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COLLIER COUNTY
SEA TURTLE PROTECTION PLAN
ANNUAL REPORT – 2011

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ABSTRACT

Collier County was responsible for the daily survey of 23.7 miles (38.1 km) of beach for sea turtle activities during the 2011 sea turtle season (May through October). The Collier County Parks and Recreation Department surveyed 16.9 miles (27.2 km) of beach including Barefoot, Vanderbilt, Park Shore, and Marco Island. Staff documented 404 nests in 2011, a slight decrease from 422 nests in 2010. Under contract to Collier County, the Conservancy of Southwest Florida documented 67 nests on the 5.6 mile (9.0 km) City of Naples beach. Eighteen nests were documented on the 1.2 mile (1.9 km) beach along Delnor-Wiggins Pass State Park. During the 2011 nesting season, 4% (16) of the documented nests were disoriented. Eleven percent (46) of the nests were depredated, which is an increase from the seven percent last year. A total of 26,070 hatchlings were estimated to have reached the Gulf of Mexico. The number of successfully emerged hatchlings represents a decrease compared to 27,142 hatchlings that reached the Gulf of Mexico in 2010. The number of strandings in Collier County was 35 for 2011. This was a slight decrease from the forty-seven in 2010.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
ATV	All Terrain Vehicle
BG	Bonita Grande – Upland Sand Source
BI	Big Island – Upland Sand Source
CCCL	State Coastal Construction Control Line
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CSWF	The Conservancy of Southwest Florida
DNR	Florida Department of Natural Resources (now called FWC)
DNWSP	Delnor Wiggins State Park
ERJ	E.R. Jahna – Upland Sand Source
ESD	Collier County Environmental Services Department
FDACS	Florida Department of Agriculture and Consumer Services
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
P&R	Collier County Parks and Recreation Department
STSSN	Sea Turtle Stranding and Salvage Network
TED	Turtle Excluder Device
USFWS	United States Fish and Wildlife Service

SECTION 1

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 nesting sea turtle species 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 loggerhead turtles 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 23.7 miles (38.1 km) of beach for sea turtle activities. The Sea Turtle Protection Program within the Collier County Parks and Recreation Department (CCPRD) monitored 16.9 miles (27.2 km) of shoreline on Barefoot, Vanderbilt, Park Shore, and Marco Island. 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 1.2 miles (1.9 km) 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 CCPRD), and Coconut and Sea Oat Islands (monitored by Rookery Bay NERR).

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).

This report details the methods established by the CCPRD with updates based on the Florida Fish and Wildlife Conservation Commission Sea Turtle Conservation Guidelines (FWC, 2002). The report includes an analysis of sea turtle emergences, effects of beach renourishment, historical trends, nesting and hatching, depredation, strandings, beach lighting, and public awareness. Program research and management recommendations are also provided.

SECTION 2

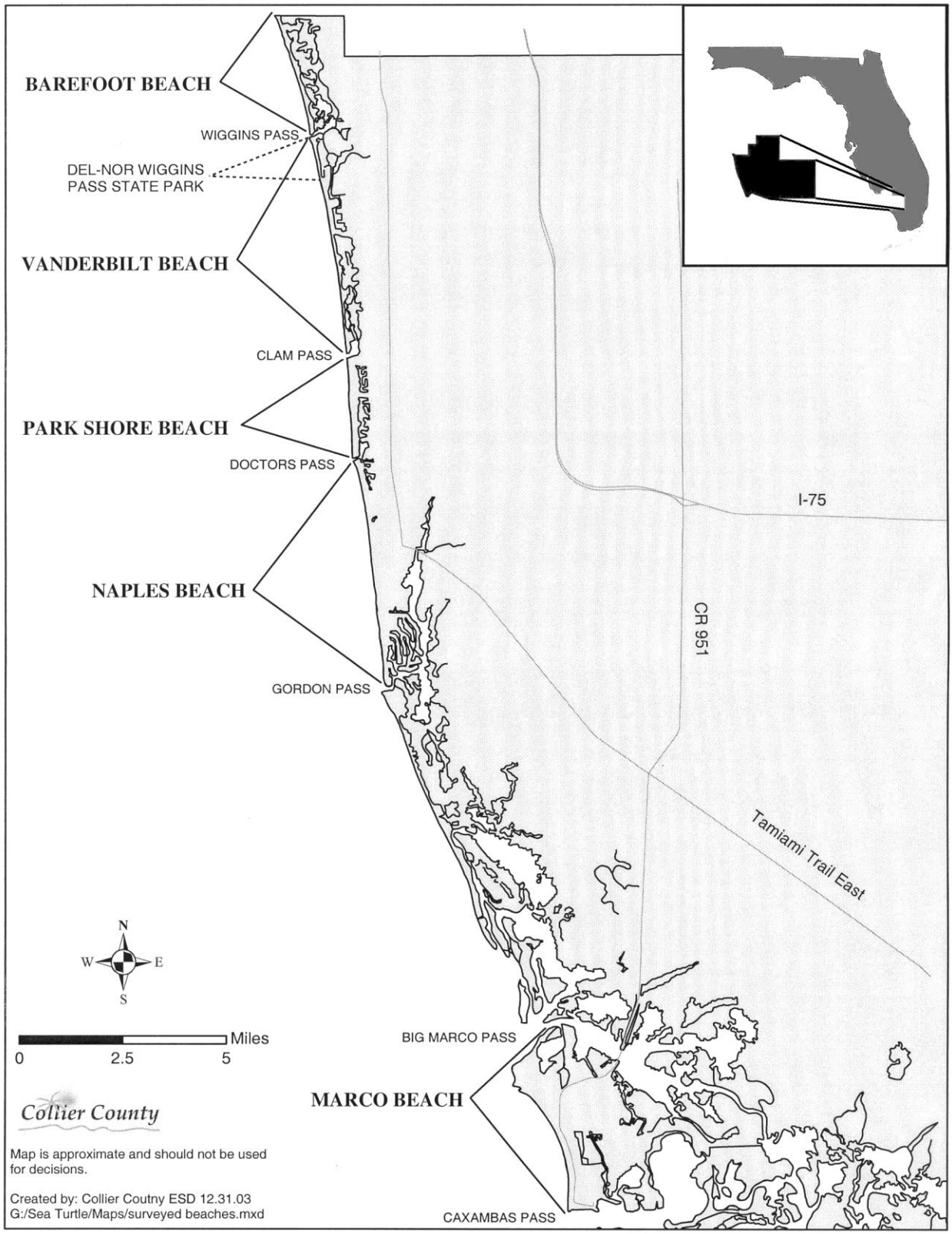
SEA TURTLE MONITORING PROGRAM

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 barrier beach units are surveyed daily (May 01–October 31) for sea turtle activities including Barefoot, Vanderbilt (including Delnor-Wiggins Pass State Park), Park Shore, City of Naples, and City of Marco Island beaches (Figure 2.1.1).

Since 1990, beach renourishment activities have occurred in Collier County. The following sections outline the year (1990–2011), DNR monument location, and sand source (hydraulic, mechanical, or upland) for each renourishment event. Hydraulic sand is transported by pipe from an offshore sand source or from a pass, with seawater as a transport medium. Mechanical sand is excavated from a pass, stockpiled and placed onto the beach. Upland sand is trucked from an inland quarry source and spread onto the beach.

Figure 2.1.1. Collier County Surveyed Beaches, 2011.



2.1.1 Barefoot Beach

Barefoot Beach is the northern-most beach unit in Collier County, which encompasses 3.1 linear miles (5.0 km) of barrier beach extending from the County line south to Wiggins Pass (DNR monument R-1 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	1,000
1991	250' North R-13 to 30' North R-15	Hydraulic	34,010	2,264
1998	R-12.5 to R-13.5	Hydraulic	11,980	913
2002	250' North R-8 South 250'	Upland (ERJ) *Dune Only	n/a	ca. 500
2002	250' North R-5.5 South 250'	Upland (ERJ)	n/a	ca. 500
2005	250' South R-5 to 250' South of R-8	Big Island *Dune Only	n/a	3,000

ERJ indicates an upland sand source known as E.R. Jahna. * Upland sand placed into dune only, this is not a beach renourishment.

2.1.2 Vanderbilt Beach / Delnor-Wiggins Pass State Park

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-41.5). The northern most mile of the Vanderbilt Beach unit, Delnor-Wiggins Pass State Park (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 activities 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 Park 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	Hydraulic	35,250	1,000
1995	*R-19 to R-20	Hydraulic	46,580	1,000
1996	100’ North R-22.5 to R-29 R-29 to 50’ South R-30.5 R-40 to R-41 (North of Clam Pass)	Hydraulic Upland Mechanical	322,800 3,000 4,500	7,490 1,588 1,000
1998	*R-19 to R-20	Hydraulic	19,550	1,000
2000	*R-18 South 850’	Hydraulic	16,960	850
2002	*R-18 to 400’ South R-20 500’ South of R-23 to R30 (Dune Protection) 150’ South R-39 415’ South (Dune Protection) 500’ South R-36 to 322’ South R-38 (Dune Protection)	Hydraulic Upland (ERJ) Upland (ERJ) Upland (ERJ)	50,614 22,138 655 4,445	2,400 6,500 265 1,822
2006	R-22 to37	Hydraulic	178,442	14,900
2007	*R-18 south to 19.5	Hydraulic	48,405	1,591

* Indicates an area within the Delnor-Wiggins Pass State Park. ERJ is an upland sand source known as E.R Jahna.

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-41.5 to R-57). Clam Pass County Park extends from Clam Pass southward approximately 2,000ft (610 m) 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
1996	Clam Pass to R-42.5	Mechanical	6,000	1,788
	350’ South R-50 to 350’ North R-54	Hydraulic	90,700	3,589
1997	Clam Pass to R-42.5	Mechanical	6,000	1,788
	350’ North R-48 to 350’ South R-50	Mechanical	8,000	2,751
1998	Clam Pass to 143’ North R-45	Mechanical	8,000	4,208
1999	Clam Pass to 270’ North R-42	Mechanical & Hydraulic	3,500	310
	430’ South R-42 to 250’ South R-43.5	Hydraulic	26,500	1,365
2000	R-50.5 to 100’ South R-53	Upland (ERJ)	35,000	2,600
2001	R-50.5 to R-54	Upland (ERJ)	28,268	3,500
2002	Clam Pass to 40’ South R-43	Hydraulic	11,725	1,975
	700’ South R-49 to 40’ South R-54	Upland (ERJ)	9,067	4,700
2006	R-45 to R-55	Hydraulic	140,336	10,543
2007	R-42 + 180 South to R-43 +500	Hydraulic	20,603	1,464
2011	R 45- R 46	Upland	7,836	1,000

ERJ indicates an upland sand source known as E.R. Jahna.

2.1.4 City of Naples Beach

The City of Naples beach unit encompasses approximately 5.6 miles (9.0 km) of shoreline from Doctors Pass south to Gordon Pass (DNR monument R-57.5 to R-89). The Conservancy of Southwest Florida monitors the City of Naples beach for sea turtle activities, contracted by Collier 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 the City of Naples beach.

Table 2.1.4.1. City of Naples Beach Renourishment History.

Year	DNR Location	Sand Source	Cubic Yards	Linear Feet of Beach
1996	Doctors Pass (R-57) to 350' North R-78	Hydraulic	759,150	18,253
	R-69.5 to R-72	Upland/Hydraulic	55,000	2,438
1998	R-69.5 to R-72	Upland (BG)	8,820	2,438
	R-75 to 400' South R-76	Upland (BG)/Hydraulic	6,696	1,213
1999/ 2000	500' North R-63 to R-64 (Naples Beach Club)	Upland (BG)	8,036	1,500
	Doctors Pass (R-57) to R-58	Upland (BG)	6,804	1,000
2000	R-88 to R-89	Upland (BI)	6,000	1,000
2002	Doctors Pass (R-57) to R-68	Upland (ERJ)	45,047	11,000
2006	R-58A to R-79	Hydraulic	345,307	18,935
2010	R-57 to R57 A +100 ft.	Upland (IM)	3,000	1,000
2011	R-57 to R-58A	Upland (IM)	22,393	2,000

BG indicates an upland sand source known as Bonita Grande. BI indicates an upland sand source known as Big Island. ERJ indicates an upland sand source known as E.R. Jahna.

2.1.5 City of Marco Island Beach

The City of Marco Island coastal barrier unit encompasses 7.1 miles (11.4 km) of beach, from inside Big Marco Pass [Hideaway Beach (DNR monument H-16 to H-1)] south to Caxambas Pass (DNR monument R-131 to R-148). The City of Marco Island is a highly developed beach with high-rise condominiums and hotels. This beach 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 the City of Marco Island.

Table 2.1.5.1. City of Marco Island Beach Renourishment History.

Year	DNR Monument	Sand Source	Cubic Yards	Linear Feet of Beach
1990	*H-3 to H-7	Hydraulic	70,000	2,063
	R-136.5 to R-138.5	Hydraulic	284,600	2,189
	R-142.5 to R-148	Hydraulic	715,400	5,533
1997	*130’ South H-9 to 45’ South H-11	Upland (BG)	1,000	1,345
	*370’ South H-1 to 131’ South H-3	Upland (BG)	4,000	1,636
	R-145.5 to R-148	Upland (BG)	80,000	1,781
1998	*H-9 to H-11	Upland (BG)	15,000	1,250
	*400’ South H-1 to H-2	Upland (BG)	10,000	900
1999	*H-1 to H-3	Upland (BG)	3,528	985
	R-148 South to Caxambas Pass	Upland (BG)	9,000	625
2000	*200’ North H-1 to H-3	Upland (BI)	3,600	950
		Hydraulic	2000	
2001	*H-1 to H-4	Upland (ERJ)	15,000	1,500
	*H-9 to H-13.5	Hydraulic	24,078	2,300
2002	R-136 to R-136.5	Upland (ERJ)	148	300
	*140’ South H-9 to 140’ North	Upland (ERJ)	359	280
2003	*200’ South H-1 to 40’ North H-4	Upland (ERJ)	11,096	1,740
	*H-9 to H-11	Upland (ERJ)	11,096	1,000
2005	H1 to H-9	Hydraulic	316,770	6,300
2007	R-144 to R-148 +549	Hydraulic	168,431	4,288
2010	H4 to H9	Hydraulic	130,000	2,500

* Indicates an area within Hideaway Beach were the H-monuments are numbered consecutively from southwest to northeast. BG indicates an upland sand source known as Bonita Grande. BI indicates an upland sand source known as Big Island. ERJ indicates an upland sand source known as E.R. Jahna

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. The objective of the surveys was to develop daily monitoring strategies, note the condition of the beaches, zone the beaches for management purposes, and conduct cone penetrometer readings to determine if the beaches required tilling pre-season.

Metal signs on 6' metal posts were placed within the dune area in approximately 1,000ft increments from the Lee/Collier County line south through Marco Island. In addition, wooden stakes were installed 500 ft south of every DNR marker. Beaches were measured along the high tide line using a Rolatape survey wheel.

2.2.2 Daily Monitoring

Prior to beach raking, daily surveys for emergence activity were performed along the high water line (HWL) utilizing all-terrain-vehicles (ATVs) equipped 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. A GPS reading was taken for each emergence location.

All nests were marked with stakes, flagging tape, and a sign to provide protection and facilitate evaluations. Four 36-inch (91 cm) long wooden stakes were placed in the corners of each disturbed area. Yellow ribbon with the word " caution" printed on it, was then placed around the stakes and a Sea Turtle Nest Sign (Figure 2.2.2.1) was affixed to alert and direct

beach rakers and the public away from nests. In addition, the stakes were marked with their direction (SW, NW, SE, NE) to facilitate clutch location if some stakes were lost during storms.

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 four-foot (1.2 m) square wire mesh screen over the clutch with metal tent stakes. The 2 by 4 inch screen openings (5.1 by 10.2 cm) were large enough to allow the natural escape of hatchlings, but were small enough to prevent mammalian 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 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 60 days). All nests were observed for signs of hatching, such as an obvious depression in the sand or hatchling tracks around the nest. Each nest was excavated for evaluation approximately 72 hours (3 days) 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 each nest evaluation was recorded on CCPRD Sea Turtle Nesting Forms. Empty eggshells 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 refer to hatchlings (dead or alive) that puncture the eggshell but did not fully emerge from 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 or absence of predatory birds in the area. Hatchling releases were conducted according to the Florida Fish and Wildlife Conservation Commission Sea Turtle Conservation Guidelines (FWC, 2007).

Nests were also inspected for evidence of predation. If signs of predation were discovered, the information was recorded. The collection of predator data aids in quantifying and determining the extent nest predation 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 ArcMap and Collier County Property Appraiser's aerial photographs taken in 2011. 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 Garmin GPS 76 marine navigator. Graphs and plots were created using Microsoft Excel. Data was analyzed with personal computers 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 (nesting success), emergences 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.

2.3 RESULTS AND DISCUSSION

2.3.1 Emergences

Sea turtles emerged upon Collier County beaches from April 27, 2011 through August 8, 2011. A total of 805 emergences (404 nests and 401 false crawls) occurred along the 23.7 miles (38.1 km) of the daily surveyed shoreline. A breakdown of emergence activity for each beach is listed in Table 2.3.1.1. Aerial maps showing emergence location by beach are available as an additional appendix separate from this report. A comparison of nests and false crawls for each beach segment is given in Figure 2.3.1.1. A breakdown of emergences per mile on each beach is illustrated in Table 2.3.1.1. Vanderbilt beach recorded the most sea turtle activity with an average of 57 emergences per mile. The City of Naples beach received the least activity with an average of 21 emergences per mile.

Table 2.3.1.1. Emergences, 2011.

	Barefoot	Delnor Wiggins	Vanderbilt	Park Shore	Naples	Marco	Total
Total Nests	71	18	93	90	67	65	404
Total False Crawls	38	12	107	69	51	124	401
Total Emergences	109	30	200	159	118	189	805
Nest / Emergence (%)	65.1	60	46.5	56.6	56.8	34.4	50.2
Beach Length (mi.)	3.1	1.2	3.5	3.2	5.6	7.1	23.7
Emergences / mi.	35.2	25.0	57.1	49.7	21.1	26.6	34.0
Nests / mi.	22.9	15	26.6	28.1	12.0	9.2	18.9
False Crawls / mi.	12.3	10	30.6	21.6	9.1	17.5	16.8

Figure 2.3.1.1. Sea Turtle Emergences in Collier County, 2011.

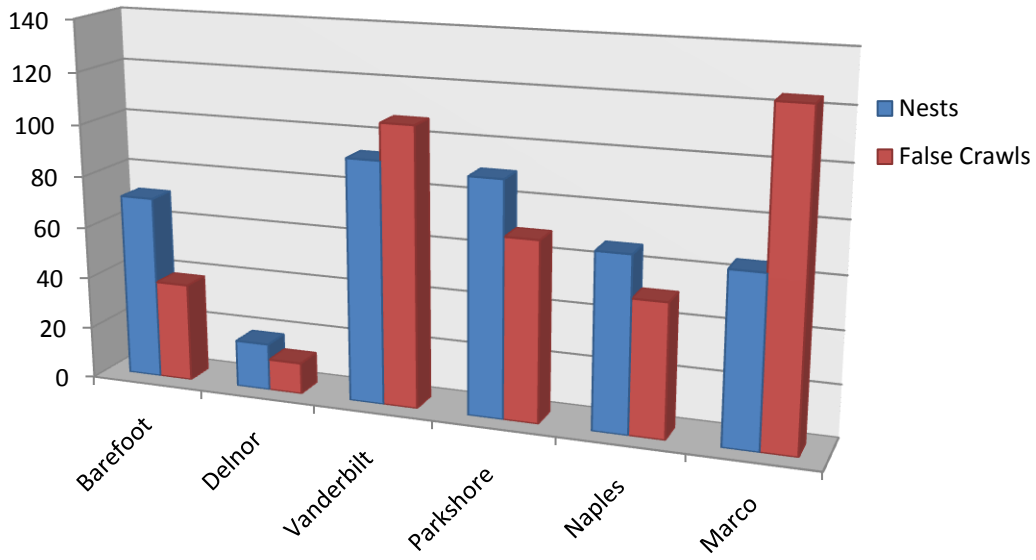


Table 2.3.1.1 shows some variation in total nests and false crawls between beaches. This variation is difficult to explain since nest-site selection of the female turtle is still poorly understood. Some important factors include, but are not limited to: beach compaction, artificial lighting, human activity, 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 aborted egg cavities on renourished beaches (Raymond, 1984a; Nelson, 1991). Witherington (1991) found that the "presence" of lights in beach areas "sharply reduce" the number of sea turtles that emerge to nest. 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, Australian pine trees (*Casuarina* spp.), and boats stored on the beach.

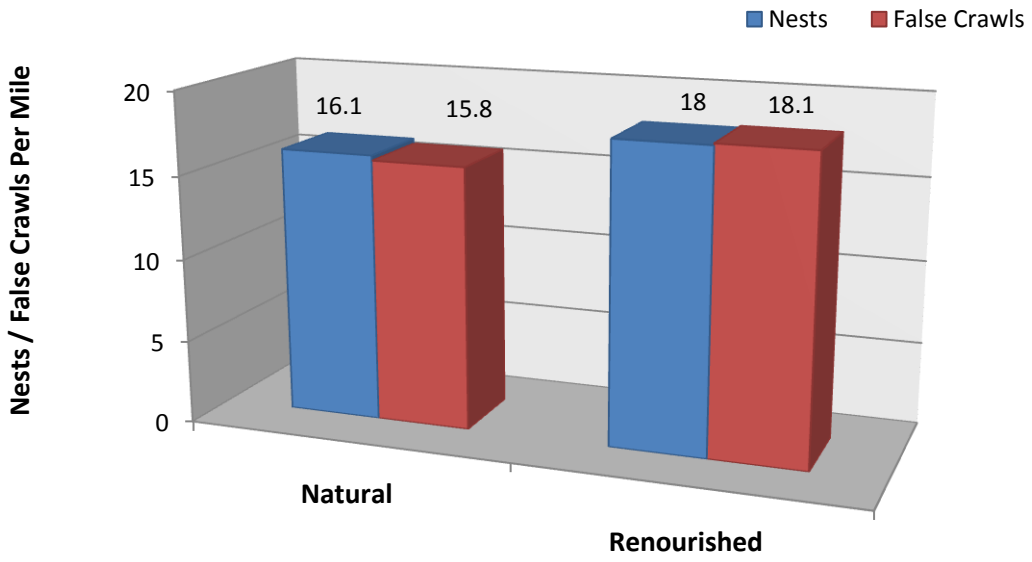
Abandoned nesting attempts (false crawls) are a common occurrence for loggerheads and have been recorded at all nesting beaches (Dodd, 1988). Raymond (1984b) reported that on natural beaches, 46% to 49% of emergences resulted in false crawls. The 401 false crawls in Collier County, represents 50% of the total emergences. The reasons for the 2011 false crawl ratio may include: lighting violations, human activity, furniture and vending materials left on the beach overnight and boardwalks.

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.

2.3.2 Effects of Beach Renourishment

Figure 2.3.2.1 compares the 2011 nests and false crawls per mile on natural and renourished beach areas on the combined beaches of Barefoot, Vanderbilt (including Delnor Wiggins Pass State Park), Park Shore, City of Naples, and City of Marco Island.

Figure 2.3.2.1. Natural Versus Renourished Beaches, 2011.



Dodd (1998) reported that loggerhead sea turtle nest site selection might be influenced by "micro-habitat cues" that initiate the nesting process. Microhabitat cues may be significantly different on renourished beaches when compared to natural, non-renourished beaches, and these differences may influence nesting preferences and success. Collier County beaches are continually nourished and renourished, therefore, continued research and data collection is imperative. Studying the historical nesting data from different sand types will ensure the best selection of sand to reduce negative impacts of future renourishments.

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 Park (from Clam Pass south to Seagate beach access) in 1992. In 1994, the "Collier County Sea Turtle Protection Program" was developed to survey 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 2.3.3.2 – 2.3.3.6 for all beaches. Figure 2.3.3.1 reflects the overall County beach totals.

Table 2.3.3.1. Historical Trends of Sea Turtle Nests and False Crawls (FCs), 1998–2011.

Beach Unit	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Barefoot Nests	108	104	96	104	62	88	84	72	56	40	75	59	87	71
Barefoot FCs	90	89	85	84	28	66	73	67	55	33	85	50	90	38
Delnor Nests	29	33	17	23	15	21	11	15	10	18	17	22	20	18
Delnor FCs	24	33	32	25	22	49	38	46	12	20	33	36	20	15
Vanderbilt Nests	186	170	167	125	90	159	90	61	78	55	82	62	111	93
Vanderbilt FCs	175	111	136	118	131	125	45	91	81	69	64	65	88	107
Park Shore Nests	150	106	154	105	81	122	73	40	68	67	73	50	86	90
Park Shore FCs	133	119	186	79	75	188	64	58	78	60	52	43	74	69
Naples Nests	49	87	68	52	31	59	61	31	30	42	50	50	72	67
Naples FCs	70	74	70	49	49	52	39	55	40	43	38	42	35	51
Marco Nests	91	91	50	79	28	55	59	39	56	40	34	54	46	65
Marco FCs	117	113	52	115	54	80	97	75	107	96	52	94	90	124
Total Nests	613	591	552	488	307	504	378	258	298	262	331	297	422	404
Total FCs	603	539	541	470	359	560	356	392	373	321	324	330	397	401

Figure 2.3.3.1.Collier County Annual Emergences, 1998 – 2011.

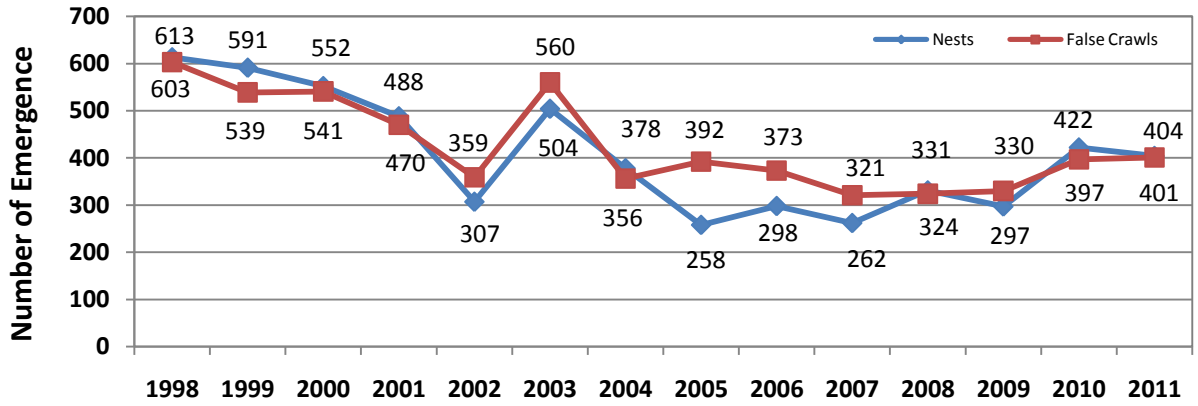


Figure 2.3.3.2.Barefoot Annual Emergences, 1998 – 2011.

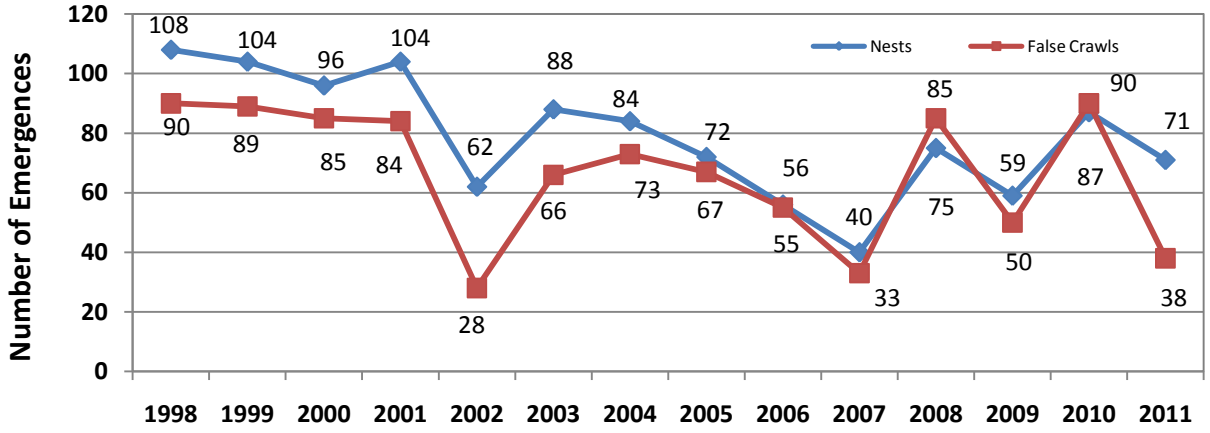


Figure 2.3.3.3.Delnor-Wiggins Pass SRA Annual Emergences, 1998 – 2011.

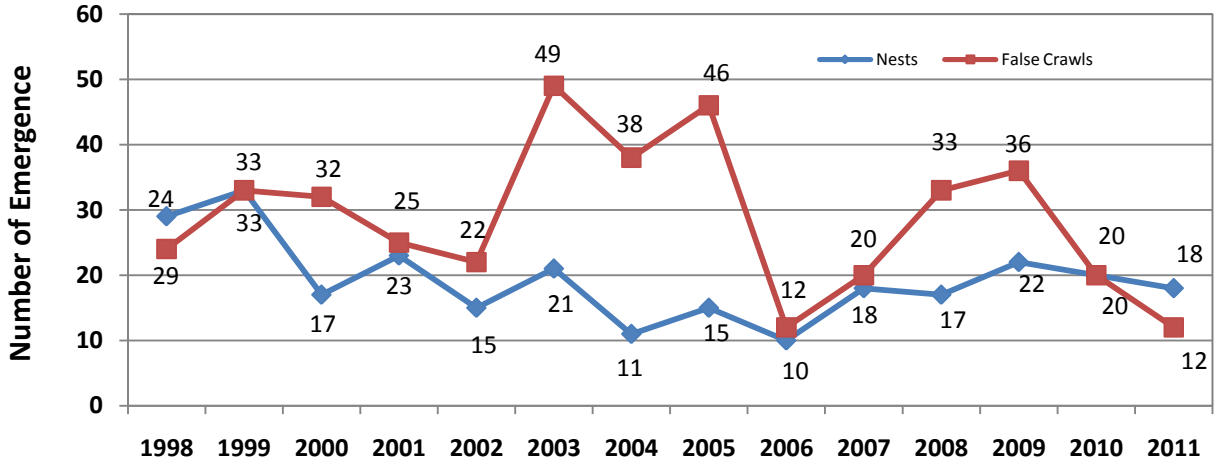


Figure 2.3.3.4.Vanderbilt Beach Annual Emergences, 1998 – 2011.

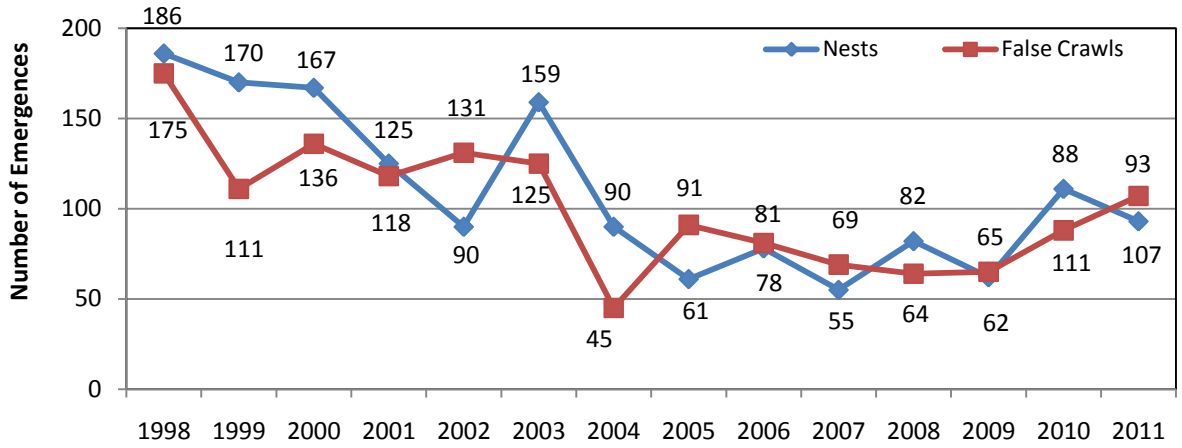


Figure 2.3.3.5.Park Shore Beach Annual Emergences, 1998 – 2011.

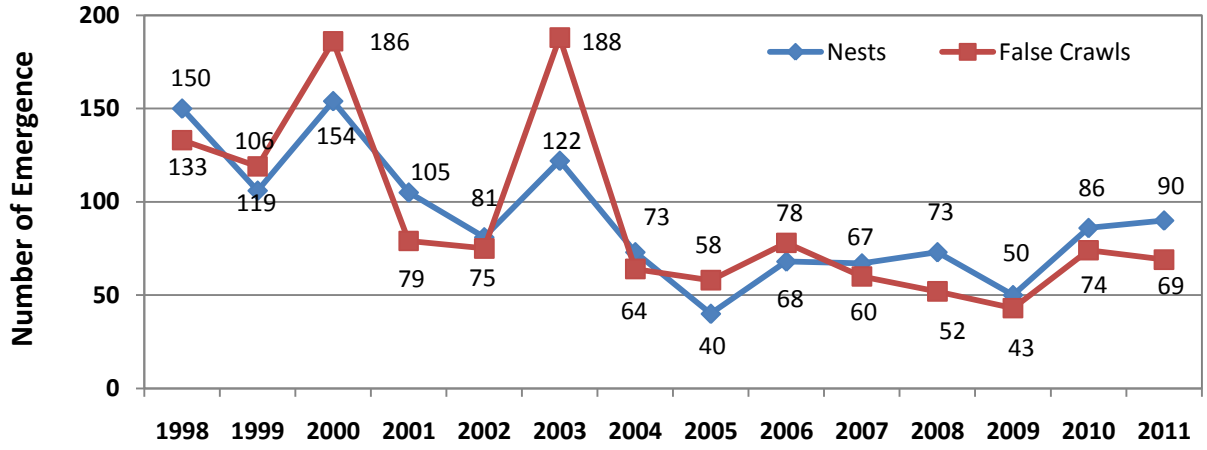


Figure 2.3.3.6.City of Naples Annual Emergences, 1998 – 2011.

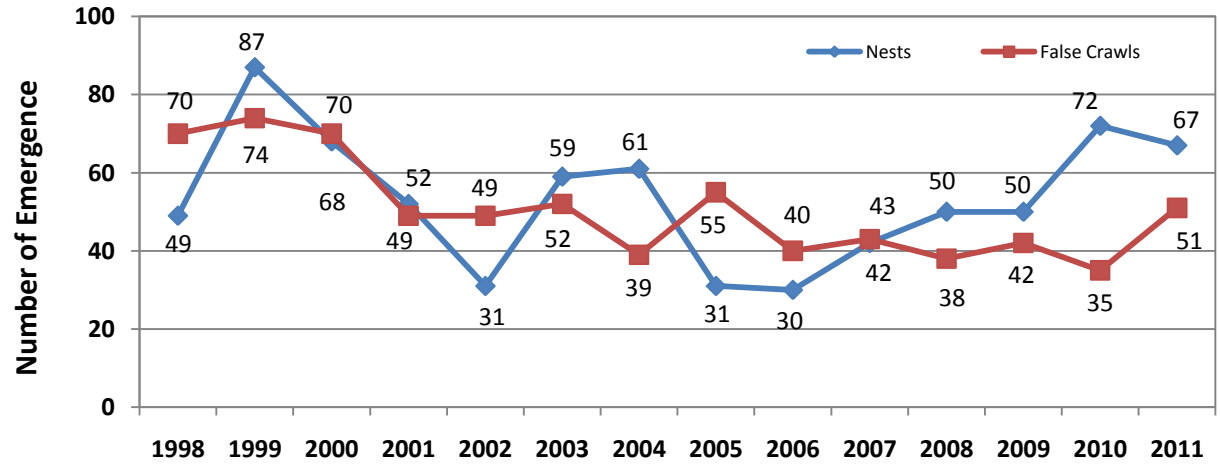
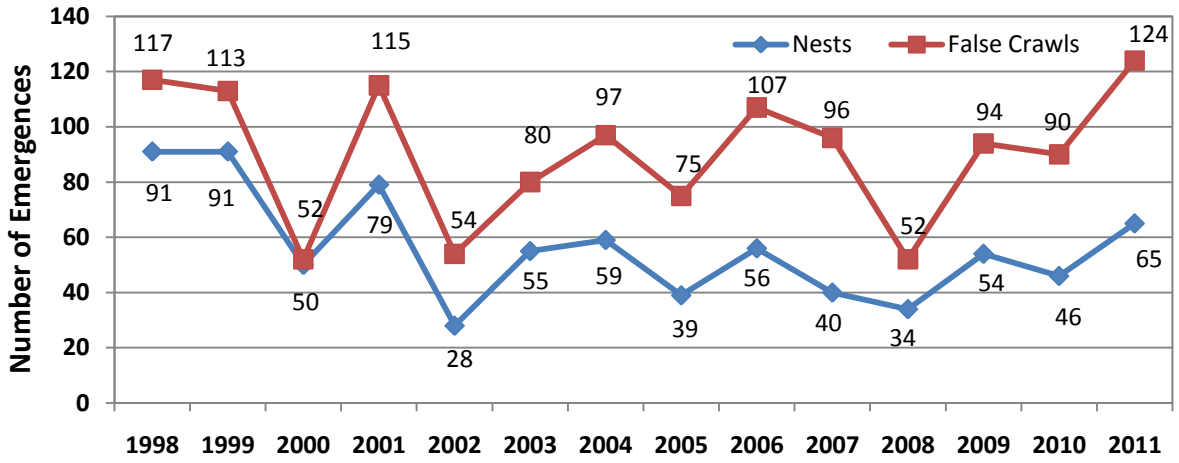


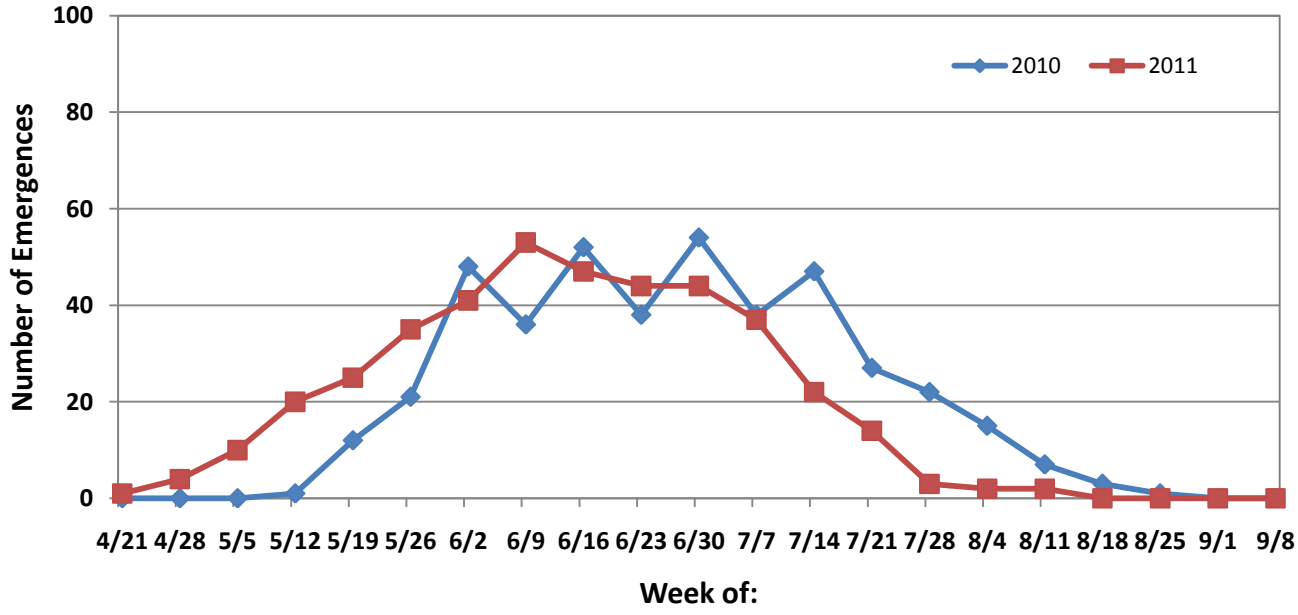
Figure 2.3.3.7.City of Marco Island Annual Emergences, 1998 – 2011.



2.3.4. Weekly Emergence Analysis

Sea turtle weekly emergence (nest and false crawls) trends are depicted in Figure 2.3.3.1 for 2010 and 2011. There are typically two peaks of sea turtle emergences for each season. The peaks for the 2011 season occurred in the beginning of June and the first week of July, which is representative of an average season.

Figure 2.3.4.1.Collier County Emergences Per Week, 2010 –2011



2.3.5 Clutch Depth

Measurements of the egg cavity were taken for each excavated nest when possible. Clutch depths were recorded from 339 of the 404 nests deposited. 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 firm bottom of the egg cavity. A significant difference was found when the clutch depths were compared between renourished and non-renourished beaches ($p = 0.015$; $df = 1,337$; $F = 3.87$).

Table 2.3.5.1.Clutch Depth in Renourished Sand Types, 2011.

	Natural	Renourished
Mean Clutch Depth (Inches)	19.8	20.5
Number of Nests	164	175

2.3.6 Hatching Evaluation

In 2011, 404 nests were marked for evaluation. Of these nests, the Sea Turtle Protection Program, The Conservancy of Southwest Florida, and Delnor-Wiggins Pass State Park staff evaluated a total of 368 nests. Thirty-six (9%) were lost due to storms during the 2011 season. Tidal flooding inundated 23% (n = 95) of all nests. Tidal flooding and washed out nests combined accounted for 32% of all nests compared to 28% in 2010.

The average number of eggs per nest (clutch size) was 102 (range = 35–174). 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 2.3.6.1.Collier County Mean Clutch Size, 2011.

	Barefoot	Delnor Wiggins Pass	Vanderbilt	Park Shore	Naples	Marco
Mean Egg Count / Nest	97	106	104	98	102	109

A total of 36,481 eggs were deposited into the evaluated nests and 26,070 hatchlings entered the Gulf of Mexico (Table 2.3.6.2). The total number of hatchlings that entered the Gulf of Mexico includes 25,866 that emerged on their own and 204 that were found alive in the nest cavity.

Table 2.3.6.2.Nest / Hatchling Evaluations by Beach Unit, 2011.

	Barefoot	Delnor Wiggins Pass	Vanderbilt	Park Shore	Naples	Marco	Total
Total Nests	71	18	93	90	67	65	404
Lost Nests	2	1	7	11	3	12	36
Total Eggs	6,725	1,804	8,616	7,627	6,043	5,666	36,481
Emerged Hatchlings	4,470	1,180	6,583	5,510	4,135	3,988	25,866
Hatchlings Alive in Nest	40	7	35	24	34	64	204
Hatchlings Dead in Nest	209	46	39	299	16	212	821
Undeveloped Eggs	1,472	374	1,545	1,118	1,425	585	6,519
Dead Embryos	211	65	328	502	286	732	2,124
Predated Eggs	228	133	45	121	121	22	670
Pipped Live Eggs	96	3	35	61	28	83	306
Pipped Dead Eggs	20	3	34	54	25	74	210
Overall Hatch Success of Evaluated Nests	70%	68%	77%	76%	69%	75%	73.7%
Overall Hatchling Emergence Success	66%	65%	76%	72%	68%	70%	70.9%

Unhatched eggs (8,643) were opened to identify fertility and embryonic development. Dead embryos comprised 23% of the unhatched eggs, depredated eggs made up 7%, and the remaining 70% were labeled as undeveloped due to lack of evidence of advanced embryological development. The 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 20 are difficult to distinguish and were recorded together and labeled as "less than stage 21". Stages 21 through 30 are determined relatively easily with the naked eye and were recorded separately. Embryos too decomposed for identification were labeled as "undetermined".

The mean incubation rate for nests deposited in non-renourished areas was 59.9 days. This rate is only slightly higher than the 59.2 days experienced for nests deposited in renourishmed sands (hydraulic and upland). Finally, there was no significant difference in the mean incubation rate between nests that were fully exposed to the sun and nests that were shaded by vegetation or buildings ($p = 0.99$; $df = 1,318$; $F = 2.23exp\text{-}4$).

Table 2.3.6.3. Mean Incubation Rate in Natural and Renourished Sand Types, 2011.

	Natural	Hydraulic	Upland
Mean Incubation Rate (days)	59.9	59.0	60.6
Number of Nests	153	146	21

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 including live hatchlings and dead 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 emergence success was 65% and the mean hatching success was 62% for all beaches and sand types (Table 2.3.6.5). The emergence success of nests found on natural, non-renourished beaches versus renourished beaches was not significantly different ($p = 0.18$; $df = 1,403$; $F = 1.81$). When comparing the hatching successes on natural non-renourished beaches with those of renourished beaches, there was also no significant difference found ($p = 0.19$; $df = 1,403$; $F = 1.71$).

Table 2.3.6.4. Hatching and Emergence Success in Natural and Renourished Sand, 2011.

Natural Sand or Renourishment Type	Natural	Renourished	Overall
Mean Hatching Success	62%	67%	65%
Mean Emergence Success	60%	65%	62%

2.3.7 Nest Predation

Depredation by raccoons (*Procyon lotor*), fire ants (*Solenopsis invicta*), ghost crabs (*Ocypode quadrata*), roots and humans affected 11% (46 nests). Most depredations occurred on Barefoot Beach, where 7 nests (10%) were depredated. The damage caused by predators to sea turtle eggs was not significant. Of 36,481 eggs deposited in 2011, 670 (1.8%) were lost to predators, which represents no change from 688 (1.8%) in 2010. Table 2.3.7.1 provides a breakdown of egg predation during 2011.

Table 2.3.7.1. Egg Depredation in Collier County, 2011.

Predator(s)	Number of Eggs Taken	Percentage By Predator
Raccoons	517	77%
Ants	7	1%
Human	4	1%
Roots	113	17%
Another Nesting Female	3	< 1%
Ghost Crabs	26	4%
Total	670	2%

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. In 2001–2011, the majority of the nests were raccoon-depredated within 24 hours of deposition.

Section 3

Public Awareness and Beach Lighting

Public education plays a vital role in conservation. Many beach goers are unaware of the problems sea turtles encounter. The CCPRD staff provides an important link to knowledge and understanding of the characteristics and natural history of the sea turtles inhabiting our area. In 2011, staff responded to the inquiries of approximately 3,933 people during morning surveys and over 8,911 people during educational programs and exhibits. Through public presentations, mail distributions and related local events, the CCPRD staff works to make sea turtle conservation a community challenge that brings to light the importance of our common natural environment. Our local beaches are an important habitat requirement for sea turtles and making homeowners and visitors aware of the possible impact of artificial lighting is also an important aspect of the public education 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 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, causing them to crawl towards sources of the light pollution (disorientations). Disorientations affect sea turtles by leaving them vulnerable to dehydration, exhaustion, and predation (Witherington, 1999). Hatchling loggerhead turtles appear 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.

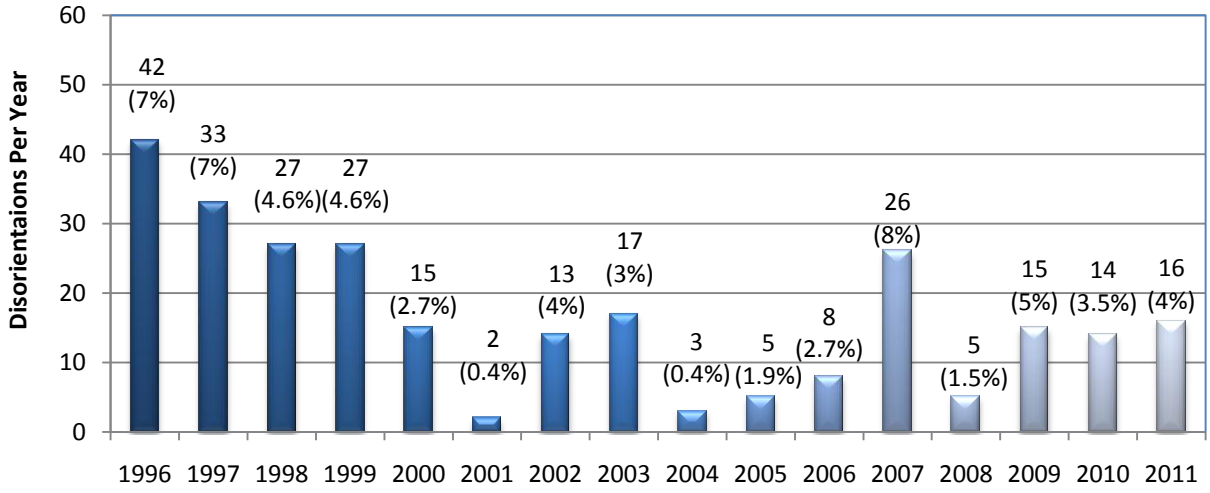
In accordance with the "Collier County Sea Turtle Protection Regulations" (Land Development Code Sec.3.10, 1994), CCPRD developed a program to minimize the damages caused by light pollution. The program is composed of two annual mail-outs prior to season, night lighting compliance inspections, violation notices, and code enforcement action. The first annual mail-out is a sea turtle information package sent to beachfront homeowners and establishments. The mail-out illustrates the importance of shielding or turning off lights during sea turtle nesting season and suggests inexpensive methods of reducing and minimizing beach lighting. It also reminds the residents to remove any obstacles to nesting and hatching sea turtles such as beach furniture or recreational accessories, and reminds them to refrain from trimming beachfront vegetation during and prior to season. The 2nd mail out is a post card/sticker and is sent a few days prior to May 1.

Throughout sea turtle nesting season (May 01 – October 31), the CCPRD staff conducts monthly lighting compliance inspections. The monthly inspections 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 property managers and owners to correct the problem. Violations with no attempt to correct are sent 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 formal "Notice of Violation". Additional violations may result in citations and court actions.

By working with property owners, managers, and renters, the beach lighting program decreased the amount of hatchling sea turtles affected by light pollution. In 1996, ESD staff

documented 42 disorientations (7% of the nests), since that time the amount of disorientations has decreased. In 2011, there were 16 disorientations (4% of the nests) caused by severe beach lighting violations, including a beach renourishment that was conducted during sea turtle season on Hideaway Beach. Ten disorientations were documented during this event. Figure 3.1 shows a yearly decrease in disorientations beginning one year after the initiation of the beach lighting program and continuing through 2011.

Figure 3.1. Disoriented Nests in Collier County, 1996–2010.



In addition to documenting lighting violations, Parks and Recreation staff also recorded objects left on the beach that could be an obstacle to nesting and hatchling sea turtles. The Collier County Land Development Code section 3.13.3 requires that any structure such as beach umbrellas and furniture not requiring a building permit, be removed nightly from the beach. Objects left on the beach over-night were documented and a NOV sticker adhered to the object to inform the owner of the need for furniture or equipment to be removed. Staff hopes to reduce this number by notifying people about the harm furniture and other equipment can cause on nesting or hatchling sea turtles.

SECTION 4

SEA TURTLE STRANDING AND SALVAGE PROGRAM

Stranded sea turtles are those which wash ashore or are found floating, dead or alive in a weakened condition. Collier County has been actively involved in assisting the Florida Fish and Wildlife Conservation Commission's (FWC) Sea Turtle Stranding and Salvage Network (STSSN) with data collection on dead, sick or injured sea turtles since 1994. Prior to 1994, not all strandings in Collier County were reported and many sea turtles were disposed of without notification to staff 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 this 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 the following: incidental catch by commercial fisheries (trawling gear, gill nets, drift nets, long lines and crab traps), entanglement and ingestion of marine debris, boat strikes, poaching, injury from shark attack, disease, and natural causes. The cause of mortality is determined when possible and used to identify ways of aiding in population sustainability; although it is estimated that only 27% of the carcasses are detected and therefore reported (Murphy, T.M. and Sally Hopkins Murphy, 1989). The STSSN program is critical to the future conservation and recovery efforts of sea turtles.

In 2011, 35 sea turtles were reported stranded along the Collier County coastline (Figure 4.2). Strandings occurred every month except December (Figure 4.1).

Figure 4.1. Collier County Sea Monthly Turtle Strandings 2011

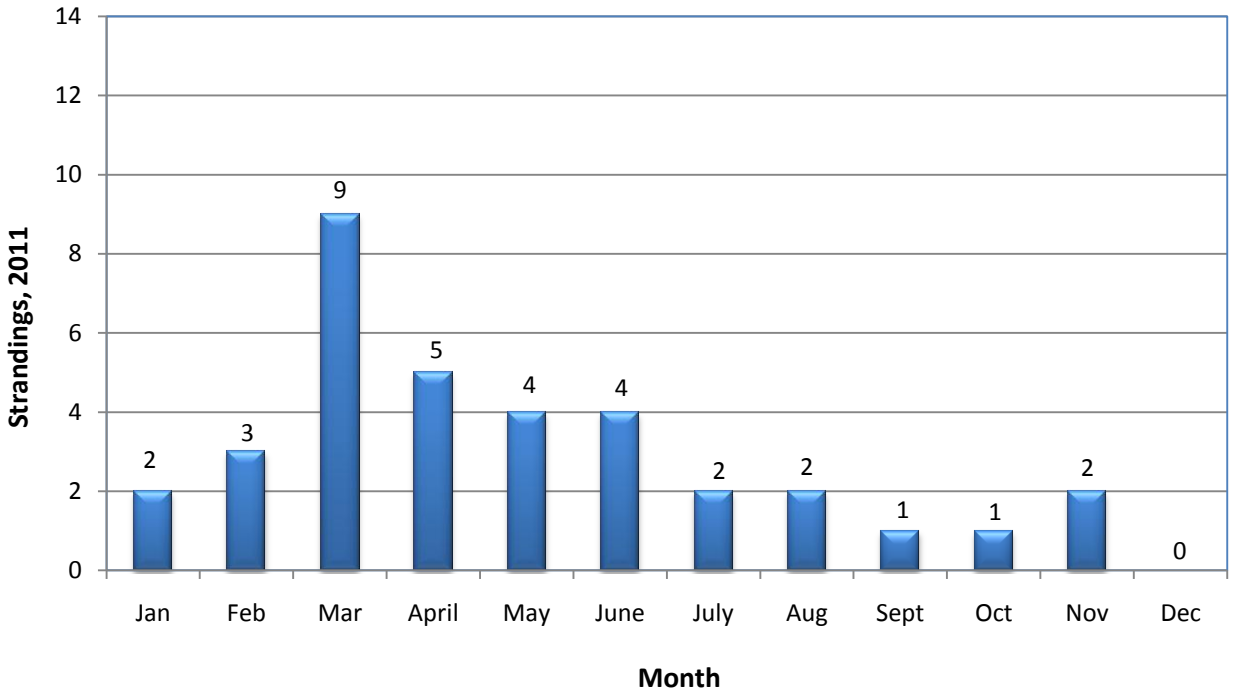
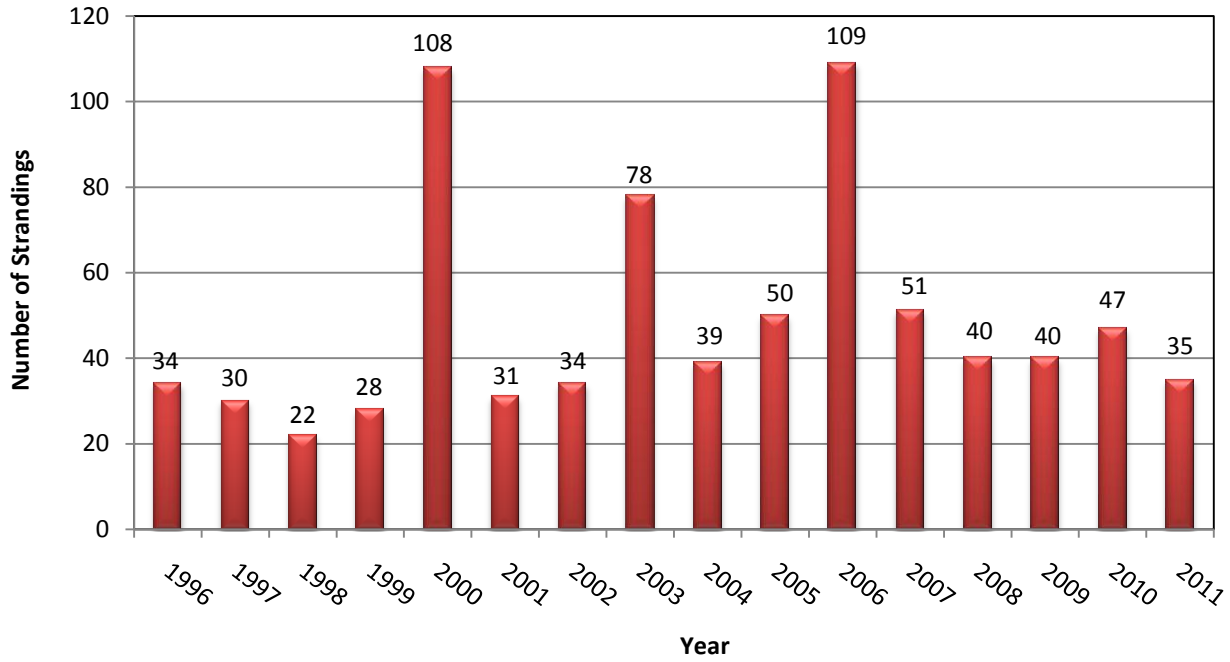


Figure 4.2. Collier County Sea Turtle Strandings, 1996-2011.



Strandings in 2011 included 21 loggerheads, six (6) Kemp's ridleys' and eight (8) green sea turtles. Three sea turtles were alive at the time of stranding, 2 died in transport to rehab facilities and one was euthanized upon arrival to the Clearwater Marine Aquarium due to the severity of injuries from a boat strike. Four of the reported turtle strandings were not recovered; and were reported as loggerheads floating in the Gulf.

Abnormalities of dead and live sea turtles ranged from boat and/or obvious propeller damage with visible markings or hull paint (9), shark bite (5) and fishing line entanglement (4) crab trap entanglement (2) there was red tide bloom offshore Collier County which may have affected one kemps ridley. The remaining turtles either had no obvious cause of death or were too decomposed to assess. In many cases it is not known if boat damage or shark bites were 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 procedures.

The Parks and Recreation Department responded to 23 of the 35 sea turtle strandings. The other strandings were responded to by the following; the Conservancy of Southwest Florida (5), Del nor Wiggins Pass State Park (1), Everglades National Park (1) and Rookery Bay NERR (1).

SECTION 5

SUMMARY

Adult loggerhead sea turtle (*Caretta caretta*) emergences were recorded on Collier County beaches from April 25 through August 14, 2011. A total of 404 nests and 401 false crawls were identified on Barefoot Beach, Delnor-Wiggins Pass State Park, Vanderbilt Beach, Park Shore Beach, City of Naples Beach, and City of Marco Island. Weekly emergence data revealed a double peak of increased emergence activity during the beginning of June and the first week of July. The summary for each beach is given in Table 5.1.

Table 5.1 Summary of Monitored Beaches, 2011.

	Barefoot	Delnor Wiggins Pass	Vanderbilt	Park Shore	Naples	Marco Island	Total
Beach Length (miles)	3.1	1.2	3.5	3.2	5.6	7.1	23.7
Nests	71	18	93	90	67	65	404
Nests / Mile	22.9	15.0	26.6	28.1	12.0	9.2	18.9
False Crawls	38	12	107	69	51	124	401
False Crawls/ Mile	12.3	10	30.6	21.6	9.1	17.5	16.8
Mean Clutch Size	97	106	104	98	102	109	103
Nests Depredated	7	7	3	6	16	7	46
Nests Inundated	22	2	21	16	18	13	92
Nest Washed Out	2	1	7	11	3	12	36
Mean Incubation (days)	60	58	58	60	58	62	60
Disoriented Nests	0	0	2	3	4	7	16
Mean Hatching Success	70	68	77	76	69	75	73.7
Mean Emergence Success	66	65	76	72	68	70	70.9
Eggs Deposited	6,725	1,804	8,616	7,627	6,043	5,666	36,481
Hatchlings Emerged	4,470	1,180	6,583	5,510	4,135	3,988	25,866

In natural beach areas, a mean of 16.1nests/mile were recorded while 18nests/mile were recorded on renourished beach areas (Table 5.2). There was a significant difference found when the clutch depths were compared between renourished and non-renourished beach areas.

Table 5.2 Summary of Natural Beaches Versus Renourished Beach Areas, 2011.

	Natural Beaches	Renourished Beaches	All Beaches
Beach Length (mile)	12.2	11.5	23.7
Nests	207	197	404
Nests Per Mile (mean)	16.1	18.0	17.0
False Crawls	193	208	401
False Crawls Per Mile (mean)	15.8	18.1	16.9
Mean Clutch Depth (in)	19.8	20.5	20.1
Mean Incubation (days)	59.9	58.9	59.6
Mean Hatching Success	62%	67%	65%

In 2011, 36,481 eggs were deposited and 670 (1.8%) were lost to predators. This represents no change from 688 (1.8%) in 2010.

Strandings in 2011 included 21 loggerheads, 6 Kemp's ridleys and 8 green sea turtles. Three of the 35 sea turtles were alive at the time of stranding.

SECTION 6
ACKNOWLEDGMENTS

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The CCPRD would also like to extend appreciation to the Tourist Development Council, the Collier County Board of County Commissioners, the Beach Nourishment/Maintenance Committee, and all others we may have failed to mention.

SECTION 7

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