Tagging and Nesting Research on Leatherback Sea Turtles (*Dermochelys coriacea*) on Sandy Point, St. Croix, U.S. Virgin Islands, 2002

Annual Report to Fish and Wildlife Service

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ABSTRACT

The Sandy Point National Wildlife Refuge in St. Croix, U.S. Virgin Islands supports the largest and best studied population of nesting leatherback sea turtles in the United States and northern Caribbean. Flipper tagging began in 1977, and since 1981 saturation tagging and consistent night patrols during the nesting season have yielded a comprehensive database of information on each female nesting at Sandy Point. The 2002 nesting season began with a nest discovered during U.S. Fish and Wildlife surveys on January 30th, and ended with a final nest on August 1st. Activity was highest from May 13th to June 2nd. One hundred fifteen turtles laid a total of 583 nests with an average of 75.4 yolked eggs per clutch. Of nests laid in 2002, 237 (41%) were relocated to protect them from inundation or erosion. The number of documented nests per female ranged from 0 - 10 with an average of 5.1. Seventy of the turtles were remigrants, with remigration intervals of 1 - 7 years. Of the 346 nests analyzed, mean overall hatch success was 53%. Like most previous years, emergence success of *in situ* nests was significantly higher than that of relocated nests ($p<0.01$). We estimate that 4% of the nests were lost to erosion. With the addition of 45 untagged turtles in 2002, a total of 633 leatherbacks have been tagged since 1977. Nightly patrols and a concerted relocation effort have reduced the major historical threats of poaching and erosion, although there is still poaching of both eggs and adults of green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles after nightly patrols cease.

INTRODUCTION

For the twenty second consecutive season, research has continued on the nesting ecology and population biology of the endangered leatherback turtle (*Dermochelys coriacea*) at the Sandy Point National Wildlife Refuge (SPNWR), St. Croix, U.S. Virgin Islands. The objectives of the project are to assess the size, productivity, and management priorities of this population (by documenting and tagging all nesting females), to protect adults, nests and hatchlings from predators and poachers, and to protect nests from erosion and inundation. The leatherback is the largest and most morphologically divergent species of sea turtle. The biology of this little-known reptile is reviewed in Marquez (1990). Pelagic in nature, it is rarely encountered except on the nesting beaches, where virtually all of the information on this species has been collected. The SPNWR supports the largest and best-studied nesting population of endangered leatherback turtles in the United States and northern Caribbean. As recently as a decade

ago, there were only 13 significant nesting sites worldwide (Sternberg 1981), including six in the western Atlantic (Carr *et al*. 1982). However, leatherbacks have been virtually eliminated from some of these nesting sites, and have declined on almost all beaches where they are known to nest (Betz and Welch 1992, Chan and Liew 1996, Sarti et al. 1996, Spotila et al. 1996). In contrast, numbers are increasing on Sandy Point and on Culebra, Puerto Rico, where a similar project has been ongoing since 1984 (McDonald Dutton and Soler 1997). This could be due to intensive long-term conservation efforts on these beaches. This project provides a unique opportunity to study recruitment into a population that appears to be recovering from previously declining numbers. The Sandy Point beach and surrounding waters has been designated as critical habitat by the National Marine Fisheries Service, and in 1984 became part of the U.S. Fish and Wildlife Service's Caribbean Islands National Wildlife Refuge System. This study began in 1981 under the auspices of the U.S. Virgin Islands Department of Planning and Natural Resources, Division of Fish and Wildlife. Funding is provided through Section 6 Endangered species grants of the U.S. Endangered Species Act and, since 1982, by Earthwatch and the Center for Field Research, Watertown, Massachusetts. Further information on the history of Sandy Point and the development of the present study can be found in Eckert and Eckert (1985).

The following is a summary of the results of the 2002 data, including comparisons with previous years. Detailed information from those years can be found in Eckert *et al*. (1982, 1984), Eckert and Eckert (1983, 1985), Basford *et al*. (1986, 1988, 1990), Brandner *et al*. (1987, 1989), Boulon (1992), McDonald *et al*. (1991, 1993, 1995, 1996, 1997, 1998, 1999, 2000, 2001), and Dutton *et al*. (1992, 1994).

Study Area

The study area at Sandy Point national Wildlife Refuge (Figure 1) is 3.0 km long, with numbered stakes marking the entire length of the study area. Stakes placed along the vegetation line at 20M intervals enable us to obtain exact measurements on nest locations within the Refuge. The beach is divided up into 2 sections, including the “grassy” side and the “sandy” side. The sandy side covers stakes 209 to 140 (the point). This half of the beach faces North and West, on the leeward side of St. Croix. It is relatively wide and contains very little vegetation extending out onto the sand, thus the label “sandy” side. The Western portion of the beach on this side erodes away during the nesting season from approximately stake 140 to stake 169. Erosion patterns result in extensive loss of beach so that at times, less than 2 meters of beach remain. This area of sandy side beach is thus referred to as the “erosion zone”. The sand which erodes away from this area re-deposits itself in the area from 170 to 186 on the North side of the beach during the nesting season. This area is called the accretion zone. The process reverses itself during the winter months when the erosion zone refills with sand. This is an annual occurrence which is an indication of the dynamic forces driving the sand transport on Sandy point.

Sandy Point National Wildlife Refuge, St. Croix

Figure 1.

The grassy side of the beach faces south and is located on the windward side of the island. As a result, the beach is covered with windblown seaweed and debris. Additionally, the beach is covered with an overgrowth of vegetation (grass and sea grape), which occurs naturally on this side of the beach. Due to the extensive ground cover, therefore, this side is referred to as the "grassy" side. The stakes patrolled on the grassy side are numbered 45 to 139. Stakes 0 to 45 have little or no sand available for suitable leatherback nesting habitat.

In 2001, sand accretion occurred north of stake #195, covering rocks and providing an additional area for leatherbacks to emerge and Nest north of the traditional study area. There was no accretion in 2002, therefore, the study area only extended to stake #198. The area further north into the 200's was exposed rock and coral in 2002 preventing nesting activity. Occasionally, the area was patrolled further north into the 220's. The grassy side was patrolled regularly to stake 66, and occasionally to stake 45.

METHODS

Study Area Coverage

Nightly beach patrols on Sandy Point began starting April 1st 2002. The beach was patrolled nightly on foot, starting at 2000 hours and continuing until either 0500 hours, or until the last female finished nesting. Starting on April 17th the researchers were assisted by 8 teams of up to 10 EARTHWATCH volunteers per team, each participating for a period of 10 days, until the teams ended July 14th. The teams of volunteers were divided into 3 groups, each organized and led on patrols of the beach sections by a qualified Field Leader. Each group walked their respective study area at 45 minute intervals. As previously determined, leatherbacks require at least 1 and ½ hours to complete the nesting process, therefore, patrolling the beach at these intervals ensured that all nesting turtles were observed, tagged, and recorded.

Data Collection

Every time a turtle was encountered on the beach a separate nesting data sheet was completed (Appendix I). All data regarding nesting, identification, morphology, nest parameters, and behavior were recorded. Time and date of every encounter was also recorded. Nests were excavated once hatchlings emerged. Date of emergence and excavation were recorded. Upon excavation, all nest contents were categorized to determine nest success, and all un-hatched eggs were opened to determine stage of development. This information was recorded on a hatchling data sheet. Basic data collection remained the same as previous years. Green and hawksbill activities were also documented during the period of leatherback research.

Methods used to collect data were as follows:

A. Morphology

Over the Carapace (o.c.) length and width were recorded once a turtle successfully nested. Carapace length was recorded in centimeters using a standard metal measuring tape. The carapace was measured from the nuchal notch, alongside the vertebral ridge, to the posterior tip of the peduncle at the longest point. Width was measured from each side ridge, across the widest point of the carapace, just posterior to the front flippers. Individuals were measured every time they were encountered, and the measurements averaged at the end of the season.

B. Nesting

Whenever possible nesting behavior and technique were observed and any anomalies recorded. Abnormalities in digging, condition of rear flippers, nest cavity structure, and condition of sand in the nest were noted.

C. Relocated Nests

Any nests that appeared to be in imminent danger of erosion or inundation were relocated. All nests in the area previously designated as the erosion zone, in addition to those with standing water in the nest cavity were also relocated. Eggs from "doomed" nests were collected upon deposition, before they contacted the sand in the nest cavity, and placed in a traditional plastic hefty cinch sac bag. The eggs were then transported to a safer, stable area of the beach, where they were relocated in nests constructed by the field leaders or Fish and Wildlife Refuge staff. Nests were constructed (generally in the accretion zone) to specified shape and dimensions (Dutton *et al*. 1992), similar to natural nests. The locations of all relocated nests were recorded, along with the number of yolked and yolkless eggs deposited. Average depth, width and overburden (depth of sand over the eggs, measured from the top of the egg mass to the sand surface) were also documented for each nest.

D. Marginal Nests

Nests that were deemed to have a reasonable chance of survival, in spite of their location relatively close to the high water mark, or inside the erosion zone, were left *in situ* and recorded as "marginal". Nests were left *in situ* in order to minimize the potential of skewing the hatchling sex ratios. Moving nests, such as marginal nests which likely incubate at cooler temperatures due to wave washover, would inhibit the production of male hatchlings.

E. Nest Location

The location of each nest was determined by measuring the distance from the center of the nest cavity to each of the two nearest marker stakes. A standard metric 50m tape was utilized and the distance recorded in meters. The distance of each nest to the vegetation line and high water mark was also recorded. The 50m tape was placed in a straight line between the nest cavity and the stake line, in addition to the nest cavity and the high tide mark, and the distances recorded.

F. Tagging

Inconel tags were attached to the inguinal skin flap between the rear flipper and the tail of every untagged turtle. In previous seasons Monel tags were applied, however, Monel tags are no longer produced and therefore the smaller Inconel tags were utilized. Traditional tagging pliers were used to attach the flipper tags. No tags were applied to the front flippers of leatherbacks due to decreased retention rates. Flipper tags were applied to both front and rear flippers of hawksbill and green turtles.

Turtles were also tagged with a small (14 mm long x 2 mm diam.) glass-encased electromagnetically encoded microchip, or Passive Integrated Transponder (PIT) tag (AVID, Inc., Norco, CA). The tags were injected using a plastic applicator gun, directly into the left or right shoulder muscle of each turtle as described in McDonald and Dutton (1996). The tags were detected using hand held scanners (AVID Power Tracker II and IV) which when passed over the shoulder area, displayed the I.D. number on a digital scanner screen. The numbers of all applied and detected PIT tags were recorded on the nesting data sheets. All tagging procedures were designed to cause minimal disturbance to the turtles. No PIT tags were applied unless the turtle commenced laying eggs (for approximately 5 minutes), was motionless, and had entered the nesting trance. No PIT tags were applied if the turtle had finished laying or started the disguising phase.

G. Emergence and Excavation

Nests were monitored nightly, three days before the expected emergence date. After emergence, the location, date, time and number of hatchlings seen were recorded. A wooden stick, with a piece of tape denoting the location and identification number of the nest, was placed behind the emergence area to mark the spot for future excavation. Live hatchlings were guarded from potential predators until they successfully entered the water. Disoriented hatchlings, those wandering the beach, going away from or parallel to the water, or hatchlings trapped in vegetation, were assisted to the waters edge. If a nest did not emerge within the expected time frame it was excavated to ensure that no hatchlings were trapped inside, and to reduce the high full-term pipped mortality often seen in relocated nests.

After emergence, the nests were excavated and the nest contents categorized to determine hatching success. All un-hatched eggs were opened to determine stage of development, using criteria described by Whitmore and Dutton (1985) (Appendix II). Additional sub-categories of development were added for the 2002 nesting season. All abnormalities were described. The condition of the nest cavity was noted to help determine possible causes for poor hatch success. This included extremely wet or dry sand, as well as the presence of mold, roots, and other vegetation. Live hatchlings found within the nest cavity were counted and released. Hatchlings were dispersed along the beach where they emerged, as well as on grassy side. Any eggs or live hatchlings that were not ready for release were brought back to Cottages by the Sea and incubated in Styrofoam coolers until they were ready to be re-released at Sandy point.

H. Blood and Tissue Samples

Blood or tissue samples were taken from adult turtles for genetic analysis. Blood samples were taken from veins in the rear flip using a 21 gauge needle following methods described in Dutton (1996), without disturbing or harming the turtles.

Alternatively, small skin samples (6mm diameter) were taken using a sterile biopsy tool (Dutton and Balazs 1995) or a razor blade. All sampling was carried out during or shortly after the turtle laid her eggs, to ensure the least disturbance to the nesting process.

Skin samples were placed in a salt DMSO solution, labeled and frozen. Blood samples were refrigerated for 1 day. Once the blood separated out it was spun down using a centrifuge, placed in a labeled vial containing anti-lysis solution, and frozen.

Trample Zone

In addition to the traditional research, an additional experiment known as the trample zone experiment, was conducted during the 2002 nesting season. The purpose of this experiment was to determine the effect, if any, of heavy foot traffic on nest success. In order to conduct this experiment a section of beach was set aside where no foot traffic was allowed. This area of beach was called the “no trample zone”. The no trample area extended 40m long from stake 177 to stake 179 on the sandy side of the beach. It started approximately 1m from the vegetation line (this 1m zone along the vegetation provided a foot path for researchers and volunteers to walk) and extended to the water line. The entire area was staked, posted, and roped off to prevent entry by all personnel. The signs were erected to inform any visitors to the beach that the area was off limits for recreational use. The only time entry was allowed in the no trample zone was if a turtle was present in the area, or if nests were being relocated to the area. An adjacent 40m length of beach, from stake 179 to 181 was denoted the trample zone. The trample zone extended from the vegetation line to the water line. This area of beach was patrolled hourly as normal, in addition to the normal presence of personnel going to and from the

water, attending to turtles, and relocating nests. This area of the beach also remained available for recreational use.
All adult and hatchling data was collected as normal in both sections of the beach, and hatch success was compared among the two sections.

RESULTS

Adults

During the 2002 nesting season 115 adult leatherback sea turtles were observed at Sandy Point (Figure 2). This included 45 previously untagged turtles and 70 remigrants. Of the 70 remigrants, 2 turtles were originally tagged in Culebra, an island off the coast of Puerto Rico, and 1 turtle was tagged in mainland Puerto Rico. The remigration interval for all turtles ranged from 1 to 7 years with an average remigration interval of 2.67 years (Table 1). Information has not been obtained on the remigration intervals of the 2 Culebran turtles. Remigration intervals were similar to previous years. The carapace lengths of the recorded turtles ranged from 138.5 to 173.2 cm with an average of 153.2 cm ± 6.71 cm . The carapace widths of the recorded turtles ranged from 98.5 to 141.6 cm, with an average width of 110.9 cm ± 4.49 cm . Size class distribution among new and remigrant turtles is depicted in Figure 3. The average size (length and width) of the 2002 nesting population is consistent with that of the population in past years.

The average number of nests laid per individual female ranged from 0-10, with an average number of 5.1 ± 2.39 nests laid per female during the 2002 nesting season. Four turtles were documented as never successfully completing a nest on Sandy Point, while some nests, such as those laid prior to April 1 were deposited by unidentified turtles. In addition to early season nests, probable lays, and nesting on beaches other than Sandy point result in an underestimate of the number of nests laid per turtle. As an alternative method of determining the average number of nests laid per turtle, the number of total nesting activities (583) may be divided by the number of individual turtles (115). The average number of nests laid, when calculated in this manner, is also 5.1. This is consistent with the 2001 nesting season which averaged 5.4 nests/turtle, as well as previous nesting seasons.

The average number of dry runs per adult was also determined for the 2002 nesting season. A dry run is defined as an unsuccessful attempt at egg deposition. A dry run is not a track only, and must consist of the turtle attempting to body pit, and/or dig a nest cavity before returning to the water. There were 219 documented dry runs during the 2002 nesting season, with the number of dry runs per turtle ranging from 0 to 24. The average number of dry runs was 1.8 ± 3.01. Two turtles in particular, a new turtle (NNE239) and a remigrant turtle (AAM898) exhibited patterns of consistent dry runs, with 24 dry runs and 15 dry runs respectively.

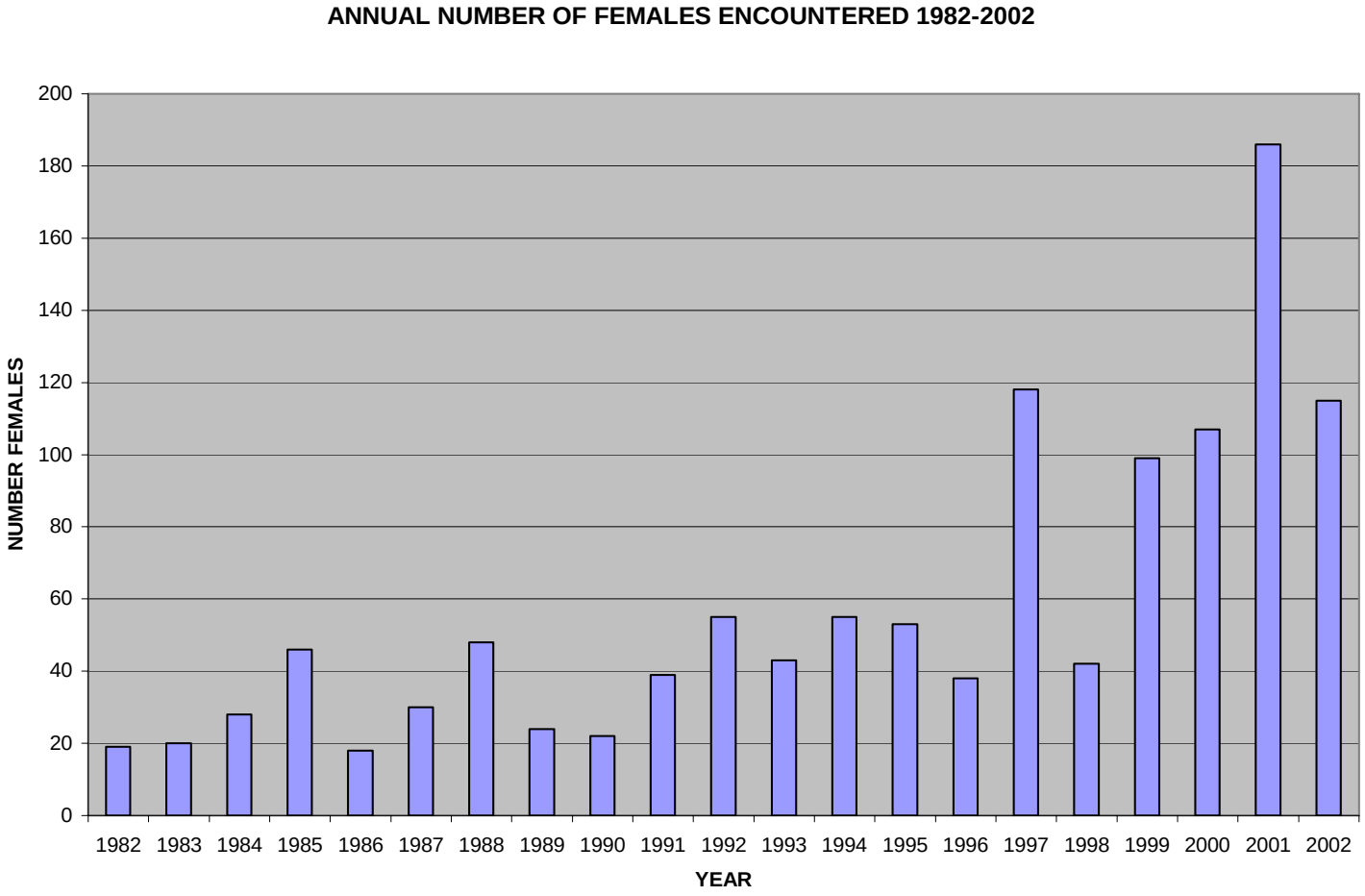
ANNUAL NUMBER OF FEMALES ENCOUNTERED 1982-2002
NUMBER FEMALES
0
20
40
60
80
100
120
140
160
180
200
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
YEAR

Figure 2.

Table I. Leatherback remigrations to Sandy Point from 1977 to 2002 (population not monitored 1978 and 1980).

Season	Total Turtles Encountered	Remigration Interval						Tag Scarred	Total Remigrant
		1	2	3	4	5	>5		
1977	10[1]	0	0	0	0	0	0	0	0
1979	6[1]	0	0	0	0	0	0	0	0
1981	20[2]	0	3	0	0	0	0	0	3 (15.0%)[3]
1982	19	0	0	0	0	0	0	1	1 (5.3%)[3]
1983	20	0	7	0	0	0	0	2	9 (45.0%)
1984	28	0	4	0	0	0	0	0	4 (14.3%)
1985	46	1	10	3	0	0	0	2	16 (34.8%)
1986	18	0	1	2	0	0	0	0	3 (16.7%)
1987	30	0	9	5	0	0	0	0	14 (48.3%)
1988	48	0	5	7	1	0	0	4	17 (35.4%)
1989	24	0	7	0	0	0	0	0	7 (29.2%)
1990	22	0	2	3	1	0	0	0	6 (27.3%)
1991	39	0	8	8	0	0	0	1[4]	16 (41.0%)
1992	55	0	6	4	7	0	0	4[4]	17 (30.9%)
1993	43	0	13	4	0	0	0	7[4]	17 (39.5%)
1994	55	0	14	8	1	1	0	14[4]	24 (43.6%)
1995	53	0	16	7	5	0	0	N/A[5]	28 (52.8%)
1996	38	0	13	5	4	2	0	N/A[5]	24 (63.2%)
1997	118	0	27	22	5	3	0	N/A[5]	57 (48.3%)
1998	42	0	15	6	3	1	0	N/A[5]	25 (59.5%)
1999	99	1	32	9	4	2	2[6]	N/A[5]	50 (50.5%)
2000	107	0	10	28	2	3	2	N/A[5]	45 (42.1%)
2001	186	1	45	12	26	1	2[7]	N/A[5]	96 (51.6%)[8]
2002	115	1	35	23	5	3	1	N/A[5]	70 (60.9%)[9]
Totals		3	247	133	59	13	6	35+[5]	

[1] Does not represent total number of turtles nesting.
[2] May or may not represent total number of turtles nesting.
[3] Not accurate due to incomplete tagging in previous years; proportions in later years are more accurate but still not complete.
[4] We do not include tag-scarred turtles in the count of remigrants, as we cannot determine if they were tagged at Sandy Point.
[5] Photoidentification and PIT tags have identified many tag-scarred turtles as remigrants.

[6] 7 year remigration interval
[7] 1 six year, 1 nine year remigration interval
[8] 9 turtles were originally tagged in Puerto Rico; we have no information on remigration intervals
[9] 2 of the 3 turtles that were originally tagged in Puerto Rico; we have no information on remigration intervals

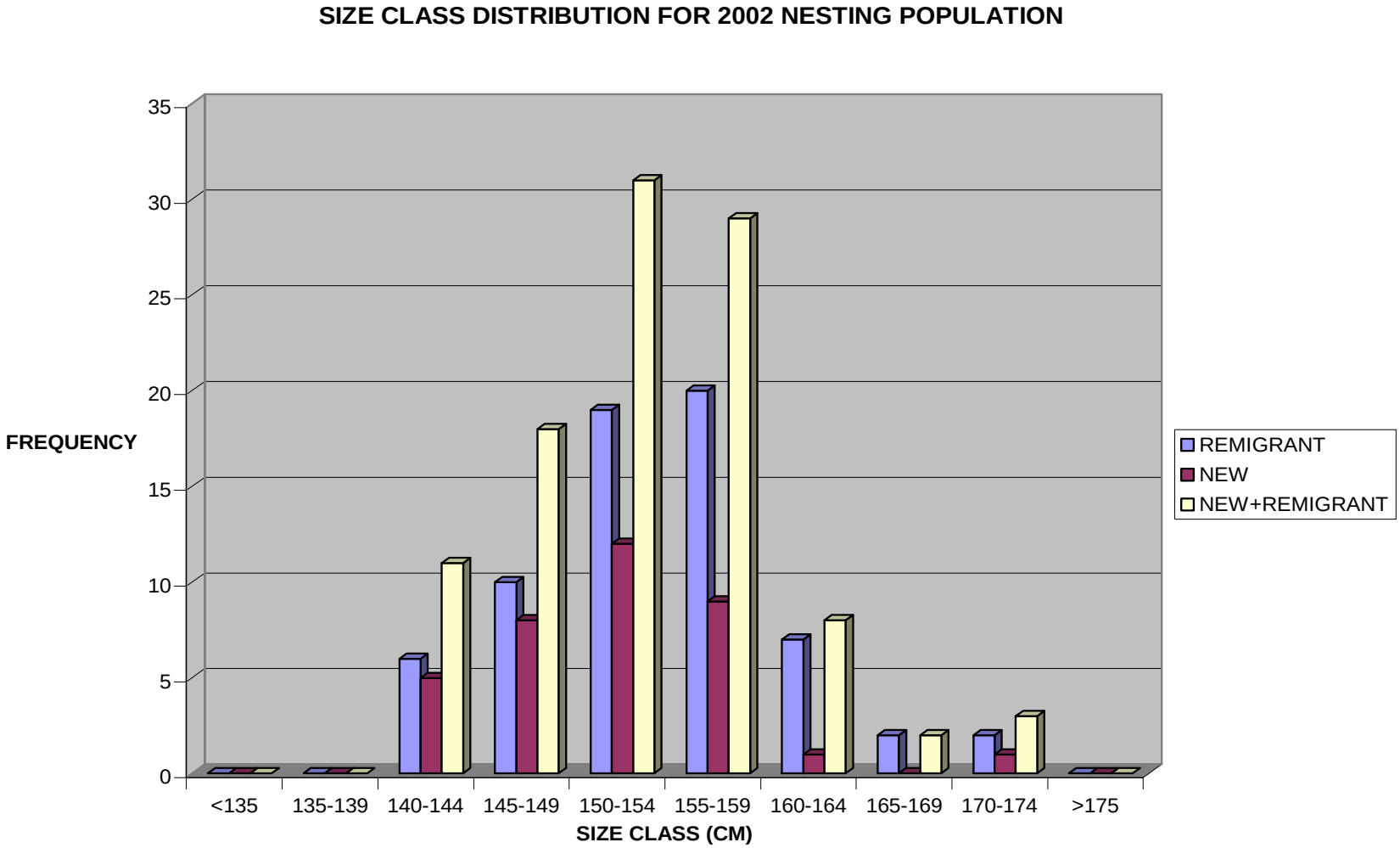
SIZE CLASS DISTRIBUTION FOR 2002 NESTING POPULATION
FREQUENCY
35
30
25
20
15
10
5
0
<135
135-139
140-144
145-149
150-154
155-159
160-164
165-169
170-174
>175
SIZE CLASS (CM)
REMIGRANT
NEW
NEW+REMIGRANT

Figure 3.

Inconel tags were applied to all turtles without flipper tags. This includes those that were not previously tagged, as well as turtles that had been previously tagged, but lost their tags. We also removed tags that were damaged or detaching, and retagged the turtles. As a result, 61 flipper tags were applied this season, with all 45 new turtles tagged. PIT tags were also applied to the new turtles, as well as remigrant turtles, as needed. Many remigrant turtles had detectable pit tags, but were tagged with AVID encrypted PIT tags only readable by AVID scanners. Therefore, unencrypted "Focava" code PIT tags, readable by scanners from various manufacturers, were additionally applied to the opposite shoulder of remigrants with only one PIT tag. As a result, 90 PIT tags were applied to both new and remigrant turtles during the 2002 season. Of the 45 new turtles in 2002, 41 were PIT tagged, with only 4 new turtles left without PIT tags. Forty-nine remigrant turtles were also PIT tagged.

Pink spot photographs were taken of 32 turtles, including 26 new, 4 remigrant turtles, 1 turtle from mainland Puerto Rico, and 1 turtle from Culebra. There were also 49 wound photos taken of 37 injured turtles, including 18 new, 16 remigrant turtles, 1 turtle from mainland Puerto Rico, and 1 turtle from Culebra. Of these documented injuries, 42% involved the shoulders, 42% involved the head, neck and eye, while 16% included carapace, flippers and other. Figure 4 illustrates recorded injuries and frequency. Turtles with major wounds, not including lesser injuries documented on other turtles throughout the season, accounted for 32% of the 2002 nesting population. Many injuries appeared to be caused by interactions with boats, fishing tackle, nets, ropes and lines.

All ectobiota was documented throughout the season and as in past years three main types of barnacles were found. These included the *Stomatolepas dermochelys, Conchoderma sp.,* and *Platylepas hexastylos.* Barnacles were found primarily attached to the shoulders, neck, carapace and wounds of adult leatherback turtles. The fish *Remora remora* was encountered attached to 2 turtles in 2002. Fewer remora were observed this year than in 2001, when at least 8 remora were observed.

Blood and skin samples were collected for genetic analysis, with 36 blood samples and 10 skin samples collected from 37 turtles. This included 30 of the 45 new turtles, 6 remigrants, and the turtle from mainland Puerto Rico. Thirty-Five plasma samples were also collected for further analysis of physiological parameters. Genetic analysis is currently being conducted by Dr. Peter Dutton at the NOAA-NMFS Southwest Science Center's La Jolla Laboratory.

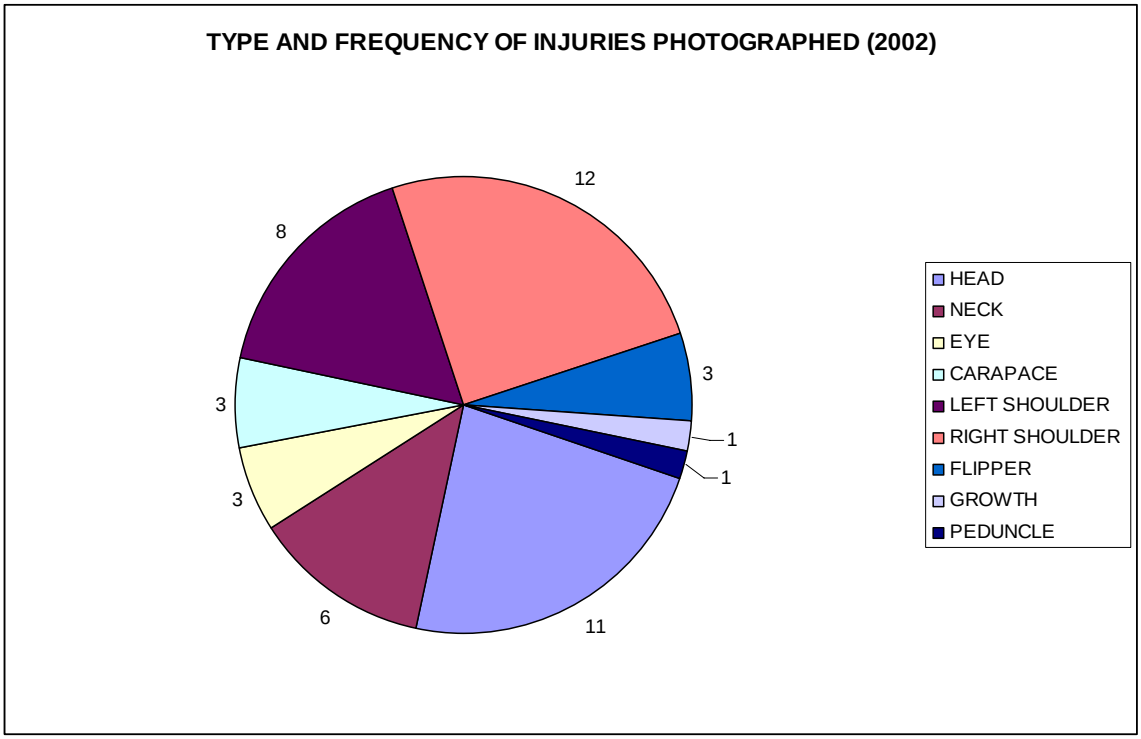
TYPE AND FREQUENCY OF INJURIES PHOTOGRAPHED (2002)
12
8
3
3
1
1
3
6
11
HEAD
NECK
EYE
CARAPACE
LEFT SHOULDER
RIGHT SHOULDER
FLIPPER
GROWTH
PEDUNCLE

Figure 4

Nesting Activities

During the period of monitoring (April 1 – September 1, 2002) a total of 912 activities were recorded at Sandy Point. This number is down from 2001 when there were 1,289 activities recorded, but is on par with the 2000 nesting season which had a similar number of turtles. The first nest was recorded on January 30th (Mike Evans and Claudia Lombard, USFWS). The early season nesting activities were numerous (over 60), and greater than any of the previous seasons in project history. Known egg deposition occurred in 59% (583) of the nesting activities, while 24% (219) of all activities were dry runs. Only 6% (59) of the activities were probable lays, with another 6% (51) of the activities recorded as track only. Of the 583 known nests deposited on the beach this season, 59% (346) were *in situ*, while 41% (237) were relocated. GPS readings were taken on 441 of the 583 nest locations. Of the 237 nests which were relocated this year, it is estimated that 100% of them would have been lost to erosion or inundation had they not been removed and relocated to a different area of the beach.

Figure 5 represents the breakdown of turtle activity during each week of the study period, starting April 1st. Peak activity occurred during the month of May, with the greatest activity recorded during the week of May 20th. No turtles were observed on April 8th, and again at the end of the season starting July 20th. The last activity, a probable lay, was recorded on August 1st.

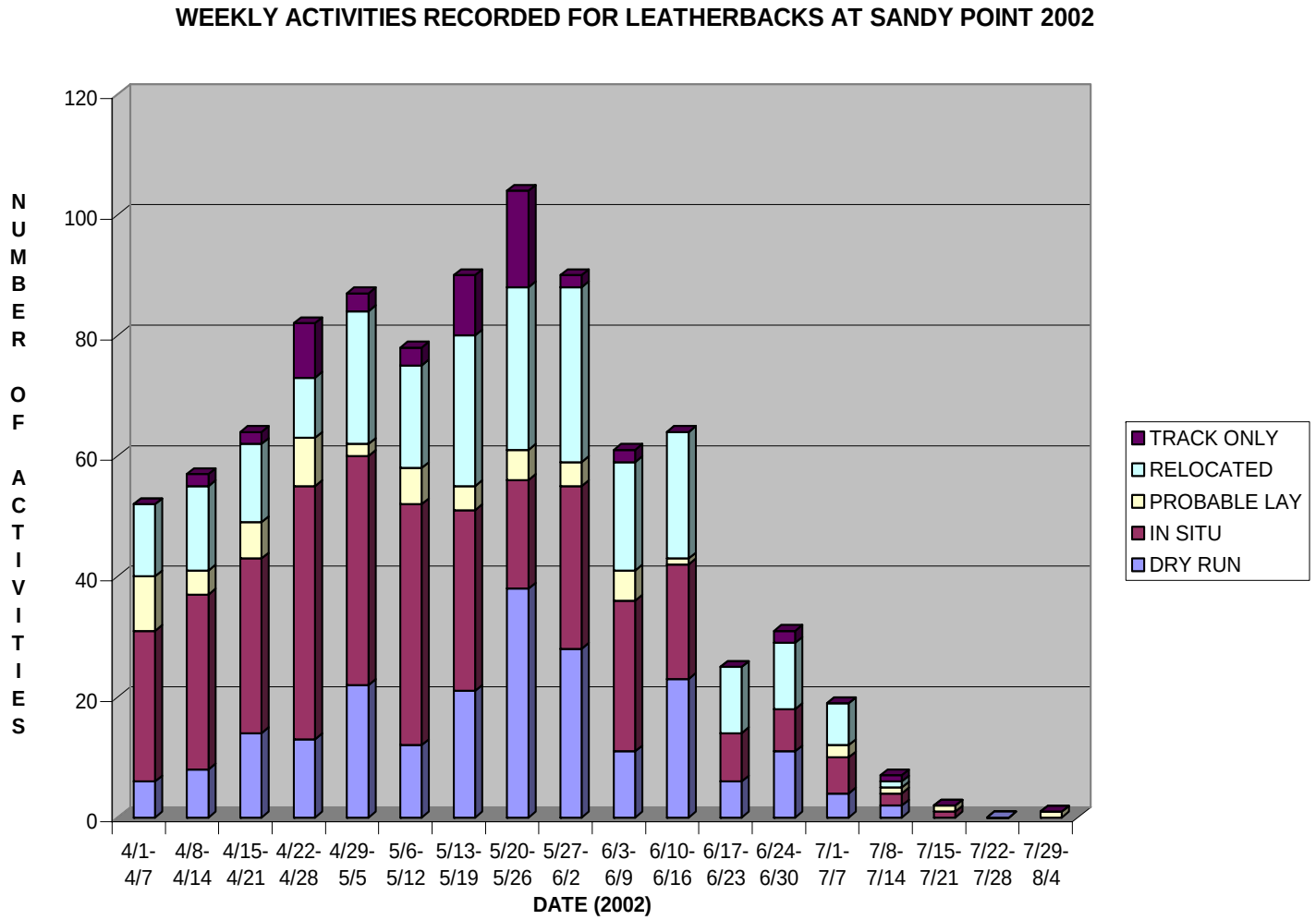
WEEKLY ACTIVITIES RECORDED FOR LEATHERBACKS AT SANDY POINT 2002
NUMBER OF ACTIVITIES
120
100
80
60
40
20
0
4/1-4/7
4/8-4/14
4/15-4/21
4/22-4/28
4/29-5/5
5/6-5/12
5/13-5/19
5/20-5/26
5/27-6/2
6/3-6/9
6/10-6/16
6/17-6/23
6/24-6/30
7/1-7/7
7/8-7/14
7/15-7/21
7/22-7/28
7/29-8/4
DATE (2002)
TRACK ONLY
RELOCATED
PROBABLE LAY
IN SITU
DRY RUN

Figure 5

In order to illustrate the distribution of activities on the beach, the monitored area at Sandy point was divided into 5 sections. The grassy side was divided into 2 sections, from stake 66 to the entrance at 123 and from stake 124 to the point (stake 140). The sandy side was divided into 3 sections, with section 1 starting from stake 141 around the point, and encompassing the entire erosion zone to stake 169. The remaining 2 sections include the accretion zone, from stake 170 to the entrance at stake 186, as well as from stake 187 to stake 198 at the end of the patrol area. The distribution of nesting activities within these given areas (Figures 6 and 7), shows that a majority of the *in situ* nests, 47%, were laid in the accretion zone from stakes 170 to 186, while 26% were laid on the grassy side between stakes 66 and 123. The erosion zone was the section of the beach where most dry runs (43%) occurred, while 24% of dry runs occurred in the accretion zone between stakes 170 and 186 on the sandy side. Another 20% of the dry runs occurred on the grassy side between stakes 56 and 123. Stakes 123 to 140 on the grassy side (to the point) had very little activity of any kind.

The concentration of relocated nests on various sections of the beach are also illustrated (Figure 8), with 8% of the nests relocated in the upper level of the erosion zone during the early part of the season (until May 1), and another 8% relocated on the grassy side throughout the season. As in past seasons a majority of the nests were relocated in a designated zone on the sandy side. This year, however, the relocation area was extended further South on the beach to stake 170 at the beginning of the accretion zone. As a result, 56% of the nests were relocated between stakes 170 and 186, with another 28% relocated between stakes 187 and 198.

A total of 36 nests were documented in the area designated for the no trample zone, with 13 laid *in situ* and another 23 relocated to this area. Of the total 346 *in situ* nests, 27(including 5 probable lays) were considered marginal and left. Of the 22 known marginal nests, at least 12 emerged. It is estimated that at least 8 washed away. One marginal nest which was in the process of being washed away was collected, the eggs incubated, and over 20 hatchlings produced. With 8 nests documented as washouts, 2% of the nests were definitely lost due to erosion. However, since it is likely that more nests washed out than were documented, it is estimated that 4% of the nests were lost due to erosion. This is similar to previous years.

The number of yolked eggs per clutch varied from 7 to 113 eggs, with a mean of 75.4 ± 1.09 eggs. This number is down slightly from 2001 when the mean number of yolked eggs was 81.6 ± 16.85 eggs. The number of yolkless eggs varied from 0 to 99, with a mean of 37.6 ± 1.00 yolkless eggs. This is similar to last year, when the average number of yolkless eggs was 35.64 ± 16.78 yolkless eggs. Accurate accounts of the number of yolked and yolkless eggs were obtained by utilizing information solely from the relocated nests.

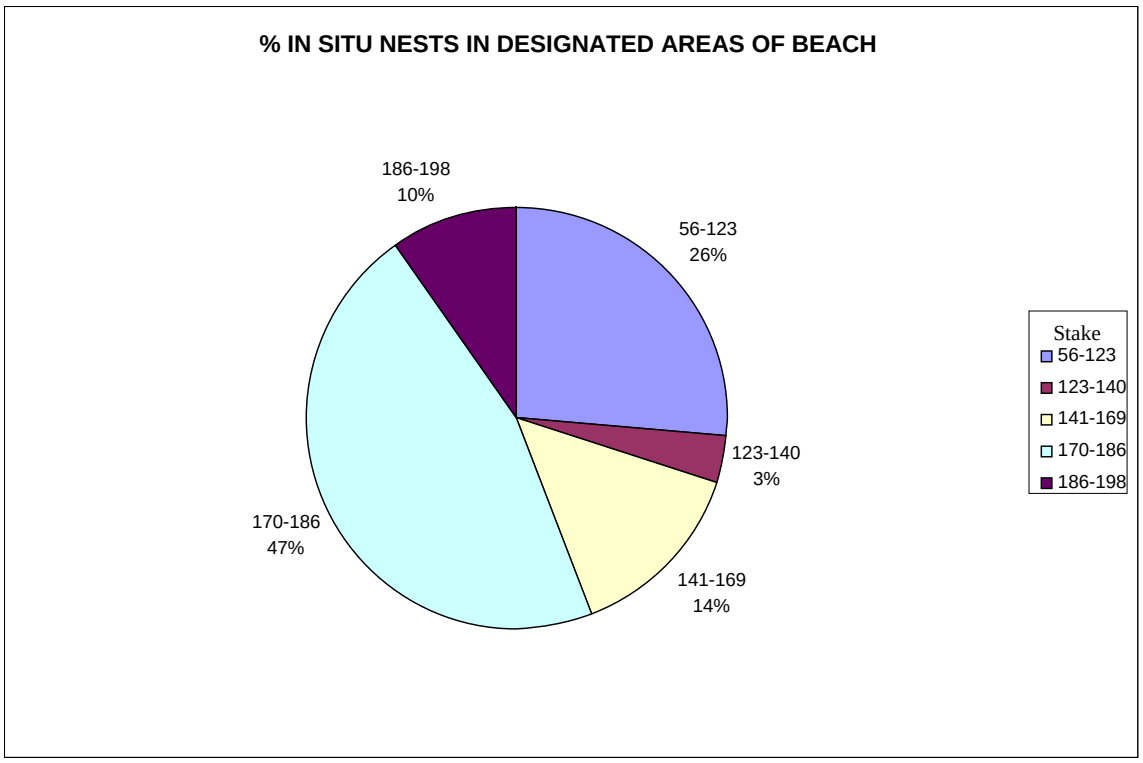
% IN SITU NESTS IN DESIGNATED AREAS OF BEACH
186-198
10%
56-123
26%
123-140
3%
141-169
14%
170-186
47%
Stake
56-123
123-140
141-169
170-186
186-198

Figure 6.

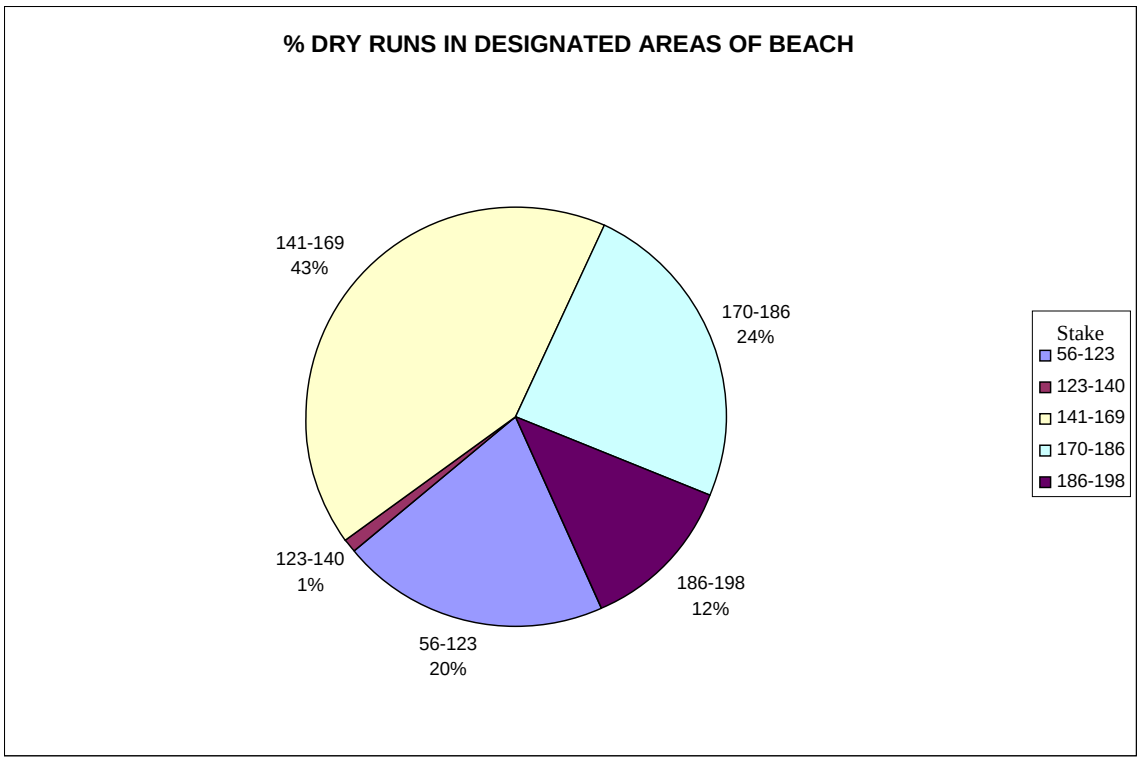
% DRY RUNS IN DESIGNATED AREAS OF BEACH
141-169
43%
170-186
24%
123-140
1%
186-198
12%
56-123
20%
Stake
56-123
123-140
141-169
170-186
186-198

Figure 7.

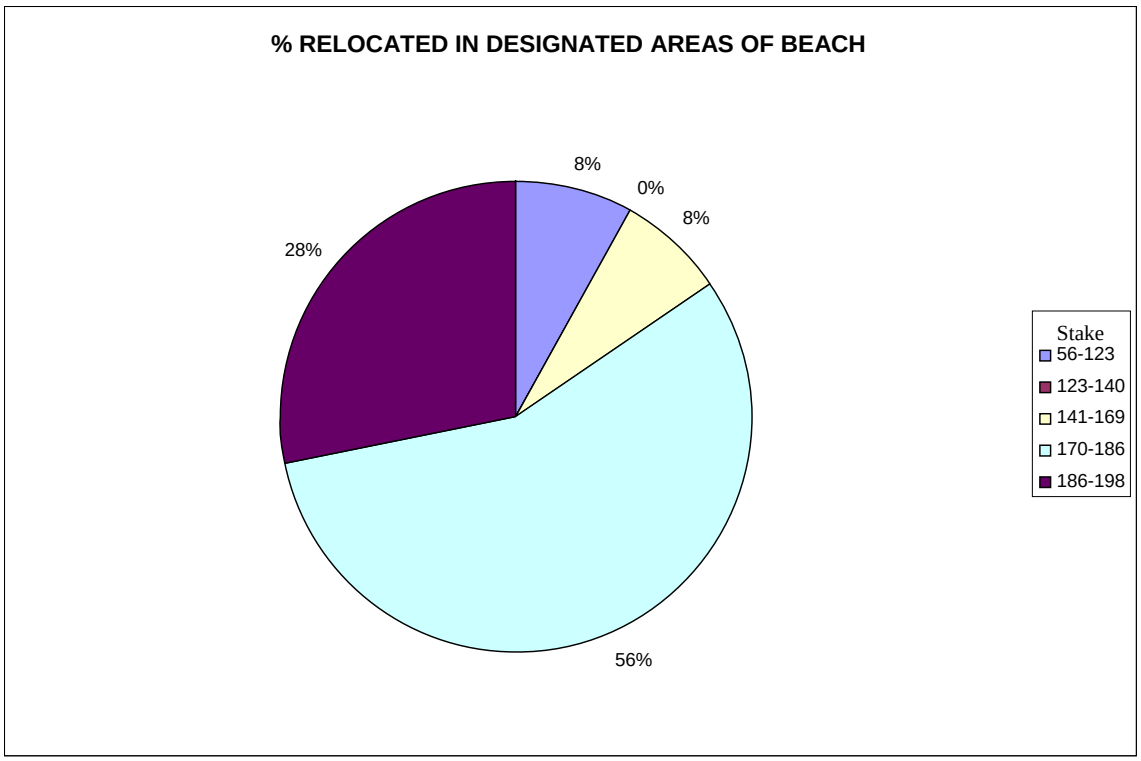
% RELOCATED IN DESIGNATED AREAS OF BEACH
8%
0%
8%
28%
56%
Stake
56-123
123-140
141-169
170-186
186-198

Figure 8.

Hatchlings

The incubation period for nests throughout the season ranged from 55 to 71 days with an average incubation period of 62.4 ± 2.99 days. This is similar to previous years (average incubation time 2001= 63.8 days). Additionally, as in previous years, the incubation period decreased throughout the season (Figure 9). In 2002 the incubation period was 64.4 days for nests laid in April, 60.7 days for May, and 60.7 days for June. Early season nests took 63 days (late March nest) to 77 days (January nest) for incubation, with an average of 69.6 days.

Of nests excavated during the 2002 season, 346 were utilized to determine hatch and emergence success. Sixty one percent of the relocated and 58% of the *in situ* nests were excavated. Mean overall hatch success (hatched shells/yolked eggs) of all excavated nests ranged from 0 to 96%, with a mean overall hatch success of 53.05 ± 23.35%. This was down slightly from 2001 when mean overall hatch success was 58.81% ± 19.62%. Actual mean emergence success (hatched shells-dead hatchlings/yolked eggs) was 50.01 ± 22.99% (n= 346, range 0-96%). This was also approximately 5% lower than the previous year (55.22 ± 19.52% in 2001). Hatch success was significantly lower ($p<0.01$, t-test) in relocated nests (46.89 ± 20.79%, n = 145, range = 0 to 86.96%), than in known *in situ* nests (57.52 ± 24.96%, n =201, range = 0 to 96%). Corresponding mean emergence success was 43.48 ± 20.42 and 54.72 ± 23.64% ($p< 0.01$, t-test). Most of the mortality in both relocated and *in situ* nests was due to hatchlings dying during pipping, or shortly after. Using the average emergence success (known nests only) of 43.48% and 54.72% for relocated and *in situ* nests, respectively, it is estimated that 21338 hatchlings emerged at Sandy Point in 2002 (Figure 10). This takes into account an estimated 4% (14 nests) that may have washed away. Relocated nests produced 36 % of total.

Aberrations

In the 346 nests utilized to determine hatch success, 22 deformities were found in unhatched eggs. The majority of deformities were found to be twins, albinos, and cylopses. Three particular turtles produced 2 deformities each, in different nests.

Additionally, it was found that one particular turtle produced abnormally small eggs (approximately 4.8 cm in diameter on average). These eggs resulted in the production of hatchlings approximately ½ the size of normal hatchlings (average 4.9cm CL and 3.5cm CW). All nests containing extremely small hatchlings were traced back to AAG908, a turtle originally tagged 10 years ago at Sandy Point.

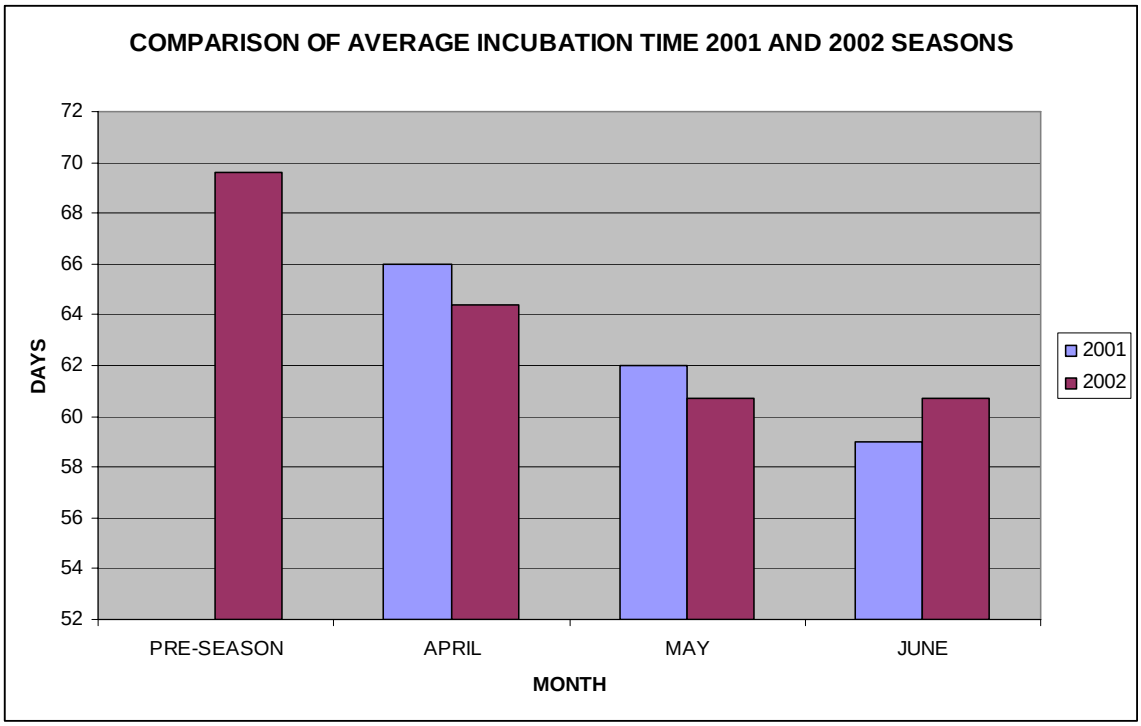
COMPARISON OF AVERAGE INCUBATION TIME 2001 AND 2002 SEASONS
72
70
68
66
64
62
60
58
56
54
52
DAYS
PRE-SEASON
APRIL
MAY
JUNE
MONTH
2001
2002

Figure 9.

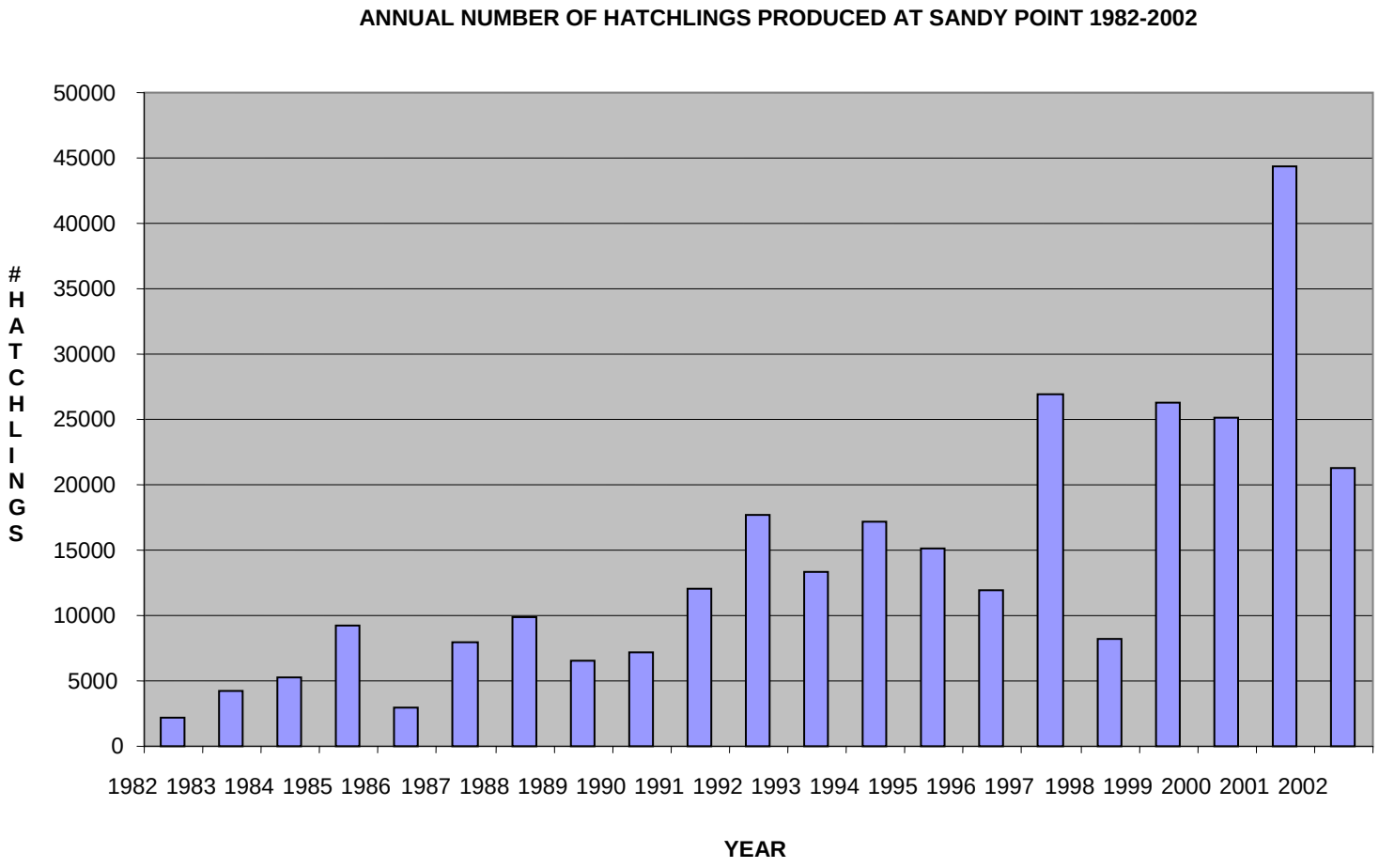
ANNUAL NUMBER OF HATCHLINGS PRODUCED AT SANDY POINT 1982-2002
HATCHLINGS
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002
YEAR

Figure 10.

Table II. Final outcome of leatherback nests on Sandy Point from 1982 to 2002.

Year	Known				Not excavated	Total
	Survive to term		Lost			
	N	% hatch success ()	erosion	poaching		
2002						
relocated	145	46.9	0	0		237
in situ	201	57.5	8	0		346
unknown	28					
total	374	53.1	8	0	209	583
2001						
relocated	61	54.3	0	0		
in situ	165	60.8	0	0		276
unknown[7]	68		30	0		732
total	294	58.8	30	0	684	1008
2000						
relocated	151	53.7	1	0	9	161
in situ	290	64.1	26	0	71	387
total	441	60.6	27	0	80	548
1999						
relocated	100	56.6	0	0	51	151
in situ	250	61.4	27	0	152	429
total	350	60.1	27	0	203	580
1998						
relocated	44	36.9	0	0	18	
in situ	117	46.8	4	0	72	251
total	161	44.1	4	0	90 (36%)[6]	
1997						
relocated	126	46.9	0	0	112	
in situ	178	53	23	0	281	
total	304	50.4	23	0	393 (55%)[6]	720
1996						
relocated	57	57.4	2	0	11	
in situ	103	68.6	6	0	61	

total	160	64.5	8	0	72 (30%)[5]	240
1995						
relocated	67	52.4	0	0	52	
boxes	17	66.2	0	0	0	
in situ	45	64	6	0	138	
total	129	57.9	6(1.8%)	0	190 (58%)	325
1994						
relocated	99	60.6	0	0	35	
in situ	107	66.8	12	0	102	
total	206	63.8	12(3.4%)	0	137 (39%)[4]	355
1993						
relocated	81	64.5	0	0	11	92
in situ	122	69.3	6	0	44	172
total	203	67.4	6(2.3%)[1]	0	55 (21%)[2]	264
1992						
relocated	123	61.3		0	22	145
in situ	108	72.2	21	0	71	200
total	231	66.3	21(6.1%)	0	93 (27%)[3]	345
1991						
relocated	99	62	0	0	10	109
in situ	122	72.3	13	0	16	151
total	221	67.8	13(5.0%)	0	26 (10%)	260
1990						
relocated	54	61.1	0	0	0	54
in situ	75	70.5	1	0	13	89
total	129	66.7	1(0.7%)	0	13 (9.1%)	143
1989						
relocated	72	63	0	0	2	74
in situ	49	76.4	4	0	10	63
total	121	67.8	4(2.9%)	0	12 (8.8%)	137
1988						
relocated	141	58.53	1	0	3	145
in situ	89	56.86	3	0	5	97
total	230	58.23	4(1.7%)	0	8 (3.31%)	242
1987						
relocated	91	62.78	3	0	1	95
in situ	63	67.41	3	0	10	76
total	154	66.55	6 (3.5%)	0	11 (6.4%)	171
1986						

relocated	30	68.97	2	0	5	37
in situ	25	64.61	6	0	14	45
total	55	66.79	8 (9.8%)	0	19 (23.1%)	82
1985						
relocated	110	53.2	1	1	8	120
in situ	90	62.8	16	2	14	122
total	200	57.6	17 (7.0%)	3 (1.2%)	22 (9.1%)	242
1984						
relocated	82	54.8	0	0	6	88
in situ	41	67.7	7	1	4	53
total	123	59.1	7 (4.9%)	1 (0.7%)	10 (7.1%)	141
1983						
relocated	69	50.5	3	0	5	77
in situ	28	64.4	6	2	0	36
total	97	54.5	9 (7.9%)	2 (1.8%)	5 (4.4%)	113
1982						
relocated	23	64.4	1	0	3	27
in situ	22	61.4	25	0	12	59
total	45	62.9	26(30.2%)	0 (0.0%)	15 (17.4%)	86

[1] This number may have been higher, since early season activities recorded as "dry runs" may actually have been nests that subsequently washed away; these would not have been recorded as nests since there was no evidence of emergence.

[2] 33 of these nests emerged (22 *in situ*, 11 relocated), as evidenced by hatchling tracks, but were not excavated. This number includes three nests that were not excavated prior to our departure.

[3] Most of these nests emerged, as evidenced by hatchling tracks. This number includes 17 nests that were not excavated prior to our departure.

[4] At least 60 of these nests emerged (52 *in situ*, 8 relocated). Thirteen nests had not emerged prior to our departure.

[5] Includes nests for which there was some success, but some eggs were washed out.

[6] A large portion of these hatched.

[7] Due to extremely high nest densities in 2001, some of the excavated nests could not be identified to female.

No Trample Zone

There were 22 nests successfully excavated in the area of the beach designated as the no trample zone, while 20 nests were excavated in the trample zone of the beach. The overall hatch and emergence success of the nests in the no trample zone were slightly higher than the trample zone. The hatch success of the no trample zone was 45.46 ± 21.18%, with a mean emergence success of 31.91 ± 15.17%. The mean hatch success of the trample zone was 43.6 ± 24.41%, while the mean emergence success of the trample zone was 28.4 ±18.42%. The slight difference between the no and high traffic areas was, however, not significant (t-test, $p>0.3$, DF=38).

Mortality

Although a third of the turtles were seen with severe and/or potentially life threatening injuries, there were no fatalities documented during the 2002 nesting season. The main threat to this population continues to be to the eggs and the hatchlings.

Eggs

As in past years the major threat to eggs on Sandy Point continues to be erosion. The seasonal beach erosion on Sandy Point follows a distinctive pattern, which results in the loss of an entire stretch of beach from the point (Stake 140) through to stake 170. Since a majority of nests are laid in this zone, the relocation effort prevents the loss of 30-65% of nests annually. In 2002, 41% of known nests were relocated, thus preventing the loss of a large percentage of nests and reducing nest loss to less than 4%, as in past seasons.

Although poaching was considered a problem at Sandy Point prior to the induction of the program, and the presence of Refuge personnel, it is no longer a serious threat to leatherback eggs. There was no evidence of poaching during the 2002 nesting season. There were also no attempts during the 2001 season, and overall, the frequency of poaching attempts has dropped dramatically since 1985, to virtually no attempts on the refuge property.

Hatchlings

The most significant terrestrial predators of leatherback hatchlings at Sandy Point continues to be the Yellow-crowned Night Herons (*Nyctanassa violacea*) and ghost crabs (*Ocypode quadrata*). This is similar to past years' results. The mongoose (*Herpestes aropunctatus*) has been an increasing problem, and its presence was documented on the beach again this season. Trapping by U.S. Fish and Wildlife personnel reduced the threat of mongoose predation. However, a serious and increasing threat is the presence of feral cats on the beach. Cats were documented numerous times this year patrolling the vegetation line for emerging hatchlings, as well as actually taking hatchlings, even in the presence of large groups of people. There was also evidence of cats digging into nests

and taking hatchlings before they had a chance to emerge. This threat was first noticed during the 2001 season, and appears to have increased significantly during the 2002 season. Dogs have historically been a problem, however, there was no evidence during the 2001 season of canine predation, and only 2 instances of attempted predation by dogs during the 2002 season. Dogs attempted to dig into 2 nests on the grassy side but were not successful. Due in large part to the trapping program run by refuge staff, predation by dogs no longer appears to be a serious threat to hatchling survival at Sandy Point.

Beach vegetation poses a threat of entanglement to emerging hatchlings, as well as to eggs and hatchlings in the nest cavity. The roots of various species of beach vines, such as (*Opmea*, *Canavalia*, and *Cassythe filiformis*) may infiltrate the nest cavity, and/or sprawl across the sand surface trapping hatchlings in the nest cavity, as well as on the surface as they attempt to journey to the water. Failure of eggs to successfully develop is also observed when eggs are subjected to root growth in the nest cavity.

A few nests this season showed fatalities when some hatchlings remained on the surface too long and either died of dehydration or attack by fire ants. Ants appeared to be a greater problem on the grassy side of the beach, where vegetation is thicker, than on the sandy side.

Other Turtle Species

Greens

The first green activity recorded during the 2002 season was May 26th. There were a total of 52 activities observed by research personnel, including 18 dry runs, 7 successful nests, 7 probable lays, and 18 tracks only. Additionally, 2 nests were laid in the erosion zone and relocated to safer areas. These nests contained 142 and 130 eggs respectively. Most nesting activity occurred on the grassy side of the beach, although green activity on the sandy side was greater than the previous year.

There were 7 green turtles documented including 5 new and 2 remigrant turtles. Remigrant turtles were identified by PIT tags. All turtles were flipper tagged, including remigrants. Some turtles were tagged twice, resulting in the application of 9 flipper tags. Three PIT tags were also applied to new turtles.

The lengths of recorded green turtles ranged from 102.9 cm to 114.7 cm. The average length of observed turtles was 111.13 ± 1.19 cm. The width of documented green turtles ranged from 91 cm to 111.8 cm, with an average of 103.53 ± 2.12 cm.

Hawksbills

The first hawksbill activity recorded during the 2002 season was June 20th. There were a total of 18 activities observed, including 4 dry runs, 5 successful nests, 2 probable lays, and 6 tracks only. In addition, 1 nest containing 167 eggs was relocated to

a safer area. Most hawksbill activity was observed on the grassy side and at the point, although hawksbill activity on the sandy side was much higher than in previous years.

There were a total of 7 turtles, including 4 new and 3 remigrant turtles. Remigrant turtles were identified by PIT tags. All turtles were flipper tagged, including remigrants. Some turtles were tagged twice, resulting in the application of 10 flipper tags. Two PIT tags were also applied to new turtles.

The lengths of recorded hawksbill turtles ranged from 79.3 cm to 91.0 cm, with an average length of 85.84 ± 2.49 cm. The width of recorded hawksbills ranged from 63.2 cm to 80.3 cm, with an average width of 73.64 ± 3.10 cm.

Mortality

The threats that are experienced by both the hatchlings and eggs of leatherback turtles are also threats that affect green and hawksbill hatchlings and eggs as well. The threat of poaching, however, is much greater for these two species. Although poaching of eggs is minimal while Sandy Point is patrolled nightly during leatherback season, once patrols stop, the threat increases dramatically. An additional threat to these species is the value of the adult. Adult green and hawksbill turtles are poached for their meat and shells, in addition to the eggs. Both eggs and adults are taken after the leatherback season ends at Sandy Point, and year round throughout the rest of St. Croix. Shortly after the 2002 season ended 1 adult hawksbill was poached, and there were numerous attempts to poach eggs.

There were also 2 green fatalities, attributable to shark attack, towards the end of the 2002 season.

DISCUSSION

The 2001 season stills maintains the record for number of nesting leatherbacks at Sandy Point with 186 nesting females. The 2002 season with 115 turtles however, was on par with the next highest year of 1997 when 117 individuals nested. The 2002 season extended from January 30th to August 1st. With the addition of 45 new animals in 2002, a total of 633 individuals has been tagged since 1977. This number likely overestimates the population size, since some untagged turtles are remigrants that lost their tags from previous years. This has been confirmed by PIT tag returns and photoidentification (McDonald and Dutton, 1996). However, this is a more accurate estimate than shown in previous years' reports of this project, as it takes into account the percentage of untagged individuals photoidentified as remigrants. Continued use of PIT tags and photoidentification will provide more accurate information on population size and remigration rates, and allow estimates of adult mortality to be made (Dutton *et al*., 2000 and in prep). As in past years, several turtles (three in 2002) originally tagged on different beaches in Puerto Rico nested at Sandy Point. This combined with results of genetic studies continues to suggest that St. Croix and Puerto Rico leatherbacks are part of a larger, regional population rather than two distinct groups.

Hatch Rates

Like most past years, hatch success for relocated clutches was significantly lower than that of *in situ* nests. Data from 1992 suggested that nest design has a significant influence on hatch rate, and that the lowered hatch rates are avoided in nests where eggs are stacked into a slanting bowl (the "natural" design, Dutton *et al*., 1992). Relocated nests were constructed using this “natural” design as a guide. Both relocated and *in situ*, as well as overall hatch success, were lower this year than the previous few years. The decrease in *in situ* hatch success was just over 3%. When this decrease is taken into account across the board, hatch success was only down by a few percent in 2002. The decrease in success of all nests suggests biological factors are a potential reason. This may be due in part to changing sand conditions. There were a high percentage of dry runs on the beach in 2002, possibly due to dry sand conditions. Dry sand makes it extremely difficult for turtles to successfully construct a nest. In addition, dry conditions have an adverse effect on the success of eggs and hatchlings.

There was an unexpected loss of prime nesting beach in 2002. Much of the area of beach from stake 186 through the 200’s was washed away, creating a very steep, narrow berm which the turtles were unable to climb and utilize. The lack of nesting beach in this area may have forced turtles to lay in other, less suitable areas of the beach.

It was also common during the 2002 season for researchers to encounter degraded nests from the 2001 season when relocating or excavating nests. This was inevitable and unavoidable due to the unprecedented high density of nests from the previous year. The large number of decomposed nests may have resulted in a high level of bacteria in the sand, especially in the zone from stakes 170 to 200, where density of both relocated and *in situ* nests was extremely high. Pathogenic bacteria, if present in the sand, may have a detrimental effect on hatching success. Although there is no direct evidence linking the two in 2002, the effect of changing sand conditions and bacterial load on hatch success bears further investigation. This may be extremely important for the future, when the continued expansion of the population is expected on a finite area of beach.

No Trample Experiment

Although the difference among hatch success in the trample and no trample areas of the beach were not significantly different, there was a 3.5% higher hatch success in the no traffic area. This is similar to results found in a preliminary study conducted during the 2000 season. Due to small sample size, results of either study remain somewhat inconclusive. It was estimated from past activity that a greater number of females would have nested in the areas set aside for the experiment. In 2002, however, the number of females able to successfully nest in this area was low. The turtles had extreme difficulty completing nests, and most attempts in this area resulted in dry runs. Very few nests were laid *in situ*. As a result, the sample size was smaller than expected. It is recommended that the experiment be duplicated in 2003 with the hope of obtaining an increased sample size. Until definitive answers may be obtained regarding the effect of

high traffic and recreational beach usage on hatch success, it is recommended that the beach remain closed during the peak of the nesting and hatchling season.

Other Research

Blood samples taken from nesting females during past seasons are being used for genetic and endocrinological studies in order to learn more about population structure and reproductive physiology in leatherbacks. Genetic analyses using mitochondrial DNA and nuclear (microsatellites) markers are being conducted by Dr. Peter Dutton at the National Marine Fisheries Service in La Jolla, California. Preliminary results suggest that some of the new nesting females are offspring of at least two of the long-term remigrants (Dutton et al., *In press*).

Visiting scientists in 2002 included Dr.'s Mike Salmon and Jeanette Wyneken from Florida Atlantic University. They visited the project along with their graduate student and a representative from National Geographic. They attached critter cams to a handful of leatherback females in order to obtain video footage and information regarding the behavior and activities of the turtles during their inter-nesting intervals. Multiple hours of video footage, along with diving information, were obtained and are currently being analyzed to provide further insight into the behavior of these unique animals.

Public Awareness and Education

The Public Education program was run by Amy Mackay under the auspices of the U.S. Fish and Wildlife Service. Visitors were limited almost exclusively to students and community groups. Lectures were presented to the visitors prior to entering the refuge, or observing the turtles. Visitors included school, community, and church groups. Numbers and compositions of groups may be obtained from either Amy Mackay, or Mike Evans, Refuge Manager, USFWS.

Management Recommendations

General management recommendations and priorities are described in McDonald-Dutton (1997). Further recommendations are outlined in previous reports (McDonald-Dutton et al., 1999, 2000). There has been a tenfold increase in the numbers of females nesting since the start of this project 22 years ago. Unfortunately, however, funding and personnel have not increased significantly and are unable to support the increasing population numbers. In order to maintain the same level of intensity as originally conceived for this project, it is important to have adequate funding and staff support. Continued involvement of USFWS personnel is highly recommended, since the problems related to lack of staff have been partially alleviated by the invaluable presence of USFWS personnel on the beach, and their assistance with patrols and the time-consuming nest relocation process.

In light of the continuing upward trend in numbers of nesting females, especially the tremendous increase shown in 2001, it is recommended that the focus of the project continue to be saturation tagging and data collection of nesting females. This is important

due to potential scientific breakthroughs which will result from the unique database that has been established from two decades of consistent monitoring and saturation tagging. This effort will only come to fruition if consistency is maintained. Adequate funding is required to support current personnel with future research, as well as to hire additional personnel to assist with future studies, tagging, and monitoring of an expanding population. In addition to continuing the present research objectives, additional research, as well as cooperation with outside scientists is advised. Satellite tagging, evaluation of sand properties, and further projects to increase the body of knowledge regarding this species and the nesting beach are encouraged. This includes studies tailored to the effects and implications of an expanding population. Continuation of the survivorship, mortality, and continuance with the injury studies are all important aspects that should not be ignored. The outcome of such studies may provide further insight into recommendations and procedures for future management of the growing population. It is currently recommended that doomed nests continue to be relocated, but not at the expense of tagging, data collection, and other innovative research projects.

CONCLUSIONS

The number of females nesting at Sandy Point has been increasing steadily since 1991, and showed dramatic increases in 1997, 1999, 2000, 2002, and particularly 2001 (Figure 2). This trend is very encouraging, since the leatherback continues to decline globally at an alarming rate. Results from this project suggest that a long-term commitment of at least ten years is needed before the effects of recovery efforts can be measured. This project serves as a model for successful recovery efforts, and for answering questions about leatherback behavior, reproductive biology and physiology.

Our findings have profound management implications for this species; if it is true that adults return to their natal beaches then we should expect a continued increase in the nesting population at Sandy Point as the hatchlings saved over the years begin to mature. Results from genetic analysis supports this theory, as does the dramatic growth of the population in the last few years. One explanation for this increase could be that hatchlings released in the first years of the project are now maturing and returning to nest at Sandy Point. If so, the upward trend in the numbers of females nesting each year should continue. If it does, this suggests an age at maturity of 10 - 15 years for leatherbacks. Genetic studies (Dutton et al. 1999) have shown that the St. Croix population is genetically distinct from others in the Caribbean outside the immediate region of the U.S. Virgin Islands and Puerto Rico, and this is also consistent with the natal homing hypothesis. Further genetic work will determine whether new turtles that nest are the offspring of females tagged in previous years.

This intensive research and conservation effort would not have been possible without the assistance of 1,231 Earthwatch volunteers who over the past eighteen years have contributed over 98,300 hours patrolling over 72,400 miles of beach. Continued commitment by the Earthwatch Institute and by the USVI Division of Fish and Wildlife will help protect the leatherback as well as add to our knowledge of its reproductive and population biology. This is essential to the evaluation and modification of recovery and

management plans to ensure the survival of this endangered species.

ACKNOWLEDGMENTS

Funding was provided by the United States Fish and Wildlife Service Section 6 appropriations, and by the Earthwatch Institute in Watertown, MA, and the U.S. National Marine Fisheries Service. Donna and Peter Dutton reviewed the manuscript and provided advice during the project. We would like to express our deep appreciation and respect to the past project and field leaders and the 1,231 Earthwatch volunteers who have provided this project with continuous quality field assistance since 1982, and without whom this level of research would not be possible. Much respect and appreciation also go to Mike Evans, USFWS Refuge Manager, who not only put in long hours and often assumed personal risk to maintain order at the refuge and ensure that regulations were being followed, but also volunteered many hours on the beach and helped out with visitors. Claudia Lombard and Amy Mackay, USFWS, recorded early-season nesting activities prior to April 1, in addition to assisting with patrols and relocating a majority of the threatened nests this season. Amy Mackay also developed and implemented the Education Program and served as Education Coordinator. We can not express how invaluable the help was that was provided by USFWS personnel. We would like to reiterate that the utmost appreciation goes to the entire U.S. Fish and Wildlife staff for their involvement, un-tiring effort, and support throughout the entire season.

We would especially like to thank the Benedict family, proprietors of Cottages-By-The-Sea, for their support and for providing a friendly and comfortable base of operations for this project.

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