df=5$) between the 27.8 nests per mile on natural beach and the 21.5 nests per mile on renourished beach.

Nests per mile and false crawls per mile showed a significant drop-off in areas from the most recent renourishment (1^{st} year renourishment). After the first year, there is a significant positive correlation ($r=0.31$, $df=11$, $t=0.56$) between nests per mile and the amount of time after the beach renourishment (Figure 2.3.2.2). On natural beach areas the ratio of false crawls to nests was roughly 2:3; whereas the ratio on the first year renourished beach was roughly 2:1. This marked increase in the ratio of false crawls to nests is still evident 3 years after renourishment, but four years after renourishment the

nesting improves to that of natural beach. Dodd (1998) reported that loggerhead sea turtle nest site selection may be influenced by "micro-habitat cues" that initiate the nesting process. The increase in false crawls on renourished beaches implies the renourished beaches may change the micro-habitat enough to disrupt the natural "cues", or there may be other factors at work. Based upon the analysis, future renourishment projects may best be designed to minimize impacts on nesting turtles by allowing a minimum number of years before subsequent renourishment. This additional time is needed to ensure the recovery of nesting densities on renourished beaches.

Figure 2.3.2.1. Renourished Versus Natural Beaches, 2000.

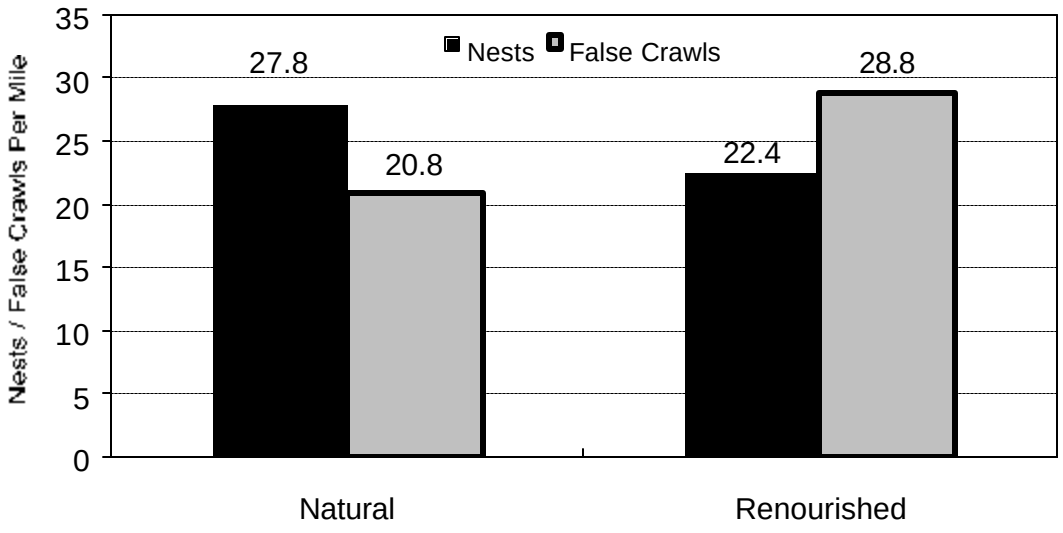
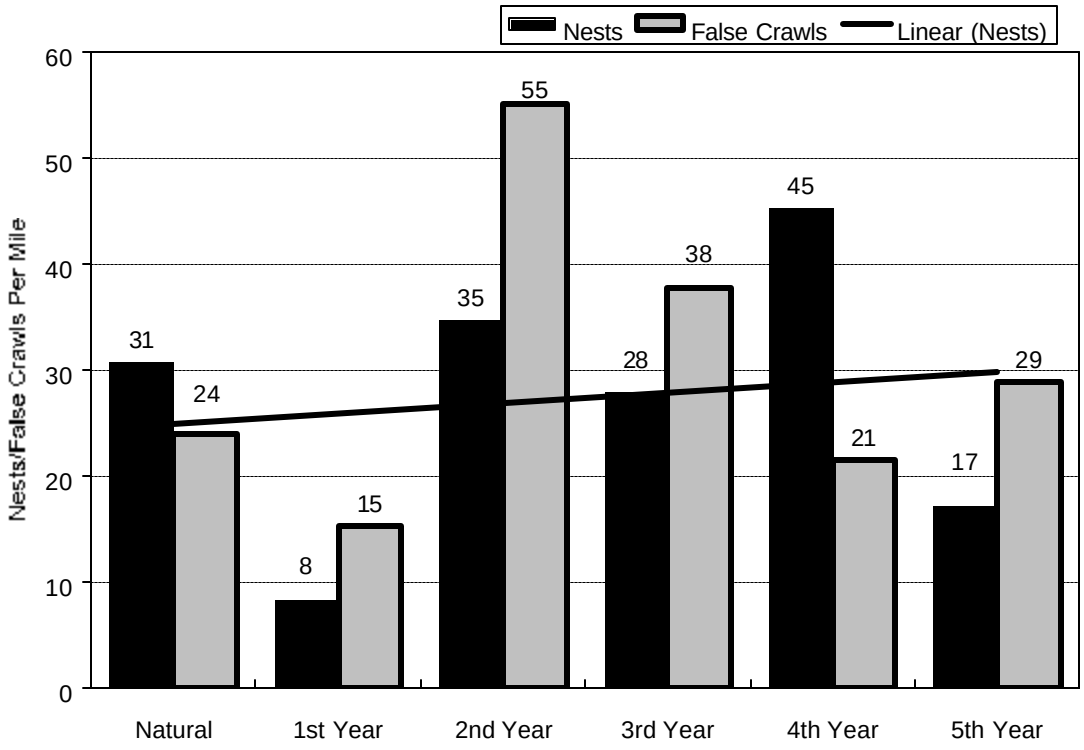


Figure 2.3.2.2. Emergences on Renourished and Non-renourished Beaches.



2.3.3 Historical Trends

Marco Island Beach was first surveyed for sea turtle activities in 1990, followed by Barefoot in 1991 and Clam Pass (from Clam Pass south to Seagate) in 1992. In 1994, the "Collier County Sea Turtle Protection Program" was developed to survey each of the five (5) mainland beaches in response to area-wide beach renourishment. Consecutive years of consistent data collection will assist biologists in detecting local population trends of loggerhead sea turtles, and the local impacts of beach renourishment.

Most loggerhead sea turtles do not nest every year. In the "Synopsis of the Biological Data on the Loggerhead Sea Turtle", Dodd (1988) compiled studies reporting that 90% of loggerhead sea turtles nest on a 2 to 4 year cycle. This factor requires many

years of consistent data collection before any trends can be accurately detected. Historical sea turtle emergences are presented in Table 2.3.3.1 and Figures 2.3.3.1 – 2.3.3.5 for all beaches. Figure 2.3.3.6 shows all of Collier County beaches totaled to show the overall trend.

Table 2.3.3.1. Historical Trends of Sea Turtle Nests and False Crawls (FC), 1990-2000.

Beach Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Barefoot Nests	*	62	71	64	102	105	106	117	108	104	96
Barefoot FC	*	62	129	75	98	146	74	93	90	89	85
Delnor Nests	*	*	*	*	*	*	29	22	29	33	17
Delnor FC	*	*	*	*	*	*	37	22	24	33	32
Vanderbilt Nests	*	*	*	*	131	156	155	141	186	170	167
Vanderbilt FC	*	*	*	*	122	214	143	118	175	111	136
Park Shore Nests	*	*	*	*	153	110	166	134	150	106	154
Park Shore FC	*	*	*	*	107	165	145	120	133	119	186
Naples Nests	*	*	*	*	59	73	62	45	49	87	68
Naples FC	*	*	*	*	120	90	76	51	70	74	70
Marco Nests	35	46	35	33	61	55	78	39	91	91	50
Marco FC	38	124	99	98	99	80	165	71	117	113	52
Annual Nest Total	35	108	106	97	506	499	596	498	613	591	552
Annual FC Total	38	186	228	173	546	695	640	475	603	539	541

Note: *Full beach not monitored or data not available.

Figure 2.3.3.1. Barefoot Emergences, 1991 - 2000.

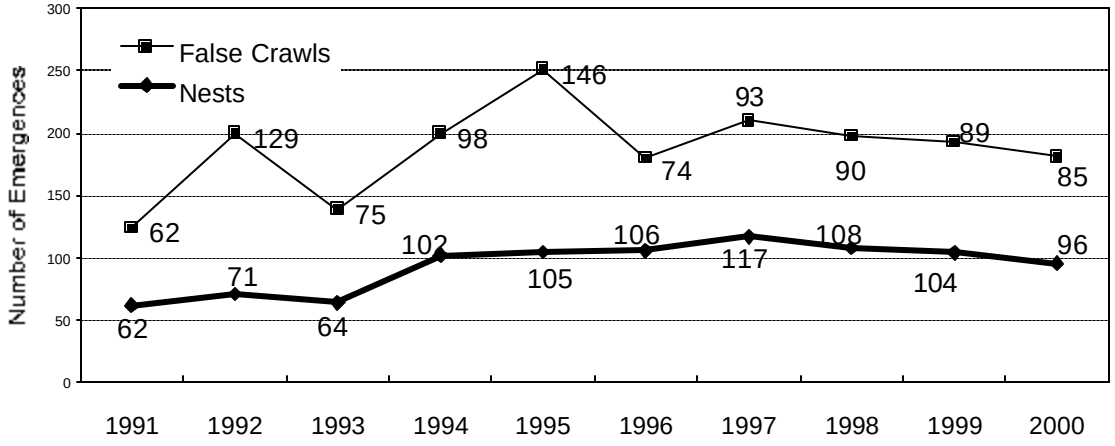


Figure 2.3.3.2. Delnor-Wiggins Pass State Recreation Area Emergences, 1996-2000.

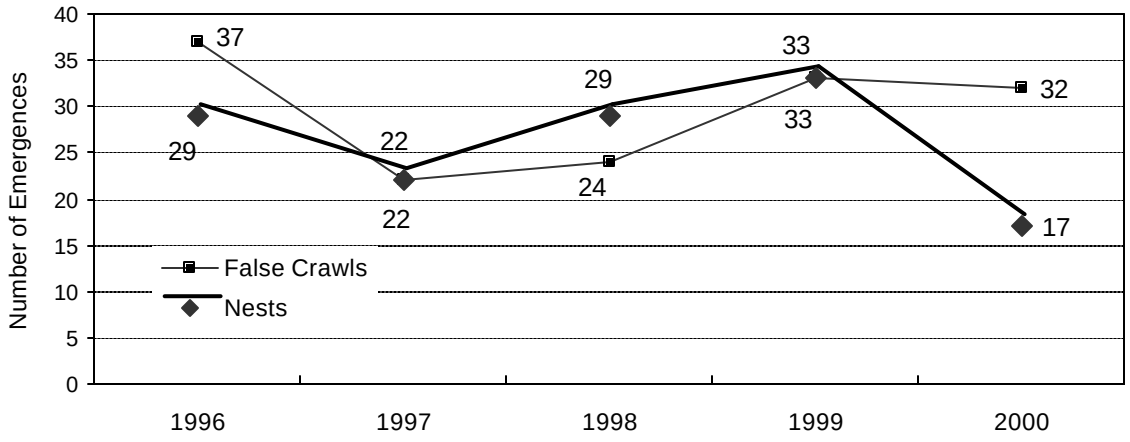


Figure 2.3.3.3. Vanderbilt Beach Emergences, 1994 - 2000.

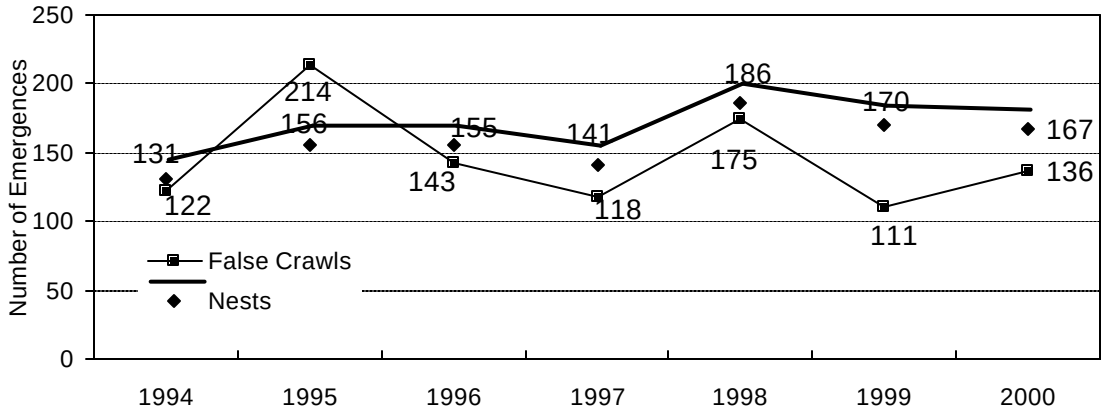


Figure 2.3.3.4. Park Shore Emergences, 1994 - 2000.

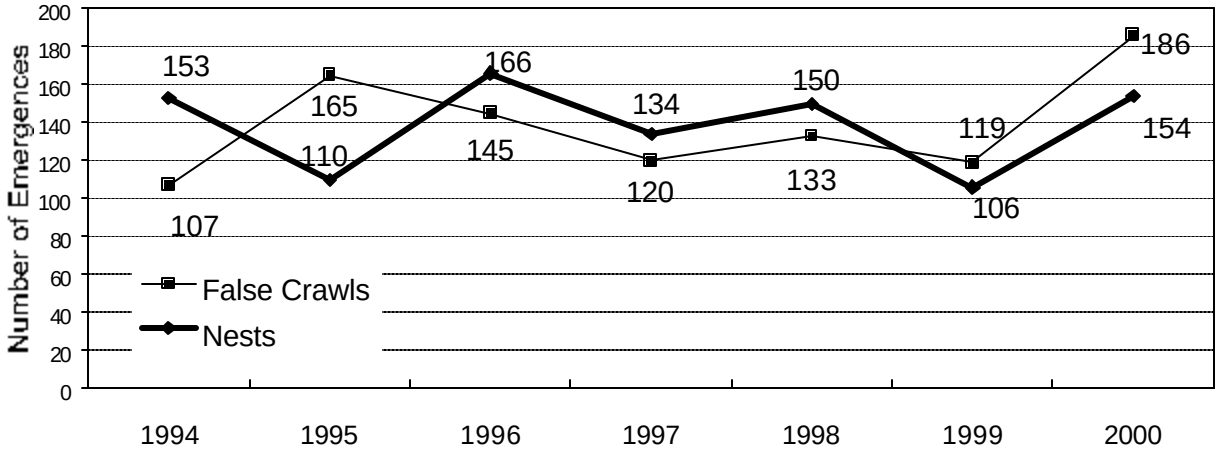


Figure 2.3.3.5. Naples Beach Emergences, 1994 - 2000.

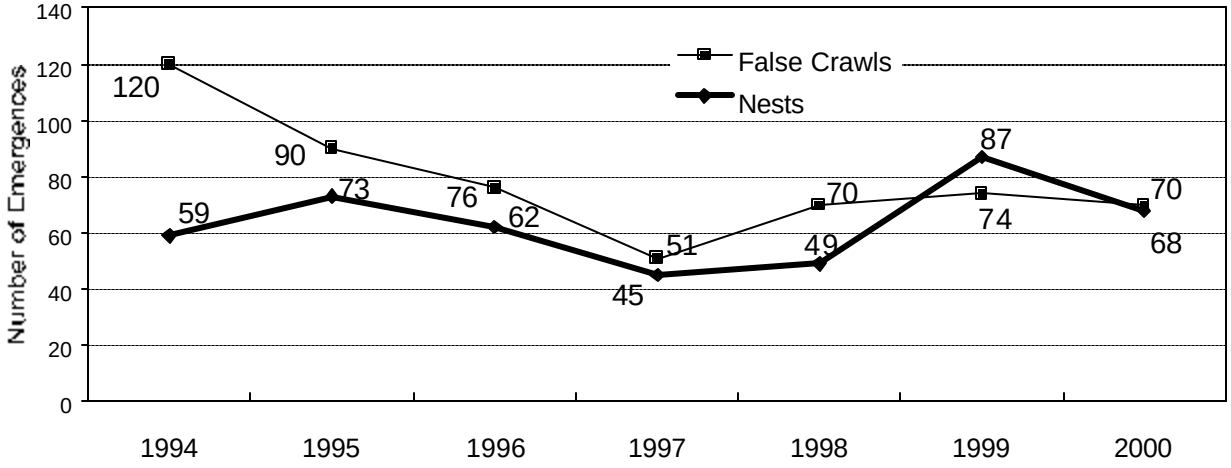


Figure 2.3.3.6. Marco Island Emergences, 1990 - 2000.

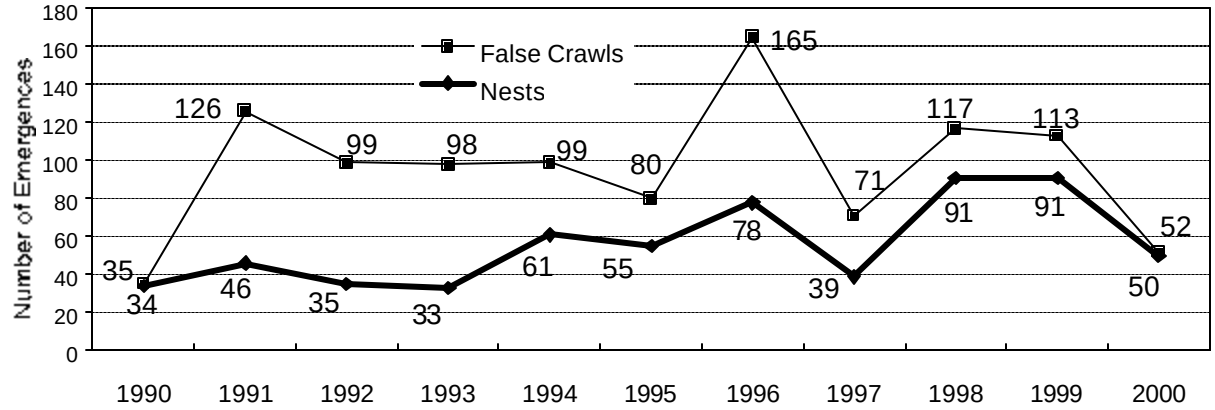
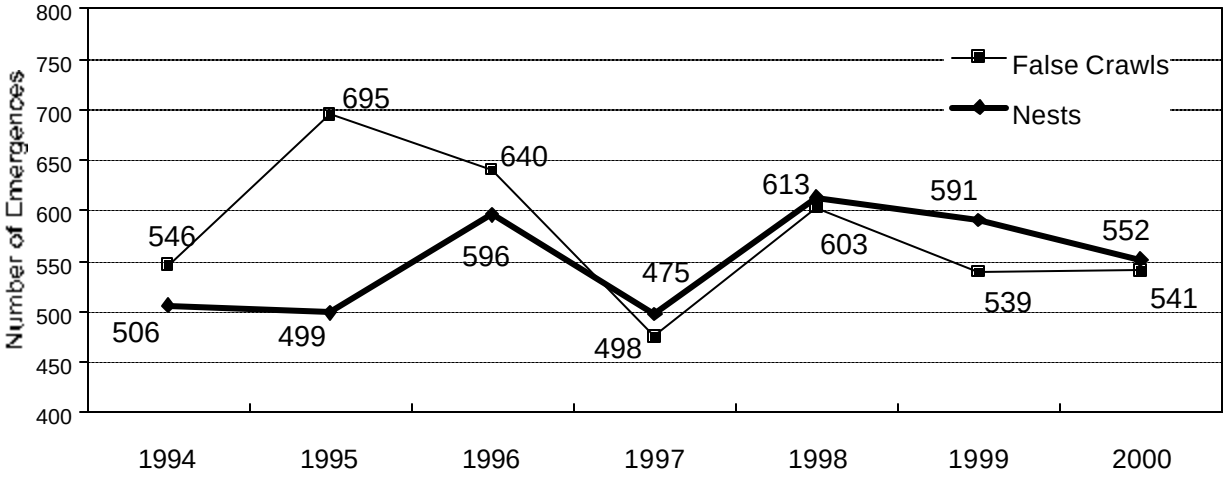


Figure 2.3.3.7. Collier County Emergences, 1994 - 2000.

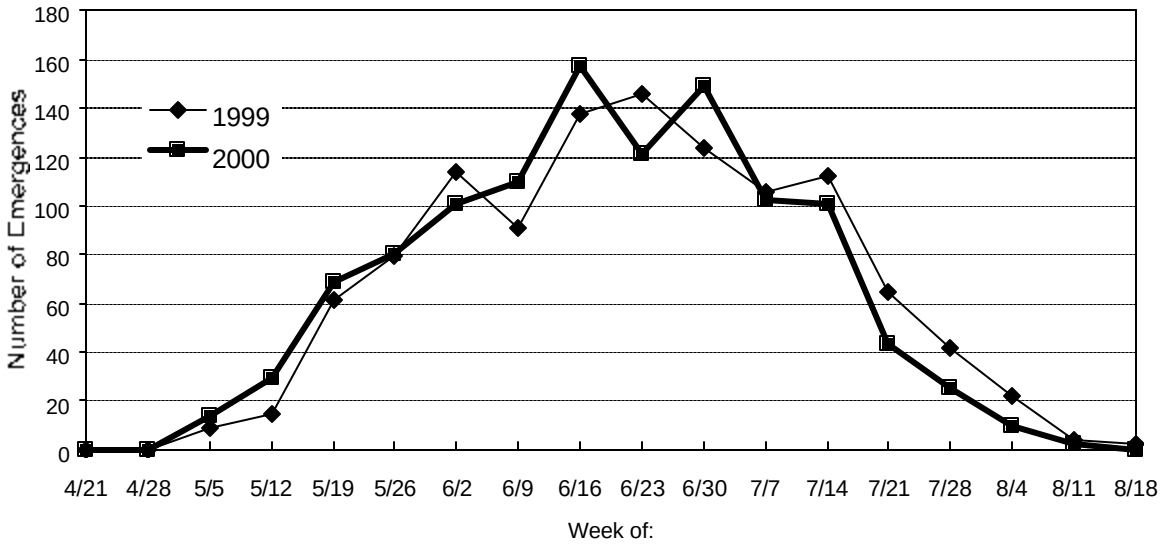


Note: Delnor Wiggins Pass SRA emergence data not included in 1994 and 1995 emergences.

2.3.4 Weekly Emergence Analysis

Sea turtle weekly emergence (nests and false crawls) trends are depicted in Figure 2.3.4.1 for 1999 and 2000. The graph shows two peaks of sea turtle emergences in 2000, 157 recorded for the second week of June and 149 emergences two weeks later at the end of June. This double peak is similar to the trend seen in the 1999 emergence data. Sea turtles are known to nest 2-3 times per season (Dodd, 1988) at 11 to 20 day internesting periods (Williams-Walls *et al*, 1983). The reduction in emergences between the peaks could be related to this internesting period.

Figure 2.3.4.1. Collier County Emergences Per Week, 1999-2000.



2.3.5 Nest Site Selection and Hatchling Disorientations

The 2000 data reveals a significant difference in the mean distances from the high water line (HWL) between disoriented and seaward oriented nests (p=2.2exp-3, f=13.8). Also, significant differences were detected in the mean distance the nests were located from the vegetation (p=2.2exp-10, f=41.9). Placement of disoriented nests was compared to those hatching with a normal seaward orientation for 2000 (Table 2.3.5.1).

Table 2.3.5.1. Mean Placement of Disoriented Nests, 2000.

Distances (feet)	Disoriented	Seaward Orientation
Mean Distance From MHW	71.8	47.9
Mean Distance From Vegetation	68.2	13.8

Disoriented nests were located further away from the dune line. The differences in the mean distance that nests were deposited away from the vegetation implies a

protective benefit of the dune vegetation by shading landward light sources. As the nests are located further from the vegetation they may become more susceptible to hatchling disorientation. Hatchling loggerhead turtles appear to be more susceptible to disorientation on wider beaches where nests are placed further from the vegetation. The implications of this for future beach renourishment indicate narrow beaches with dense dune vegetation, or higher dunes, may benefit hatchling loggerhead turtles.

2.3.6 Clutch Depth

Measurements of the egg cavity were taken for each excavated nest when possible. The clutch width was measured from the widest portion of the egg cavity and the clutch depth was measured from the sand surface to the hardened bottom of the egg cavity.

No significant difference was found when the clutch depth was compared between renourished and non-renourished beach areas ($p=0.11$, $f=2.3$). A regression analysis was performed on the mean clutch depth of nests on renourished beaches characterized by the number of years passed since renourishment (Table 2.3.6.1). The clutch depth shows no correlation between the number of years since renourishment.

Table 2.3.6.1. Mean Clutch Depth in Natural and Renourished Beaches, 2000.

Years Since Renourishment	Natural	1 Year	2 Years	3 Years	4 Years	5 Years
Mean Clutch Depth (Inches)	19	19	19.5	20	20	18

However, when comparing the clutch depth of nests placed in the three sand sources present on renourished beaches (hydraulic, mechanical, and upland) a significant

difference was found (p=4.2exp-6, f=9.5). The clutch depths in mechanically placed sand were significantly deeper than those in natural beaches (p=3.3exp-5, f=17.7). The clutch depths in upland sand were significantly shallower than those in natural beaches (p=0.02, f=5.4).

Table 2.3.6.2. Clutch Depth in Renourished Sand Types, 2000.

	Natural	Hydraulic	Mechanical	Upland
Clutch Depth	19	18	20	16
Number of Nests	292	86	61	8

2.3.7 Hatching Evaluation

During the 2000 sea turtle nesting season, 551 nests were marked for excavation. Of these nests, 519 were evaluated by the Natural Resources Department and the Conservancy of Southwest Florida staff. Many of the nests not evaluated were lost due to effects of Hurricane Gordon (September 17). Tidal flooding inundated 25% of the nests compared to 14% in 1999 and 44% in 1998.

The average number of eggs per nest (clutch size) was 102 compared to 104 in 1999, 97 in 1998, and 106 in 1997. Loggerhead sea turtles average 110 to 120 eggs per nest throughout their range, but the clutch size is highly variable (Ernst *et al*, 1994).

Table 2.3.7.1. Collier County Mean Clutch Size, 2000.

	Barefoot	Delnor Wiggins Pass	Vanderbilt	Park Shore	Naples	Marco
Mean Egg Count / Nest	107	104	98	100	97	112

A total of 52,693 eggs were deposited into the evaluated nests and 38,977 hatchlings emerged successfully (Table 2.3.7.2). The total number of hatchlings released includes 38,391 that emerged on their own and 586 that were found alive in the nest cavity.

Table 2.3.7.2. Nest / Hatchling Evaluations for Each Beach Unit, 2000.

	Barefoot	Delnor Wiggins Pass	Vanderbilt	Park Shore	Naples	Marco	Total
Total Nests	96	17	167	154	68	50	552
Lost Nests	3	2	12	1	8	7	33
Total Eggs	9,904	1,566	15,250	15,360	5,794	4,819	52,693
Emerged Hatchlings	7,171	1,202	10,508	12,136	3,980	3,394	38,391
Hatchlings Alive in Nest	208	27	157	98	34	31	555
Hatchlings Dead in Nest	484	14	369	413	103	85	1,468
Undeveloped Eggs	1,372	282	2,417	1,703	641	241	6,656
Dead Embryos	421	22	839	730	935	807	3,754
Predated Eggs	88	12	886	105	4	97	1,192
Pipped Live Eggs	1	1	0	11	1	17	31
Pipped Dead Eggs	159	6	74	164	96	147	646
Overall Hatch Success	79%	79%	72%	82%	71%	73%	77%
Overall Emergence Success	72%	77%	69%	79%	69%	71%	73%

Unhatched eggs (11,602) were opened to identify fertility and embryonic development. Dead embryos comprised 32% of the unhatched eggs, depredated eggs made up 10%, and the remaining 58% were labeled as undeveloped since there was a lack of evidence of advanced embryological development. These undeveloped eggs may be a result of infertility or early embryological death. Each dead embryo was carefully

inspected and the developmental stage was determined based on the 30 stages described by Miller (1985). Stages 1 through 21 are difficult to distinguish and were recorded together and labeled as "less than stage 21". Stages 21 through 30 was determined easily with the naked eye and were recorded as separate stages. Embryos too decomposed for identification were labeled as "undetermined". Of the number of dead embryos, 6% (229) were undetermined and 7% (266) were less than 21. Twenty-four percent (24%) of the nests containing dead embryos were inundated with seawater from the tide at some point during the incubation period.

Staff recorded, collected, and preserved any unusual invertebrate species present in the egg chamber or within pipped or damaged eggs. Positive identification was made by the Florida Department of Agriculture and Consumer Services, Division of Plant Industry located in Gainesville, FL. Several formicine ants (*Brachymyrmex obscurior*) were found in unhatched eggs with small round holes, in a single nest located on Park Shore beach. A single beetle larva was found in the chamber of a nest on Park Shore beach. The larva was identified only to the family level of Elateridae, and is probably a member of the genus *Conoderus*. Several small, thin, white nematodes were found on the drowned, pipped eggs of two separate nests on Park Shore beach. These nematodes belong to the family Rhabditidae, and are members of the genus *Mesorhabditis*. Typical members of this genus are bactivorous, and these were probably grazing on the bacteria colonizing the dead hatchlings (personal communication, Dr. Byron Adams, University of Florida Entomology and Nematology Dept.). The nematodes DNA signature is currently being studied to determine their species identification.

The mean incubation rate, 63 days, is the same as 1999 and an increase from 59 days in 1998. There was no significant difference found between the incubation rate on non-renourished beaches and on beaches that are one, two, three, four, or five years after renourishment (p=0.933, f=0.26). Incubation rate, regardless of the year of renourishment, proved to be statistically similar to that of natural beaches (Table 2.3.7.3). When comparing the types of renourishment, there was no significant difference in the incubation rate between natural sand and renourished sand (p=0.69, f=0.37) (Table 2.3.7.4). There was also no difference in the mean incubation rate between nests that were fully exposed to the sun and nests that were shaded by vegetation or buildings (p=0.84, f=0.29).

Table 2.3.7.3. Incubation Rate in Natural and Renourished Beaches, 2000.

Years Since Renourishment	Natural	1 Year	2 Years	3 Years	4 Years	5 Years	Overall Average
Hatching Success	63.5	63.5	62.6	63.1	63.2	63.4	63.4

Table 2.3.7.4. Incubation Rate in Renourished Sand Types, 2000.

	Natural	Hydraulic	Mechanical	Upland
Incubation Rate	63.5	63.1	63.5	63.4
Number of Nests	292	86	61	8

The incubation success of a nest was measured by its overall hatching success and emergence success. The hatching success was calculated as the number of hatched eggs plus live hatchlings found in the nest divided by the total egg count. The emergence success was calculated as the number of naturally emerged hatchlings divided by the total

egg count. The mean hatching success was 81%, a small increase from 80% in 1999 and 71% in 1998. The hatching success of nests found on renourished versus non-renourished beaches was not statistically different (p=0.42, f=0.65) (Table 2.3.7.5). Factoring the years of renourishment, nests show no significant difference in hatching success between the years since renourishment (p=0.59, f=0.75). The high hatching success one year after renourishment cannot be analyzed statistically due to the low number of nests in this sand. Additionally, the type of renourished sand the nests were deposited in did not significantly alter the hatching success (p=0.36, f=0.0.62).

Table 2.3.7.5. Hatching and Emergence Success in Natural and Renourished Sand, 2000.

Years Since Renourishment	Natural	1 Year	2 Years	3 Years	4 Years	5 Years	Overall Average
Hatching Success (%)	79.8	93.2	88.5	78.4	83.7	80.4	80.5
Emergence Success	78.2	92.6	88.2	75.8	79.7	78.3	78.6

The mean emergence success is 78.6% for all beaches and all sand types. There is no statistical difference between emergence success in natural and renourished sand (p=0.58, f=0.75). Again, the high emergence success value in the 1st year renourished sand is attributed to the low number of nests in that sand.

2.3.8 Nest Predation

Human destruction and poaching, depredation by raccoons (*Procyon lotor*), gray foxes (*Urocyon cinereoargenteus*), domestic cats (*Felis domestica*), fire ants (*Solenopsis invicta*), ghost crabs (*Ocypode quadrata*), birds, roots, other nesting loggerhead sea turtles, and unknown predators affected 15% (81 nests) of the total nests; an increase

from 12% (71 nests) in 1999. In some cases there was more than one predator species attacking a single nest. These included raccoons and fire ants; raccoons and ghost crabs; and raccoons and gray foxes.

Of the 81 depredated nests, 17 (21%) were caused exclusively by raccoons, 16 (20%) by gray foxes, 13 (16%) by unknown predators, and 10 (12%) by ants. In addition, 5 (6%) of the depredated nests were believed to have been poached by humans, a marked decrease from 11 (16%) in 1999. Finally, 7 (9%) depredated nests were caused by ghost crabs, 5 (6%) by raccoons and gray foxes combined, 2 (2%) by raccoons and fire ants combined, 2 (2%) by birds, 1 (1%) by raccoons and ghost crabs combined, 1 (1%) by domestic cats, 1 (1%) by roots, and 1 (1%) by a nesting female loggerhead turtle.

The damage caused by predators to sea turtle eggs was minimal, relative to the overall success. Of 52,693 eggs deposited in 2000, only 1,192 (2%) were lost to predators. However, it should be noted that the number of eggs poached or destroyed by humans was difficult to evaluate and numbered at least 96, and may be greater than that number. This season was the first to have evidence of gray foxes depredating sea turtle nests. Evidence included an individual captured and released at Vanderbilt Beach, and an individual captured and released at Clam Pass Park (north Park Shore), plaster casts made of their tracks, and by visual observations of their style of predation. Table 2.3.8.1 provides a breakdown of egg predation during 2000.

Table 2.3.8.1. Eggs Depredated in Collier County, 2000.

Predator (s)	Number of Eggs Taken	Percentage By Predator
Raccoons	517	43%
Raccoons and Gray Foxes	184	15%
Unknown	177	15%
Gray Foxes	172	14%
Humans	= 96	= 8%
Ghost Crabs	21	2%
Domestic Cats	19	2%
Birds	4	<1%
Roots	4	<1%
Loggerhead	2	<1%
Total	1,198	100%

Hatchlings were similarly unaffected by predation, with only 323 (0.8%) being taken from a total number of 40,414 hatchlings. Predators included fire ants, raccoons, gray foxes, unknown predators, birds, and ghost crabs. Table 2.3.8.2 provides a breakdown of hatchling predation during 2000.

Table 2.3.8.2. Hatchlings Depredated in Collier County, 2000.

Predator (s)	Number of Hatchlings Taken	Percentage by Predator
Fire Ants	224	69%
Raccoons & Gray Foxes	38	12%
Unknown	35	11%
Birds	8	2%
Raccoons	6	2%
Ghost Crabs	6	2%
Raccoons & Ghost Crabs	5	2%
Raccoons & Fire Ants	1	<1%
Total	323	100%

Nuisance raccoon control measures have been instituted for the past several years, although accurate data has been difficult to attain. During the winter of 1994, 40 nuisance raccoons were trapped and removed from the Barefoot Beach area by local trappers. During the spring and summer of 1995, 23 nuisance raccoons were extracted from Vanderbilt Beach and 13 from Clam Pass Park (north Park Shore). The removal of these raccoons may have contributed to the decrease in predation between 1994 and 1996. From January to October 1997, five nuisance raccoons were removed from Barefoot Beach and an additional 25 from Vanderbilt Beach. Only one documented raccoon removal was reported in 1998 for Barefoot Beach. In 1999, three raccoons were removed from Vanderbilt Beach. Also in 1999, one raccoon, one Virginia opossum

(*Didelphis virginiana*), and one striped skunk (*Mephitis mephitis*) were removed from the Naples beach using trapping efforts provided by a local trapper. In 2000, 3 raccoons were removed from Vanderbilt Beach, and one raccoon was removed from Clam Pass Park (north Park Shore) by NRD staff. During the trapping efforts by NRD staff, gray foxes were caught and released on site at both Vanderbilt Beach and Clam Pass Park. Local trappers removed 30 raccoons from Vanderbilt Beach during the months of January, May, June, August, September, and November 2000 and 4 gray foxes from the Naples beach in June.

Johnson (1970) noted raccoons learn to take advantage of new food sources, and the behavior is copied by other individuals and passed on generations. In past seasons, NRD staff has witnessed these opportunistic predators learning to recognize the marked nests to be sources of food. Raccoon tracks were seen traveling along the beach from nest to nest, as if inspecting each one. It is probable that only a handful of "smart" raccoons are causing the current predation.

Nests that are investigated by raccoons typically are predated during the first few days after deposition. Gallagher et al. (1972) found that of the 398 nests on Hutchinson Island that were predated by raccoons, 34 percent were discovered and taken within 48 hours of having been deposited. Davis and Whiting (1977) reported even higher (87%) raccoon predation during the first 24 hours after deposition at Cape Sable, Florida. However, in 1997 and 1998, raccoons were getting into nests throughout most stages of nest incubation, unlike previous years. In 1999, Vanderbilt Beach nests were depredated throughout most stages of development, but the remainder of Collier County beaches had raccoon depredations confined to within 24 hours of deposition, or as a nest hatched. In

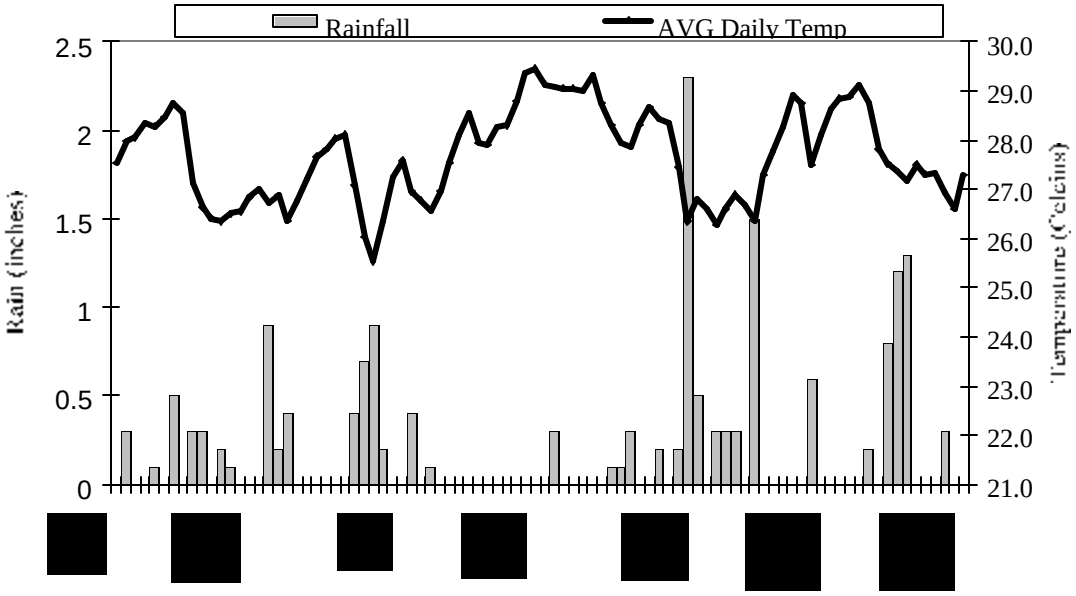
2000, all beaches that exhibited raccoon predation were depredated throughout most stages of development.

2.3.9 Sand Temperature

The combined daily sand temperature ranged from 25.5^{o} C to 29.5^{o} C with an average of 27.7^{o} C. There was no significant difference in the sand temperature between each data logger and no significant difference between the natural sand and renourished sand ($p=0.17$, $f=1.78$). The temperature fluctuation throughout the summer was minimal, with a range of only 4^{o} C. There is a strong correlation between increased rainfall and decreased sand temperature (Figure 2.3.9.1).

Sand temperature has strong implications on the sex of sea turtle hatchlings since the sex of a sea turtle is determined, primarily, by the surrounding temperature during incubation. The data suggests the possibility that summer rains act to keep the sand temperature low, which will produce more male hatchlings.

Figure 2.3.9.1. Rainfall and Daily Sand Temperature for Collier County Beaches, 2000.



SECTION 3

BEACH LIGHTING PROGRAM

Artificial lighting on nesting beaches, distant sources of illumination ("city glow") and other sources of light pollution can interfere with the normal nesting behavior of sea turtles and cause hatchling orientation problems. Light pollution has been proven to discourage sea turtles from emerging out of the water to nest (Witherington, 1996). The effect of light pollution in Collier County may be one of the factors contributing to the decreased number of emergences on the more developed, and consequentially brighter, beaches (18.2 – 94.1 emergences per mile (e/mi.)) compared to undeveloped beaches (40.8 – 167.8 e/mi.).

The negative effects of artificial lights on hatchling sea turtles are well documented (Danial and Smith, 1947; Dickerson and Nelson, 1989; Witherington, 1990). Artificial lighting interferes with a hatchling sea turtle's ability to correctly orient. These hatchlings often incorrectly crawl towards sources of the light pollution (disorientations). Ninety three percent (93%) of the 2000 disorientations occurred in developed beaches where artificial lights are more predominant. Disorientations affect sea turtles by leaving them vulnerable to dehydration, exhaustion, and predation (Witherington, 1999).

Fifteen hatchling disorientations were documented in 2000 (Table 3.1). Nest site selection itself may predispose some nests to risks of disorientation (see Section 2.3.5). Hatchling loggerhead turtles appeared to be more susceptible to disorientation on wider beaches where nests are placed further from the vegetation, implying a protective benefit of the dune vegetation, by shading landward light sources.

Table 3.1. Disorientations On Collier County Beaches, 2000.

	Barefoot	Delnor Wiggins Pass	Vanderbilt	Park Shore	Naples	Marco	Totals
Disorientations	0	0	1	2	2	10	15
Disorientated Hatchlings (estimated)	0	0	6	84	79	726	895

In accordance with the "Collier County Sea Turtle Protection Regulations" (Land Development Code Sec.3.10, 1994), NRD developed a program to minimize the damages caused by light pollution. The program is composed of an annual mail-out prior to season, night lighting compliance inspections, violation notices, and code enforcement action. Prior to nesting season, a sea turtle information package is sent to beach front property owners, managers, and renters. The information package illustrates the importance of shielding or turning off lights during sea turtle nesting season, and suggests inexpensive methods of reducing and minimizing beach lighting.

Lighting compliance inspections are conducted by NRD staff twice per month throughout sea turtle nesting and hatching season (May 01 – October 31). The monthly inspection and follow up are conducted as close to the new moon phase as possible. Light sources that create a visible shadow on the beach are considered a violation. When a violation is identified, efforts are made to work with the management to correct the problem. First time violators receive phone notification of the problem. Second time offenders are sent a non-compliance letter. Violations with no attempt to correct are sent a "Notice of Violation" (NOV) and the case is turned over to Collier County's Code

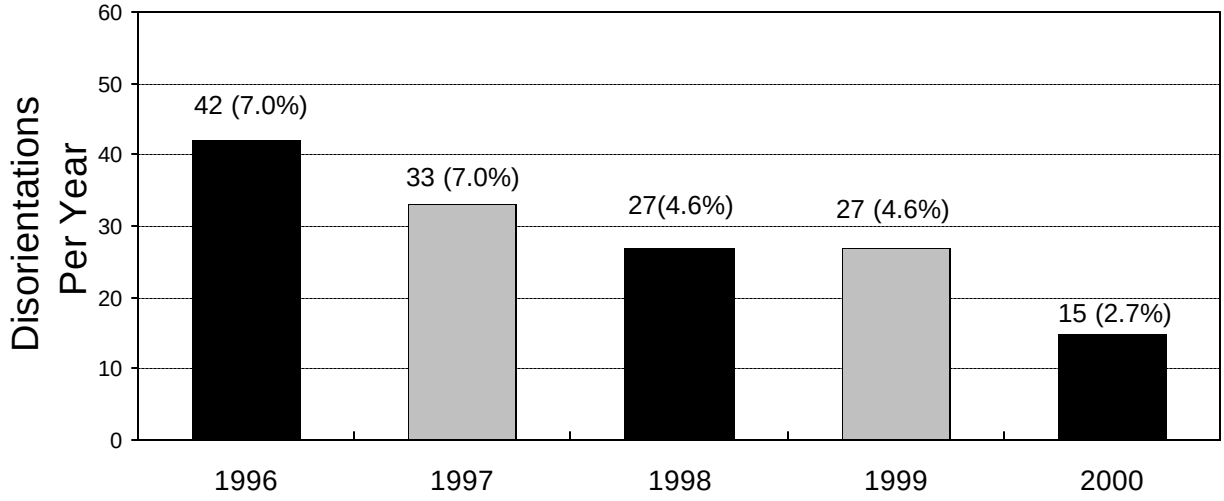
Enforcement Department for formal action. If the violation is not corrected when the Code Enforcement Inspector arrives, the establishment receives a "citation notice" and an order to appear in court. Table 3.2 is a breakdown of the 2000 beach lighting violations.

Table 3.2. Beach Lighting Violations By Month in Collier County, 2000.

	May	June	July	August	September	Totals By Beach
Barefoot Beach	0	0	0	0	0	0
Vanderbilt Beach	13	7	0	0	0	20
Park Shore Beach	14	7	0	3	0	24
City of Naples Beach	24	18	39	10	0	91
Marco Island Beach	18	10	15	25	3	71
Totals By Month	69	42	54	38	3	206

The goals of this program are to decrease the number of sea turtles affected by light pollution and increase the habitat value of the beaches. The program was instituted in 1995. In 1996, NRD documented 42 disorientations (7% of the nests). The percentage of disorientations remained the same in 1997 (33 disorientations, 7% of the nests) and decreased in 1998 (27 disorientations, 4.6% of the nests). In 1999, the percentage of disoriented nests stayed at 27 disorientations (4.6% of the nests). In 2000, the number of disoriented nests decreased to 15 disorientations, and the percentage of total nests decreased to 2.7%. Figure 3.1 shows the trend towards decreased nest disorientations on a yearly basis, beginning one year after the beach lighting program had begun, and continuing through the 2000 sea turtle season.

Figure 3.1. Disoriented Nests in Collier County, 1996-2000.



Florida Power and Light (FPL) maintains 34 electrical poles at the seaward side of 31 beach accesses in City of Naples (8th Ave N to 21st Ave S). Lighting from these poles has been hard to control in past years, as many of the lights are old and each is unique. Prior to the 2000 nesting season, all FPL poles were surveyed and photographed. The surveys documented the light type (cobra flat, cobra bulb, open bottom.); bulb wattage (70-400); location of pole at end of access (north, south, center); direction of light (north, south, east, west); FPL number on pole; and past remedial actions (paint, shield, amber lens).

The first lighting inspection revealed that 14 of the 34 poles were out of compliance and causing violations. Six of the 14 poles had been in compliance in the past and needed only minor adjustments to the shields or additional paint added to the bulb. Early June inspection reveled the same problems. NRD staff worked closely with

FPL to remedy the problems on an individual light basis. Amber lenses and shields were installed on some of the lights and by the July inspections the 14 lights were simply turned off. A few safety complaints caused three (3) of the lights to be restored. Continued cooperation between FPL and the NRD will hopefully eliminate beach access lighting problems in the future.

Of the 2 disorientations on the City of Naples Beach, one was attributed to FPL lights, however the lights were on the landward side of the Moorings Residents Beach and were not included in the original beach access surveys. Although not directly shining on the beach, the cumulative effects of streetlights, vehicle lights and condominium lights can be attributed to the lighting problems in this area. The Moorings Residents Beach area has caused annual disorientations since 1996 and will be targeted in 2001 for public awareness and increased lighting compliance.

SECTION 4

SEA TURTLE STRANDING AND SALVAGE PROGRAM

Stranded sea turtles are those that wash ashore or are found floating, dead or alive in a weakened condition. The NRD has been actively involved in assisting the Florida Fish and Wildlife Conservation Commission (FWC) with data collection on dead, sick or injured sea turtles for the "Sea Turtle Stranding and Salvage Network" (STSSN) since 1994. Prior to 1994, not all strandings were reported and many were disposed of without notification to the NRD or the FWC. The FWC is required to send all stranding data to the National Marine Fisheries Service (NMFS) on a weekly basis. The NMFS uses the data to further our knowledge of sea turtle biology, species composition, distribution, seasonality, migratory patterns, habitat use and sources of mortality.

Sources of sea turtle mortality include, but are not limited to: incidental catch by commercial fisheries (trawling gear, gill nets, drift nets, and long lines), entanglement and ingestion of marine debris, boat strikes, poaching, injury from shark attack, disease, and other natural causes. The cause of mortality is determined when possible and used to identify possible solutions to current population decline. The STSSN program is critical to the future conservation and recovery efforts of sea turtles.

In 2000, 108 sea turtles were reported stranded along the Collier County coastline, representing a 415% increase in the past five (5) year average of 26 per year (Figure 4.1). Neighboring counties including Lee County and Monroe County did not experience a significant increase in strandings in 2000. Strandings occurred during most months with peaks occurring in March and May (Figure 4.2).

Figure 4.1. Sea Turtle Strandings 1995-2000, Collier County.

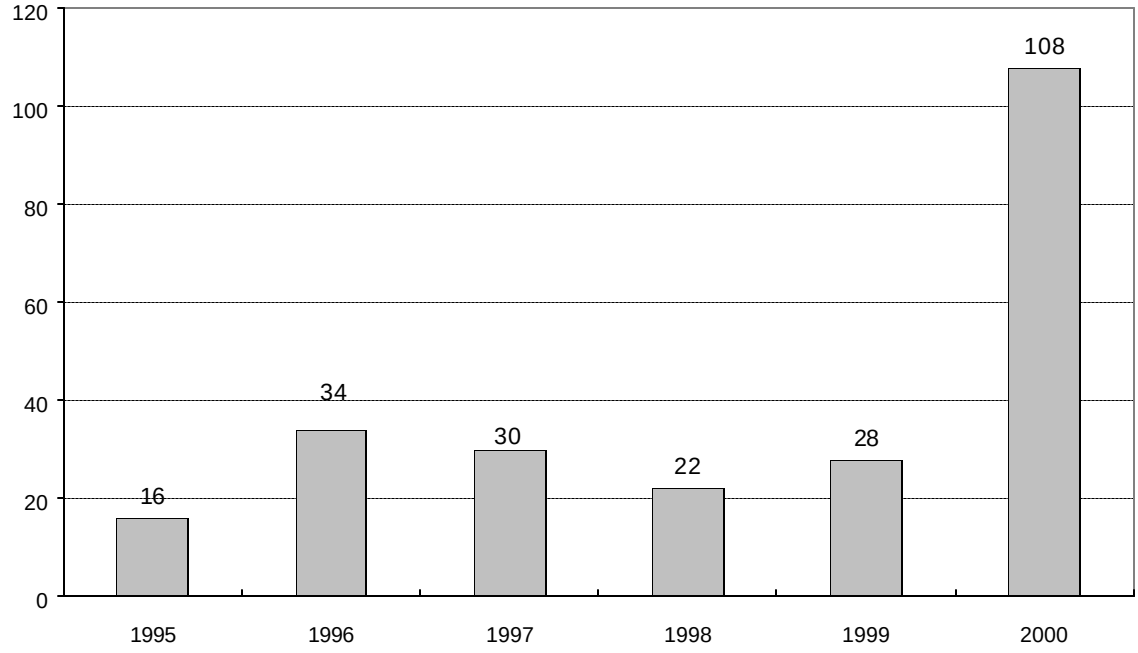
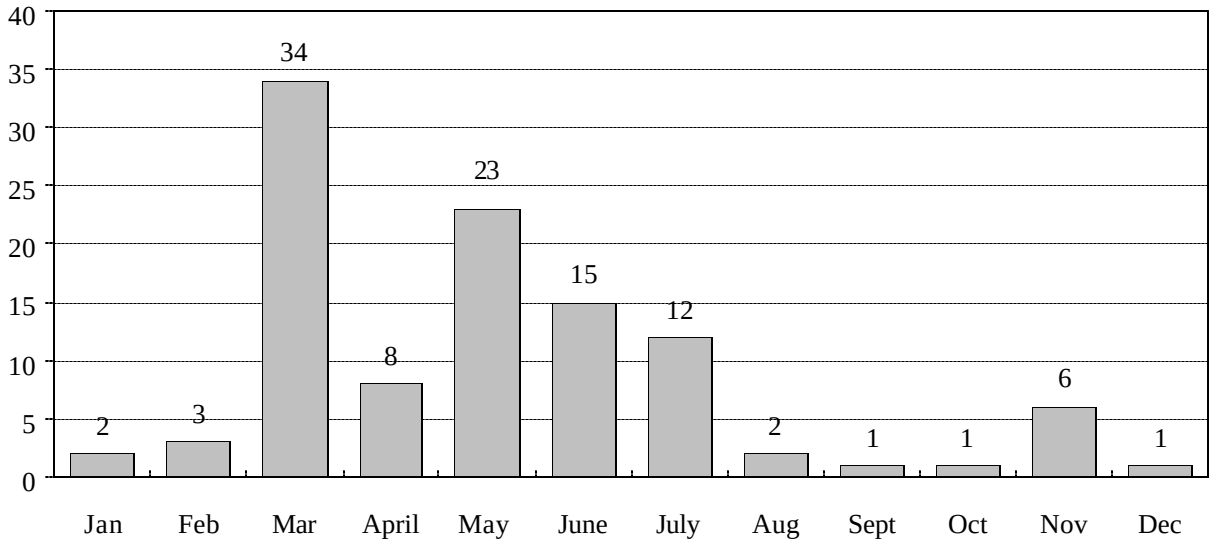


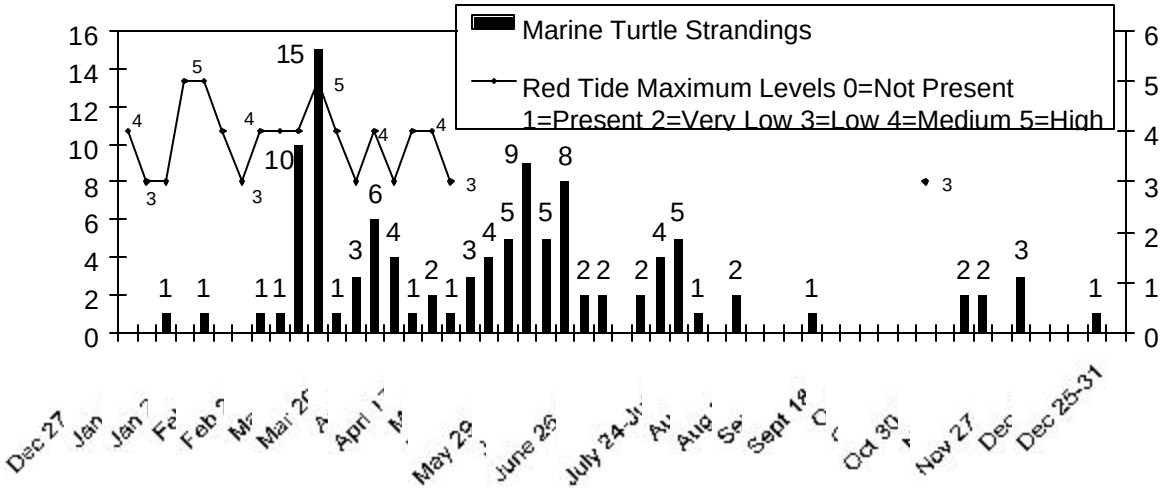
Figure 4.2. Collier County Monthly Sea Turtle Strandings, 2000.



From January through late April a widespread bloom of red tide (*Gymnodinium breve*) coincided with 46 sea turtle strandings (Figure 4.3). NRD staff performed one field necropsy, and 10 turtles during this time were frozen and later taken to the FWC Florida Marine Research Institute for necropsy. Tissue and organ samples were taken for analysis and results are pending.

Red tide dinoflagellates produce a nerve toxin that can be fatal to fish, causes respiratory irritation in humans, and can accumulate to high concentrations in shellfish. It takes approximately 2-4 weeks for the toxin to be completely purged from shellfish depending on the length of exposure and flushing of the water body (FDEP, 1999). At this time the effect of red tide poisoning on sea turtles is poorly understood. There is only circumstantial evidence that sea turtle exposure to red tide, including respiration and ingestion of filter feeding organisms such as shellfish, can be linked to a possible cause of death.

Figure 4.3. Weekly Sea Turtle Mortality and Red Tide Results.



The second peak of strandings occurred during the period of May through July. Although this time corresponds to sea turtle nesting season, 25 of the 50 strandings were fresh to moderately decomposed large male loggerhead sea turtles, compared to 12 of the 45 during the previous three months (February through April). A number of the males that were necropsied appeared to be healthy at the time of death. Biologists at FMRI indicated that fisheries interaction might have played a role in the strandings.

Federal regulations require the use of turtle excluder devices (TEDs) on shrimp nets to reduce sea turtle mortalities. Dimensions for the Gulf of Mexico TED's are a minimum of 81.28 cm (32 inches) width and 25.4 cm (10 in) height/depth (Federal Register, 1992). The height or depths of many of the Collier County strandings were measured in the field and others were calculated by a morphometric analysis described by Epperly, 1999. It was determined that 92 % (68 of the 74) of loggerheads stranded had depth measurements that exceeded the height requirements of TED's. In addition one green sea turtle and one Kemps ridley would not have been able to escape the TED under current Federal regulations. Correlations between the strandings and shrimping effort in this area will be examined when shrimping data becomes available. The data will also assist in determining if Texas shrimping ground closures will impact the eastern Gulf of Mexico shrimping grounds and sea turtle populations.

Strandings in 2000 included 74 loggerheads, 29 Kemps ridley's, three (3) greens, one (1) hawksbill and one (1) unidentified. Six of the 108 sea turtles were alive at the time of stranding and were taken to Clearwater Marine Aquarium for rehabilitation. Two (2) died in rehabilitation (one ridley and one green) and four (4) were returned to Collier County and released (one loggerhead and 3 Kemps ridleys).

Anomalies of dead and live sea turtles ranged from boat and/or obvious propeller damage with visible markings (12 including 5 which occurred during red tide), deliberate human mutilation or shark bites (17 including 3 which occurred during red tide), stranding occurring while red tide was in the area (43), no obvious cause of death (36), and too decomposed to assess (8). In many cases it is not known if boat damage or shark bites was the cause of death or a post-mortem injury.

Increased public awareness of the reporting requirements may result in better coverage for the STSSN. Stranding and salvage personnel are not in the field on a daily basis outside of the nesting season and rely on the Florida Marine Patrol and the public for stranding locations. Stranded sea turtles outside the developed beaches may not be found or reported, some are lost at sea and others buried by persons unfamiliar with the reporting procedure.

The NRD responded to 66 strandings and the Conservancy of Southwest Florida, Rookery Bay NERR, Delnor Wiggins Pass SRA or the USFWS reported all other strandings.

SECTION 5

PUBLIC AWARENESS

A vital step in sea turtle protection is public awareness of the problems turtles encounter. The NRD staff provides important public education to curious beachgoers while working on the beach. In 2000, NRD staff responded to the questions of approximately 4,929 people during morning surveys.

Public awareness is also accomplished through public presentations and displays. Upon request, NRD staff conducts sea turtle talks, slide shows, and displays for local organizations and schools. A sea turtle web page containing updated information on nest/false crawl counts, beach lighting, strandings, and general information, has received over 2,741 visits since September 1998 (www.colliergov.net/natresources/turtle).

The NRD staff developed a sea turtle brochure to correspond to each of the five beaches. The brochure includes local beach nest numbers compared to the rest of the County and ways the public can get involved with sea turtle protection. The brochures are distributed when staff is stopped for questions during morning surveys and at presentations. A second brochure, "SEA TURTLES NEED YOUR HELP", focusing on the problems of beach lights was created and distributed to summer beach residents in April.

During the 2000 sea turtle nesting season a kiosk display was placed at Marco Island Residence Beach, Naples City Pier, Delnor Wiggins Pass SRA, and Barefoot Beach Park. The display was updated each week with current sea turtle activity for each

beach and for the entire county. The poster also displayed general sea turtle information and included the NRD's web site address and contact information.

A 30 second USFWS Public Service Announcement (PSA) on sea turtle disorientation and prevention was aired from August through October on WZVN-TV ABC, WINK-TV, and WEVU-UPN 10. A 60 second PSA was produced and aired on the "Visitors Channel" every 2 hours from July through October. Funding for its development was through a grant obtained from the USFWS South Florida Ecosystems Program.

The Collier County Government Access Channel produced an additional 60 second PSA broadcast on the local government access channel TV 54. A two hour "Sea Turtle Public Awareness" program was broadcast 30 times from April through October, 2000. The County Bulletin Board also had a PSA airing throughout the day. Over $48,000 of airtime was donated to the program by the Collier County Government Access Channel.

Present plans include the creation of a bumper sticker that focuses on beach lighting awareness. The bumper sticker and other public awareness activities are funded through the USFWS grant.

SECTION 6

SUMMARY

Adult loggerhead sea turtle (*C. caretta*) emergences were recorded on Collier County beaches from April 30 through August 10, 2000. A total of 552 nests and 561 false crawls were identified on Barefoot Beach, Delnor Wiggins Pass SRA, Vanderbilt Beach, Park Shore Beach, Naples Beach, and Marco Island. Weekly emergence data suggests two peaks of increased emergence activity during the second and last week of June. The summary data for each beach is given in Table 6.1.

Table 6.1. Summary of All Monitored Beaches, 2000.

	Barefoot	Delnor Wiggins Pass	Vanderbilt	Park Shore	Naples	Marco Island	Total
Beach Length (miles)	3.1	1.2	3.5	3.2	5.6	5.6	22.1
Nests	96	17	167	154	68	50	552
Nests / Mile	31	14	48	49	12	9	25
False Crawls	85	32	136	186	70	52	561
False Crawls/ Mile	28	27	39	59	13	9	25
Mean Clutch Depth (in)	20	18	18.5	20	18	18.6	19
Nests Depredated	5	3	55	12	4	2	81
Nests Inundated	28	3	44	31	16	18	140
Mean Incubation (days)	62	60	64	64	64	66	63
Nests Disoriented	0	0	1	2	2	10	15
Mean Hatching Success	79%	79%	72%	82%	71%	73%	77%
Mean Emergence Success	72%	77%	69%	79%	69%	71%	73%
Eggs Deposited	9,904	1,566	15,250	15,360	5,794	4,819	52,693
Hatchlings Emerged	7,171	1,202	10,508	12,136	3,980	3,394	38,391

Data showed a possible nesting preference for the natural (non-renourished) beach areas. In natural beach areas, 27.8 nests/mile were recorded while only 21.5 nests/mile were recorded on renourished beach areas (Table 6.2). There is a strong correlation between nests/mile and years after renourishment and it appears the nesting activity returns to pre-nourishment numbers after three to four years. Nests laid in mechanically renourished sand were significantly deeper than in natural sand and nests laid in upland renourished sand were significantly shallower than in natural sand. Incubation rates were the same in the different sand types.

Table 6.2 Summary of Natural Versus Renourished Beach Areas, 2000.

	Natural Beaches	Renourished Beaches	All Beaches
Beach Length (mile)	11.9	10.2	22.1
Nests	332	220	552
Nests Per Mile	27.8	21.5	25
False Crawls	267	294	561
False Crawls Per Mile	22.4	28.8	25.4
Mean Clutch Depth (in)	19.1	19.3	19.2
Mean Incubation (days)	63.5	63.3	63.4
Nests Disoriented	4	11	15
Mean Hatching Success	80%	82%	81%

Nest placement was compared for both disoriented nests and those with normal seaward orientation. Significant differences were found in the distance that these nests were located away from the dune vegetation. This comparison implies a protective benefit of dune vegetation against hatchling disorientations caused by landward lighting.

Reviewing previous years disorientation numbers reveal a decrease in disorientations each year. In 1996, NRD staff documented 42 disorientations, which made up 7% of the total nests in the county. In 1997, 33 disorientations were recorded and this was also 7% of the total nests. Disorientations decreased to 27 (5% of total) in 1998 and to 27 (4%) in 1999. In 2000, only 15 disorientations were recorded and this made up only 3% of the total nests in the county.

In 2000, 81 of the nests were depredated , a small increase from 71 in 1999. This increase may be attributed to the first documentations of gray fox predation on nests in Collier County. The primary predators in 2000 were raccoons (17 (21%)), gray foxes (13 (20%)), fire ants (10 (12%)), and unknown predators (13 (16%)). Five (6%) depredated nests were believed to have been poached by humans; this is a marked decrease from 11 (16%) in 1999.

The NRD staff responded to, and documented, 67 of the 108 sea turtle strandings in Collier County in 2000, a 415% increase from 28 found stranded in 1999. Species composition includes 74 loggerheads (*C. caretta*), 29 Kemp's ridleys (*Lepidochelys kempii*), three green turtles (*Chelonia mydas*), one hawksbill turtle (*Eretimochelys imbricata*), and one unidentified.

Public awareness activities included 4,929 interactions with people during morning turtle surveys. Sea turtle protection brochures were distributed during morning turtle surveys. The NRD web page has been visited 2,741 times since September, 1998. Public Service Anouncements were aired on WZVN-TV ABC, WINK-TV, WEVU-UPN 10, Collier County Access Channel, and on the "Visitors Channel".

SECTION 7

RECOMMENDATIONS

1. Continue to monitor nesting trends, incubation duration and hatching evaluations to detect differences among renourished and natural beaches.
2. Survey upland sources of water that have the potential to flood nests. Water sources may include storm water drainage systems, pool drains, sea wall drains, upland and dune irrigation systems.
3. Continue to collect, document, and identify invertebrates such as insects found within a nest cavity.
4. Continue control of raccoon populations to improve nest and hatchling success.
5. Locate additional funding sources so the NRD may expand public awareness programs.
6. Continue beach compaction study on County beaches so compacted beaches may be tilled prior to nesting season. Integrate compaction study with analysis of nest and emergence data.
7. Continue to monitor sand temperature and ground water meters and expand studies to other County beaches, both renourished and natural.
8. Continue tracking outside nuisance raccoon removal programs.
9. Continue to encourage dune vegetation enhancement as a method of shielding "necessary" lights.
10. Increase lighting compliance efforts in areas where nests may be at higher risk of disorientation (nests in areas away from dune vegetation, or with no landward vegetation).

11. Continue to work with FP&L to reduce the effects of public lighting on beaches, and resolve city access lighting issues.
12. Continue to monitor and evaluate “hot spot” renourishment and annual incremental restoration.
13. Increase efforts to minimize furniture left on the beach during sea turtle nesting season.
14. Investigate alternative methods of upland sand placement to produce optimum nesting and hatching success.
15. Continue to work closely with state and federal agents to analyze stranding events.
16. Provide a copy of annual reports on NRD website.
17. Continue to update website on a weekly basis during nesting season.
18. Collect dead hatchlings for sexing as a way of determining possible sex ratios in southwest Florida.
19. Work with the Moorings Residence Beach Association and area residences to develop a plan to reduce beach lighting and disorientations.
20. Improve historical analysis to identify trends.
21. Investigate the characteristics of various sand types, and discuss findings in next years report.
22. Consider using GPS to measure beach lengths, rather than a survey wheel.
23. Document, in more detail, any false crawl that is associated with beach furniture, scarps, or other human caused interference.

SECTION 8
ACKNOWLEDGMENTS

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The NRD would also like to extend appreciation to the Tourist Development Council, the Collier County Board of County Commissioners; the Beach Nourishment/Maintenance Committee (Richard Lydon, Bonnie MacKenzie, Alexandra Gunderson, James Brennan, Kenneth Dunne, Joseph Herms, Carol Lynn Kendall, David Roellig, Kelly Samek, Michael Simonick, Penny Taylor, and Andrew Hill); Dr. Michael Stephen and Michael Poff, Coastal Engineering Consultants Inc.; the Collier County Parks and Recreation Dept.; and others we may have failed to mention.

SECTION 9

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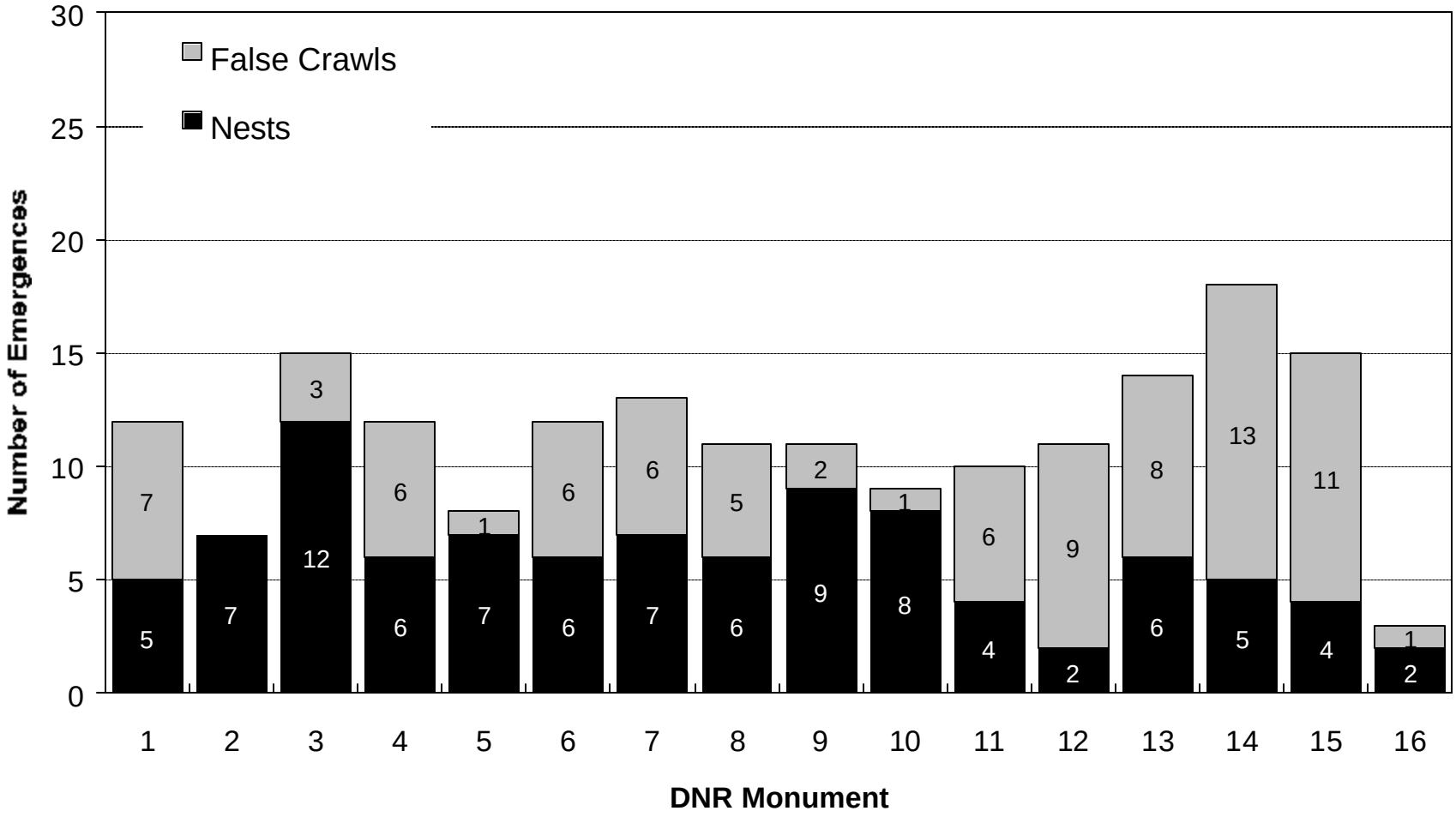
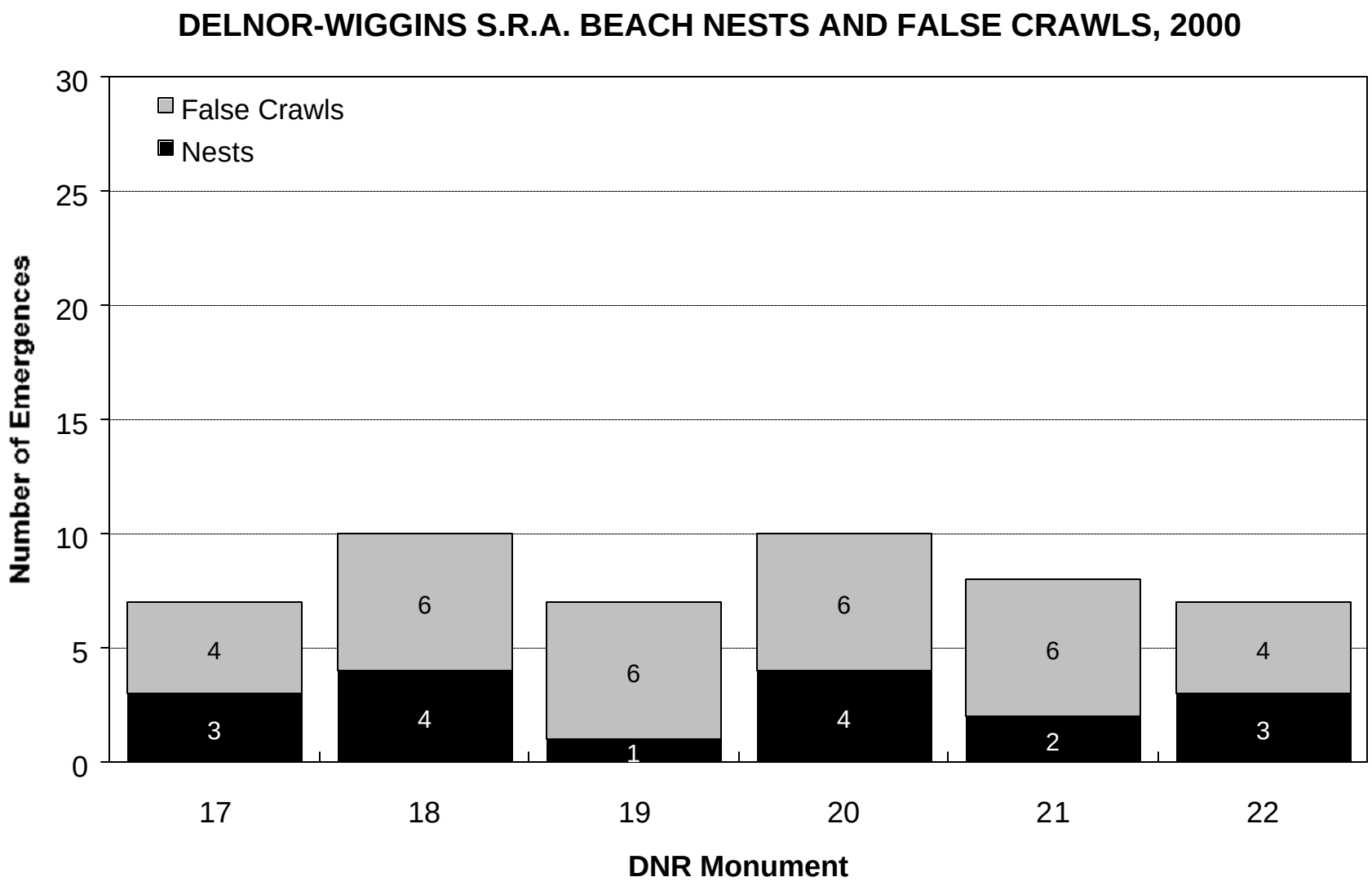
SECTION 10

APPENDIX 1

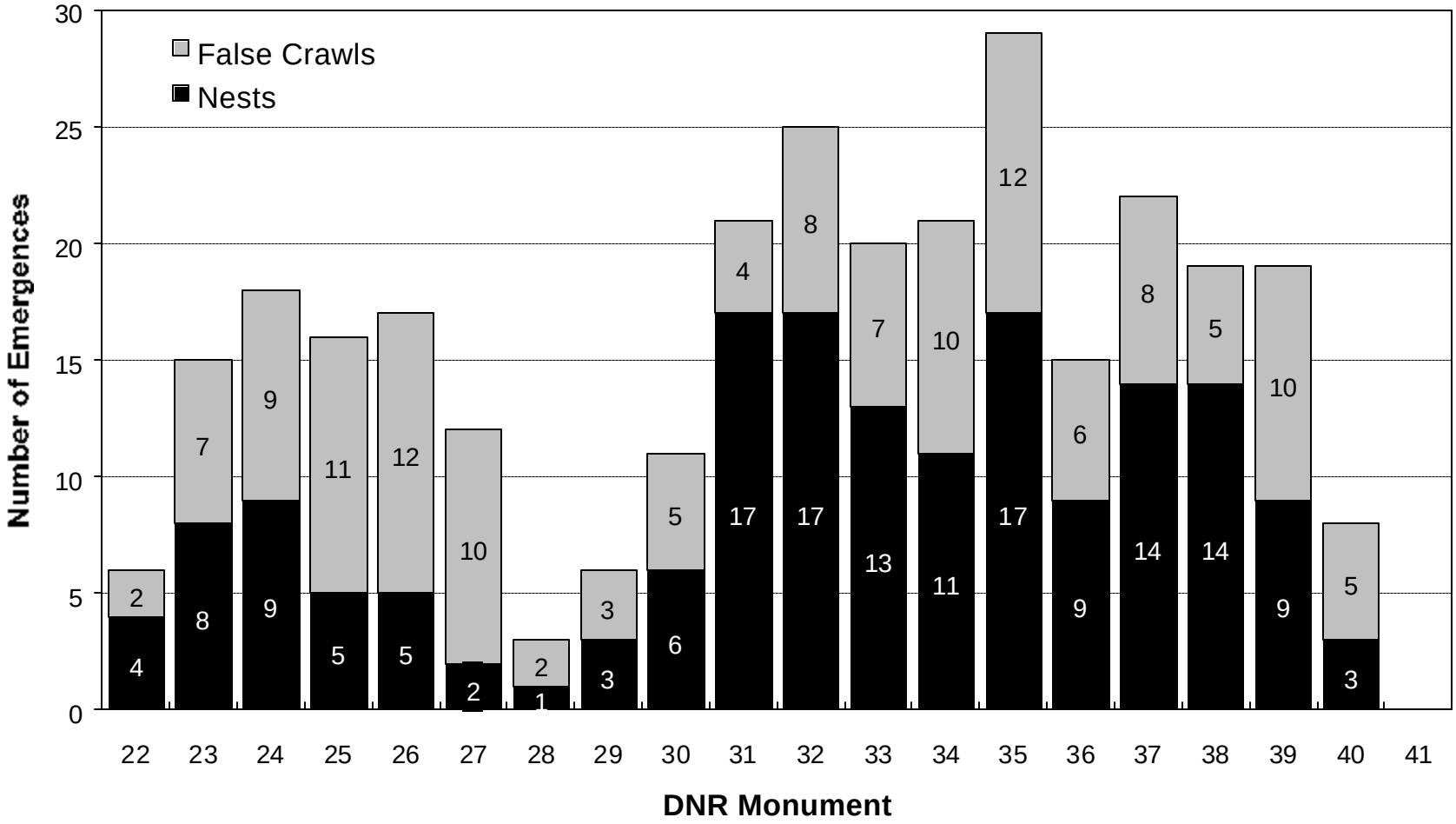
NESTS/FALSE CRAWLS BY DNR MONUMENT

BAREFOOT BEACH NESTS AND FALSE CRAWLS, 2000

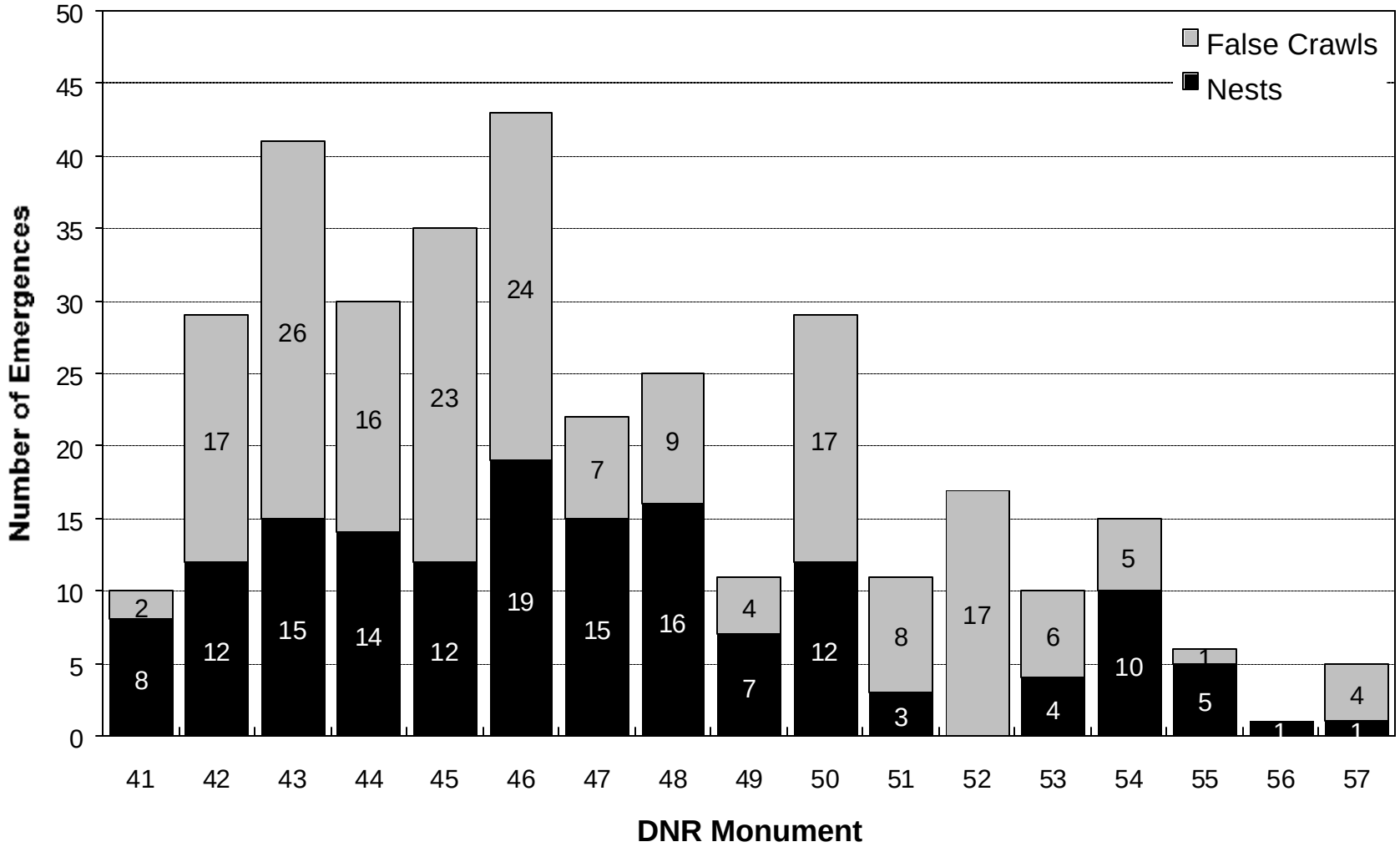



DELNOR-WIGGINS S.R.A. BEACH NESTS AND FALSE CRAWLS, 2000
False Crawls
Nests
Number of Emergences
30
25
20
15
10
5
0
4
3
6
4
6
1
6
4
6
2
4
3
17
18
19
20
21
22
DNR Monument

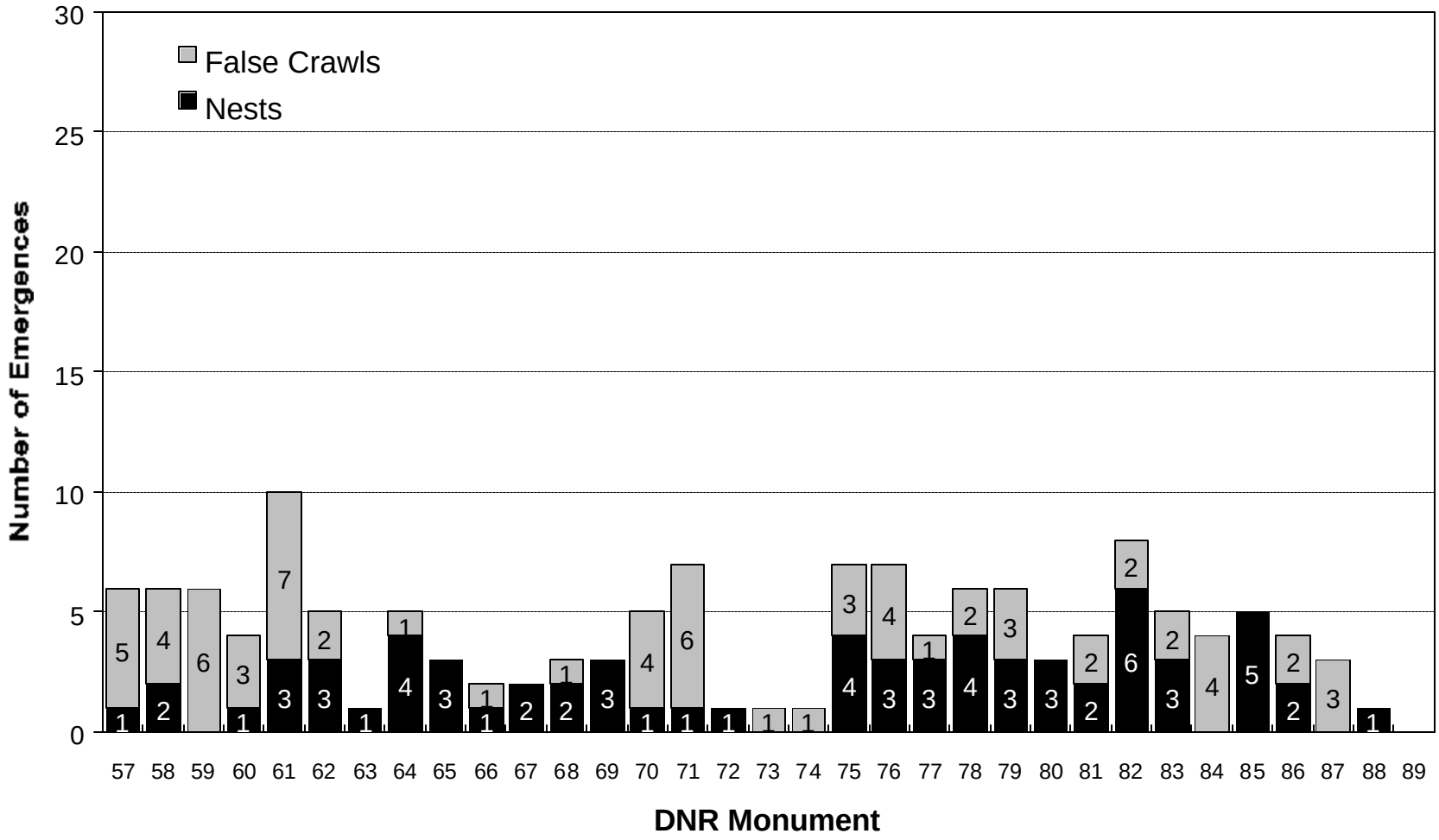
VANDERBILT BEACH NESTS AND FALSE CRAWLS, 2000



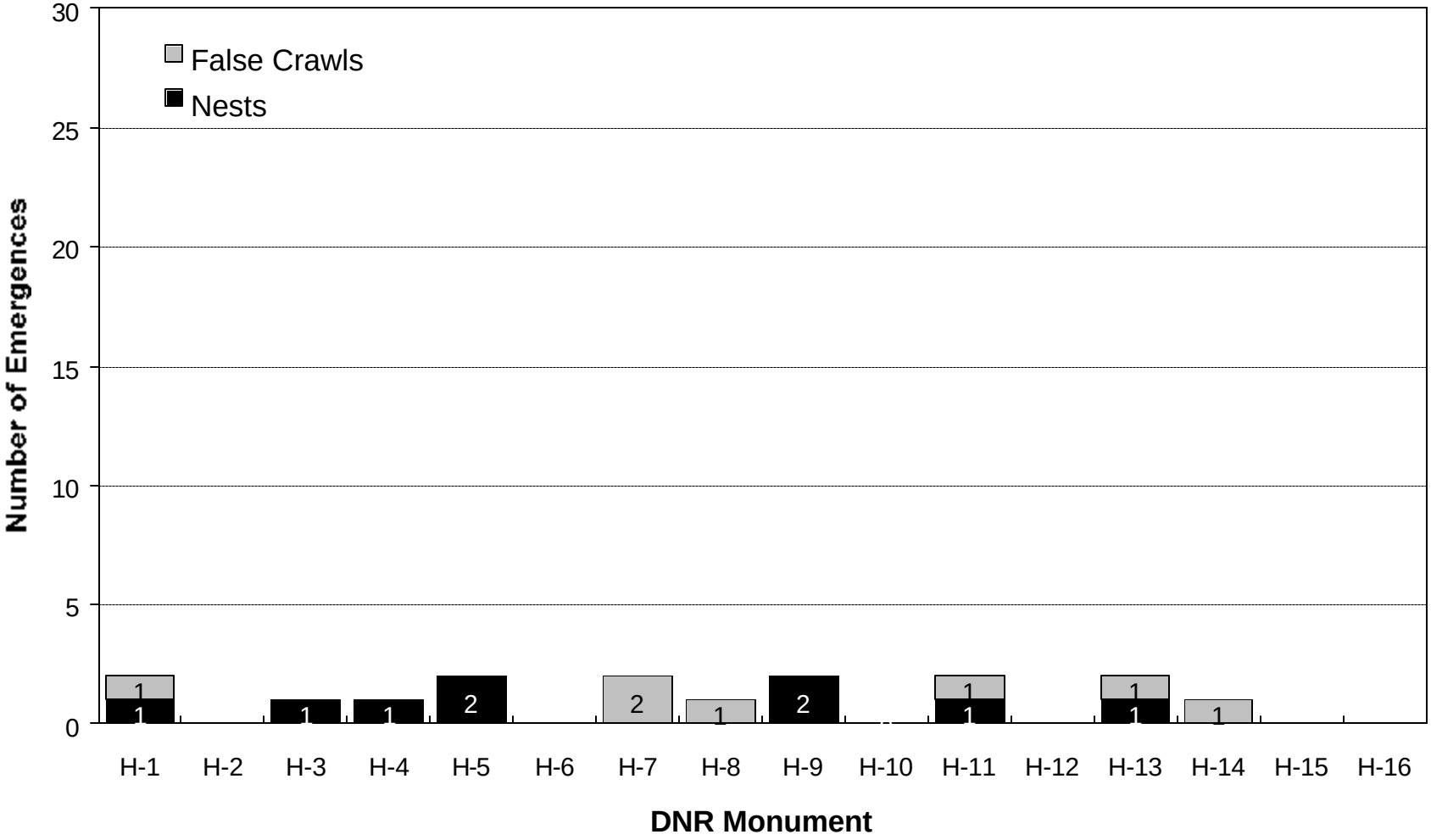
PARK SHORE BEACH NESTS AND FALSE CRAWLS, 2000



NAPLES BEACH NESTS AND FALSE CRAWLS, 2000



HIDEAWAY BEACH NESTS AND FALSE CRAWLS, 2000



MARCO ISLAND NESTS AND FALSE CRAWLS, 2000