

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

Annual Report to the U.S. Fish and Wildlife Service

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Pursuant to Contract #PC-P&NR-287-91
Division of Fish and Wildlife
Department of Planning and Natural Resources
U.S. Virgin Islands

November 1992

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ABSTRACT

The Sandy Point National Wildlife Refuge, St. Croix, supports the largest and best studied population of nesting leatherback sea turtles in the United States and northern Caribbean (Eckert and Eckert, 1985). Since 1981, saturation tagging and consistent night patrols during nesting season have yielded a comprehensive database of information on each female nesting at Sandy Point. The 1992 nesting season began February 9 and ended July 27, with a peak in late April/early May. Fifty five turtles were observed, 54 of which laid a total of 345 nests with an average of 78.3 yolkeggs per clutch. Each female produced an average of 6.4 nests with an average interesting interval of 9-10 days. Seventeen of the turtles were remigrants, with remigration intervals of 2-4 years. Of the 231 nests excavated, mean hatch success was 66.3% (SD = 19.2). Twenty one nests were lost to erosion.

Nightly patrols and a concerted relocation effort have reduced the major historical threats of poaching and erosion. Of nests laid in 1992, 145 (42%) were relocated. The slaughter of gravid female leatherbacks on Sandy Point has been eliminated, although there is still poaching of both eggs and adults of greens (*Chelonia mydas*) and hawksbills (*Eretmochelys imbricata*) after nightly patrols cease.

INTRODUCTION

For the eleventh consecutive season, research continued on the nesting ecology and population biology of the endangered leatherback sea turtle (*Dermochelys coriacea*) at the Sandy Point National Wildlife Refuge, St. Croix, U.S. Virgin Islands. The objectives of the project are to protect adults, nests and hatchlings from predators and poachers, to protect nests from erosion and inundation, and to assess the size, productivity, and management priorities of this population by documenting and tagging all nesting females.

The leatherback is the largest and most morphologically divergent species of sea turtle. The biology of this little-known turtle is reviewed in Marquez (1990). Pelagic in nature, it is rarely encountered in the wild except on the nesting beaches, where almost all of the known information on this species has been collected. There are only 13 significant nesting sites worldwide (Sternberg, 1981), including six in the western Atlantic (Carr et al. 1982). Sandy Point supports the largest and best studied concentration of nesting leatherbacks in the United States and the Northern Caribbean (Eckert and Eckert 1985).

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 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 1992 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 (1991), and McDonald et al. (1991).

STUDY AREA

The study area is the 3.0 km beach within the Sandy Point National Wildlife Refuge (Figure 1). There are 120 numbered stakes placed at 20 m intervals along the vegetation line for the length of the study area, enabling us to measure exact nest locations. Approximately half of the beach (stake #-003 to #50) is on the leeward side of St. Croix and is relatively wide, with very little vegetation extending out onto the sand. It is referred to in this report as the "sandy side". Erosion of the beach from stake #20 - #50 has historically occurred during the nesting and incubation season, so that in some years only a 1-2 m wide strip of sand remains until accretion rebuilds the beach during the winter months. The beach from stake #51 - #120 is on the windward side of the island, and is usually covered with wave-deposited debris and seaweed as well as vegetation growth for much of its length. This side is referred to as the "grassy side".

METHODS

Study Area Coverage

We began beach coverage on April 2, patrolling nightly on foot from 1930-0500 hours. Beginning April 6, we were assisted by eight Earthwatch teams consisting of 4-10 volunteers, each participating for a ten day period. The teams were divided into two groups, each led by a Field Director. Each group walked half the study area at one hour intervals. Since previous observations indicated that leatherbacks require at least 1½ hour to complete nesting, this ensured that all nesting turtles were observed and tagged. Before nightly beach patrols began, early season nests were tallied during the day on a weekly basis.

Data Collection

Each time we encountered a turtle, we completed a separate data sheet (Appendix I). Morphological, nesting, and behavioral data and nest parameters and location were all recorded as well as time and date of encounter, and weather information. We excavated nests after hatchlings emerged, and categorized the contents to determine hatching success. For the most part, basic data collection procedures were the same as in previous years. We did not weigh adults this season, as sufficient data have been collected in past years for a length/weight conversion. We also documented other species of turtles.

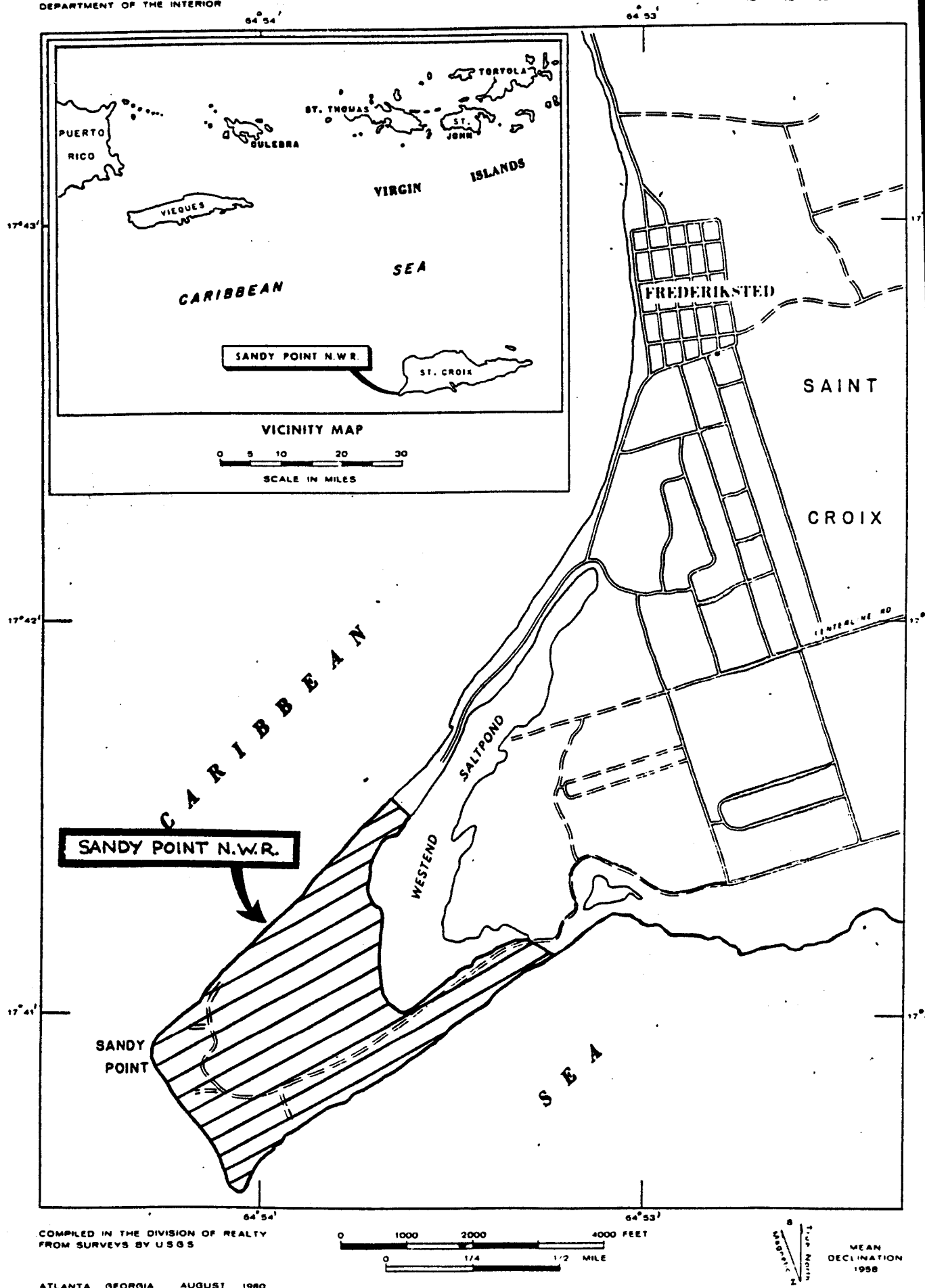
Figure 1

SANDY POINT NATIONAL WILDLIFE REFUGE

UNITED STATES
DEPARTMENT OF THE INTERIOR

SAINT CROIX, VIRGIN ISLANDS

UNITED STATES
FISH AND WILDLIFE SERVICE



We used the following methods to collect data:

A. Morphology

We recorded over-the-carapace (o.c.) length and width. Carapace length was measured from the anterior notch to the posterior tip alongside the vertebral ridge. Width was measured to each side ridge at the widest point of the carapace, just posterior to the front flippers. Individuals were measured each time they were encountered, and the measurements averaged for the season.

We examined each turtle for diagnostic markings, deformities and ectobiota. We photographed injuries when possible. We also photographed the pink spot found on the head of adult leatherbacks, and categorized their characteristics as in previous years in hopes that persistent individual variation will serve as a secondary means of identification.

B. Nesting

We measured nest depth at the completion of the nest cavity, determined when the female covered the cavity with a rear flipper just prior to egg deposition. The measurement was taken from the bottom of the nest cavity to the underside of the carapace just over the base of the tail. Abnormalities in digging, nest cavity structure, or presence of water or foreign materials in the nest cavity were noted. During egg deposition, yolked and yolkless eggs were counted.

C. Relocated Nests

If a nest appeared threatened at the time of laying by imminent erosion or inundation, if it was situated in a previously identified erosion zone, or if there was standing water in the nest cavity, we collected the eggs and reburied them in a stable area of the beach. We recorded relocated nest depth and overburden (depth of sand over the eggs, measured from the top of the egg mass to the sand surface). For each relocated nest, we weighed all yolkless eggs and a subsample of ten yolked eggs to determine the relative proportion of each. In an experiment investigating the possible causes for lower hatch success in relocated nests, we used four different nest designs: "wide" (> 37 cm wide from top to bottom), "narrow" (< 37 cm wide, in which eggs tended to be stacked into the chimney), and "natural" (having the same shape as the natural nests, with an egg chamber approximately 30x35 cm and a chimney approximately 30 cm, and with the eggs stacked against one side of the nest). The fourth category consisted of "natural" nests, using sand caved in from the sides of the nest to cover the eggs.

D. Behavior

The covering flipper, i.e., the flipper used to cover the nest cavity, as well as the female's orientation in relation to the water, was noted in an attempt to determine behavioral patterns in individual turtles. A diagram of each turtle's "crawl pattern" was drawn, including any nest attempts prior to the actual nest (i.e., cave-ins, inundated nest cavities).

E. Nest Location

We determined the location of each nest by measuring the distance from the center of the nest to each of the two nearest marker stakes. We drew a beach profile of the area near the nest

site to show the nest's relationship to the vegetation line, high tide mark, and water's edge, and we recorded the exact distances.

F. Tagging

We attached a Monel tag to the trailing edge of a rear flipper on every untagged turtle, in the thin flesh between the flipper and the tail. As in 1991, we also attached an Inconel tag to the same area on the other rear flipper on all turtles, even those previously tagged, to compare their retention rate with the Monel tags. The titanium tags used in past seasons are no longer being used, as their matte finish becomes fouled with barnacles much quicker than the other metals. We did not apply front flipper tags. Both Monel and Inconel tags had to be slightly reshaped prior to insertion for proper alignment of the locking mechanism in the tagging pliers.

We also tagged each turtle with a small (7 mm) glass-encased magnetically coded microchip, or PIT (passive inductive transponder) tag. We injected these tags directly into the shoulder muscle of each turtle. The tags are detected with a small portable scanner passed over the area, and the number is displayed on a digital screen on the scanner. In fifteen turtles, we injected two tags: one high in one shoulder under a thick blubber layer, and one lower, under a thinner blubber layer, to test tag retention in different locations.

G. Sand and Nest Temperatures

We recorded sand temperatures at three-day intervals throughout the season using a BAT-12 Physitemp electronic thermometer, with thermocouples buried at a depth of 70 cm. Four of these probes were evenly spaced in each of three transects, running perpendicular to the waterline from approximately 0.5 m above the high water mark to 0.5 m into the vegetation. Two transects were situated on the sandy side at marker numbers 12 and 33 (five probes were buried at 33, where the beach was wider), and one on the grassy side at number 66. We placed additional transects of two probes each at markers 32 and 42, in order to more closely monitor sand temperatures in the erosion zone. We also monitored the temperatures of 20 nests laid during two different time periods - early (April 13 - 19), and mid (May 14 - 18) season.

H. Blood Samples

We collected 5-10cc of blood from either the cervical sinus or a vein in the rear flipper of 25 turtles. This was done while the turtle was in her motionless nesting "trance" in order to avoid disrupting the nesting process. Serum and red and white blood cells were separated by centrifugation and the samples frozen in liquid nitrogen. These blood samples will be used for genetic and endocrinological studies.

H. Emergence and Excavation

We monitored nests nightly starting three days before the expected emergence date. After emergence, we recorded the location, date, time, and number of hatchlings or crawls. Hatchlings were guarded from potential predators until they entered the water, and any beach debris was removed from their path. Disoriented hatchlings (i.e., those wandering up in the vegetation or along the beach away from the water) or those trapped in vegetation were assisted to the water's edge.

After emergence, we excavated nests and categorized their contents to determine hatching success. We opened unhatched eggs to determine stage of development, using criteria described by Whitmore and Dutton (1985) (Appendix I). We described all abnormalities. We noted the condition of the nest cavity to determine possible causes for poor hatch success such as flooding, extremely dry sand, closely packed or compressed eggs such as were often found in high public use areas, hatchlings trapped by root growth, etc. Any live hatchlings found in the nest were released.

RESULTS

Adults

We observed and tagged 55 leatherbacks on Sandy Point in 1992, including 38 previously untagged turtles (Figure 2). There were 17 remigrants, including one first tagged in 1979, one in 1984, one in 1985, seven in 1988, three in 1989 (one of these was tagged at Manchineel Bay, St. Croix) and four in 1990. One turtle was tagged in Puerto Rico in 1990, and nested consistently at Sandy Point during the 1992 season. At least four, possibly eight, of the untagged turtles had tag scars and may have been remigrants. Of the known remigrants, six are nesting on two year cycles and four on three year cycles (Table 1). Seven are either nesting on four year cycles or nested elsewhere in 1990. Twenty seven consistently returned to Sandy Point for each nesting; 24 may have also nested elsewhere. Four turtles only nested once, three in April and one in July, and all were previously untagged. One of these was observed nesting in Puerto Rico before and after being tagged on Sandy Point. One turtle did not complete a nest.

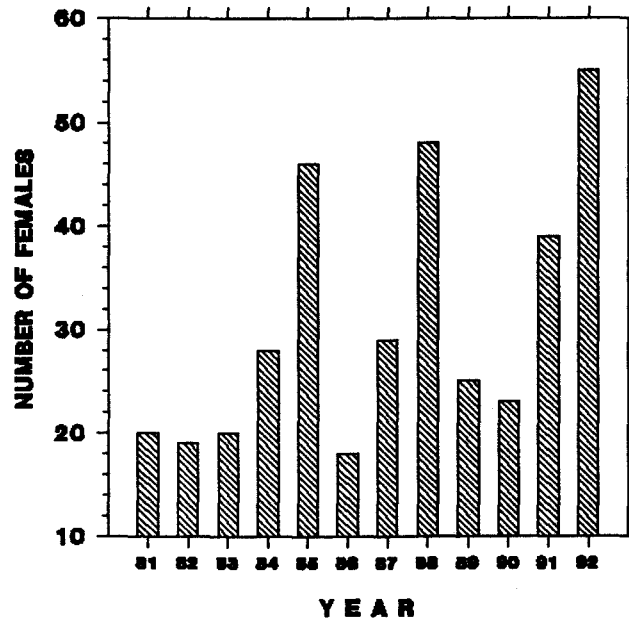


Figure 2. Number of adult female leatherbacks nesting each year at Sandy Point from 1981-1992.

Carapace lengths ranged from 138.9 - 162.2 cm, with a mean of 151.67 cm (SD = 5.66, n = 54). We categorized individuals into six size classes based on carapace length (Figure 3). We compared size class to number of clutches laid and clutch size (Figures 4 and 5). In general, the number of yolked eggs laid increased with the size of the turtle (Figure 5). Yolkless egg numbers were independent of size class. There was also a correlation between size class and numbers of

Table 1. Leatherback remigrations to Sandy Point from 1977 to 1992.

Season	Total Turtles Encountered	Years of Absence				Tag Scarred	Total Remigrant
		1	2	3	4		
1977	10 ¹	0	0	0		0	0
1978	Population not monitored						
1979	6 ¹	0	0	0		0	0
1980	Population not monitored						
1981	20 ²	0	3	0		0	3 (15.0%) ³
1982	19	0	0	0		1	1 (5.3%) ³
1983	20	0	7	0		2	9 (45.0%)
1984	28	0	4	0		0	4 (14.3%)
1985	46	1	10	3		2	16 (34.8%)
1986	18	0	1	2		0	3 (16.7%)
1987	29	0	9	5		0	14 (48.3%)
1988	48	0	5	7	1	4	17 (35.4%)
1989	24	0	7	0	0	0	7 (29.2%)
1990	22	0	2	3	1	0	6 (27.3%)
1991	39	0	8	8	0	1 ⁴	16 (41.0%)
1992	55	0	6	4	7	4 ⁴	17 (30.9%)
Totals		1	56	28	2	10	

¹ Does not represent total number of turtles nesting

² May or may not represent total number of turtles nesting

³ Does not represent accurate measure as a consequence of incomplete tagging in previous years; proportions in later years are more accurate but still not complete.

⁴ We do not include tag-scarred individuals in the count of remigrants, as we cannot determine with certainty if they were tagged at Sandy Point.

both observed and estimated nests, with the largest size class laying the fewest number of nests, and the third (144-149 cm) laying the most (Figure 4). However, these numbers should be viewed with caution as we do not know which turtles laid the early season nests.

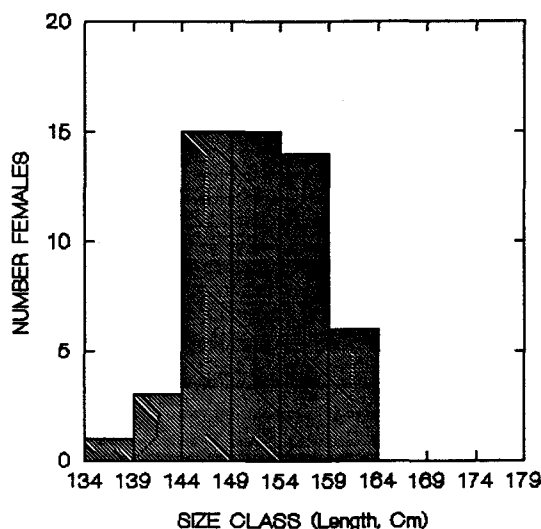


Figure 3. Size class distribution (o.c. length, cm) of leatherbacks nesting at Sandy Point in 1992.

Based on 54 turtles laying a total of 345 nests, we estimate the average number of nests to be 6.4 nests/turtle. The number of documented nests per female ranged from 1 - 9, with a mean of 5.4 (SD = 2.21) (Figure 6). Internesting intervals ranged from 7 to 28 days for 50 turtles (four turtles nested only once). In cases where the internesting interval was more than the usual interval of 8-12 days, we assume that nests were laid during these intervals but were undocumented (for instance, were laid on other beaches). This gives us an estimated mean number of nests per female of 6 (SD = 2.36). This number is likely even higher, as there were at least 32 early season nests for which the female is unknown.

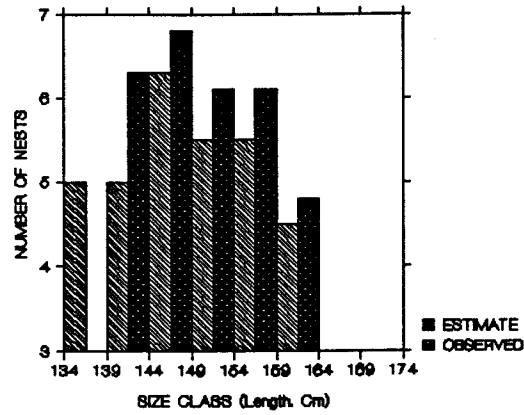


Figure 4. Average number of nests laid by size class in 1992.

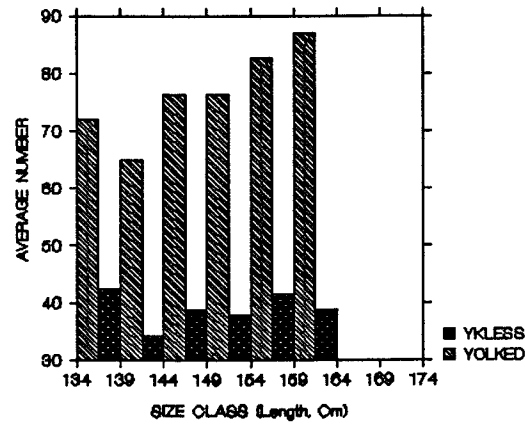


Figure 5. Number of yolked and yolkless eggs by size class in 1992.

PIT Tags

Of the 69 PIT tags injected, only one was lost (i.e. undetectable) by the end of the season. All injection sites had healed by the next consecutive nesting following injection. Continued tagging and monitoring over the next few years will give us an indication of the reliability of this new tagging method.

Nests

Leatherback nesting began on February 9 (William Tobias, pers. comm., and Greg Hughes, U.S. Fish and Wildlife Service, pers. comm.) and terminated July 27. A total of 456 activities was recorded, of which 345 (76%) resulted in egg deposition. Activities prior to April 2 were discovered during daytime surveillance of the study area, and were recorded as "judgement" nests. Of these 49 activities, 32 produced hatchlings; the rest were presumed to be false crawls or were laid in erosion zones and may have washed away. During nightly patrols (April 2 - July 31), 407 activities were recorded, of which 313 (77%) resulted in egg deposition.

We relocated 145 (42%) nests. We estimate that nearly all of these nests would otherwise have been lost. Beach erosion on the sandy side (stake #-6 to #50) was not as extensive this season as in other years. By August, the distance from the high water mark to the vegetation was approximately 3 m for most of the beach from stake #20-#50. However, many of the relocated nests were laid at or below the high water mark. Unseasonable winds and currents on the sandy side during April resulted in a steep bank from stake -006 to 10, and the turtles were unable to scale it, nesting instead at the water's edge. At the same time, erosion on the grassy side (stake #51-#120) was more extensive than usual, and some nests left in historically safe areas were washed away.

The peak activity period occurred during the second week in June (Figure 7), with 34 nests being laid. Activity was heavy from mid-April to mid-June, and declined steadily to the final nesting on July 27.

The average number of yolked eggs per clutch was 78.3 (SD = 17.06, range = 27 - 120, n = 231). The average number of yolkless eggs per clutch was 39.8 (SD = 15.71, range 7 - 100). The total weight of yolked eggs per clutch averaged 6.50 kg (range 2.05 - 9.48 kg, n = 125). Yolkless egg weights averaged .77 kg per clutch (range 0.58 - 1.74 kg, n = 123) On average, yolkless eggs made up 10.9% of the total clutch weight.

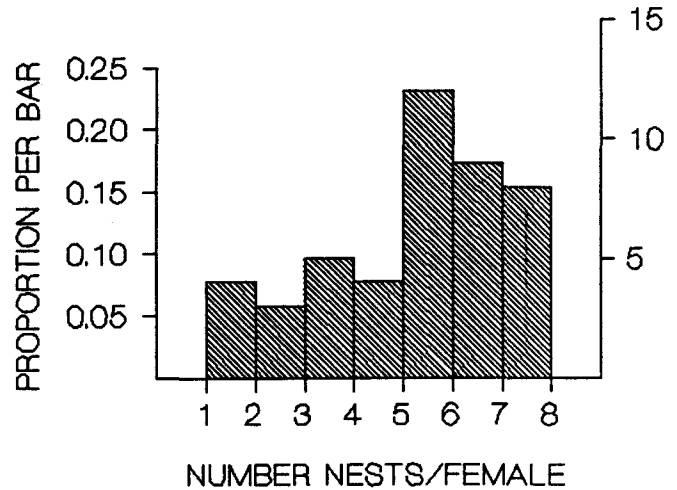


Figure 6. Observed nesting frequency of leatherbacks at Sandy Point in 1992.

Hatching

Most emergences occurred between 1800 h and 2100 h. The mean incubation period for nests throughout the season was 66 days. As in previous years (Basford et al. 1990) incubation period decreased through the season. In 1992, incubation period averaged 71 days for nests laid in February and March, 66 days for nests laid April through mid-May, and 61 days for nests laid mid-May through June (Figure 8). There was a corresponding increase in sand temperatures from an average of 28.6°C in April to 30.4°C in August (Figure 9, Table 2). During the critical period for sex determination (the middle third of incubation), nest temperatures averaged 29.0°C (SE = 0.21, n = 10) for April, and 29.8°C (SE = 0.20, n = 10) for May. These mean nest temperatures were the same as the mean sand temperatures for corresponding dates. There was a significant difference in average sand temperatures between stations (ANOVA $p < .0001$); station A, which was closest to the vegetation, was consistently over 1°C warmer than station D, which was closest to the ocean (average of 29.9°C and 28.8°C, respectively) (Table 2).

Table 2. Sand transect temperatures at 70 cm depth, averaged for all transects by month and by station. Station A is closest to the vegetation.

	Average (°C)	SD	Range (°C)	n
By month:				
April	28.6	.63	27.5 - 30.0	60
May	29.0	1.00	26.4 - 31.1	131
June	29.8	.71	28.2 - 31.5	98
July	30.4	.63	28.7 - 31.4	36
August	30.4	.29	30.0 - 30.7	4
By station (averaged among all transects):				
A	29.9	.93	26.9 - 31.4	84
B	29.5	1.01	26.7 - 31.3	84
C	29.2	.94	26.4 - 30.5	81
D	28.8	.83	26.4 - 30.4	80

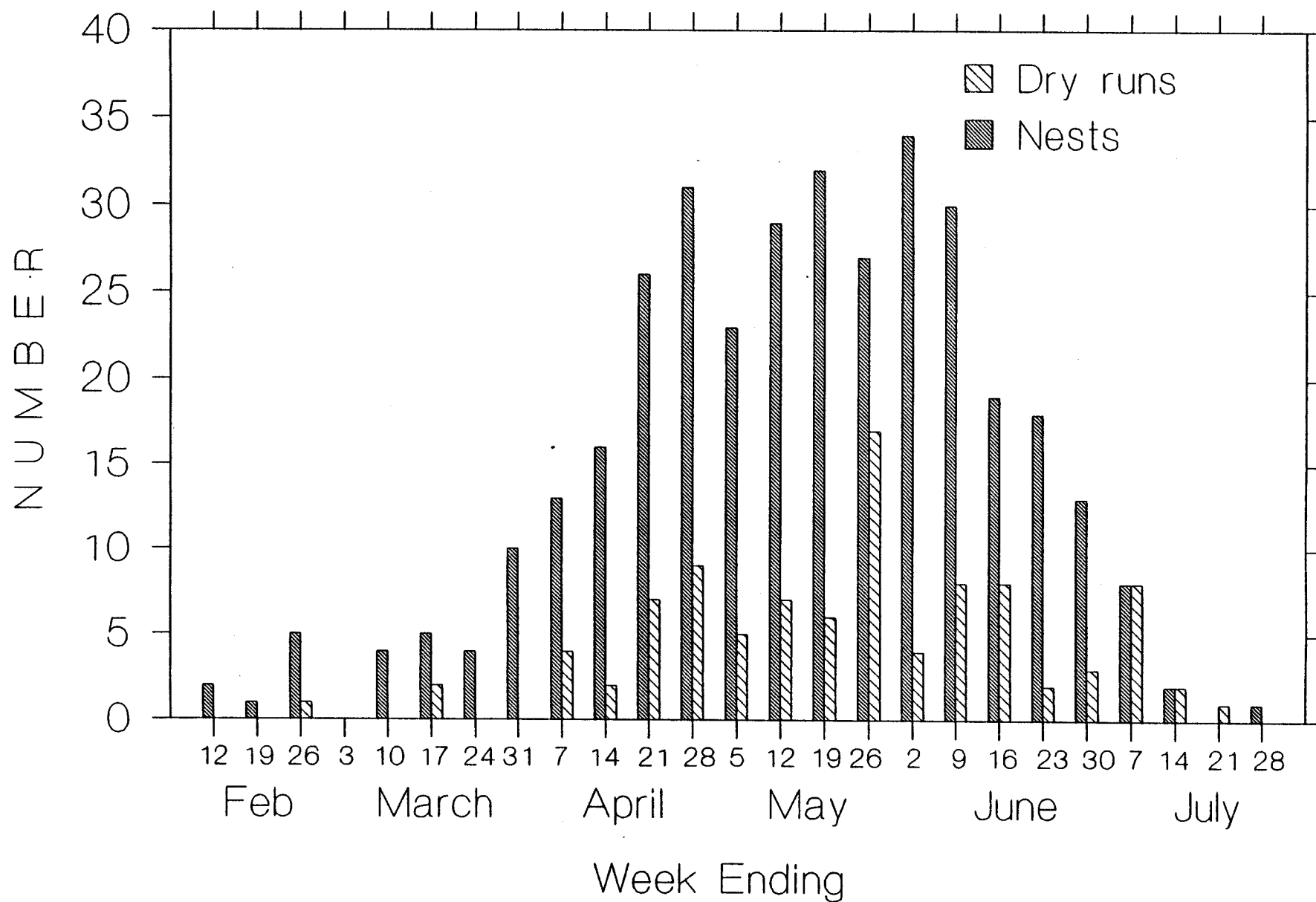


Figure 7. Total number of nests and dry runs made each week by leatherbacks on Sandy Point, St. Croix during 1992.

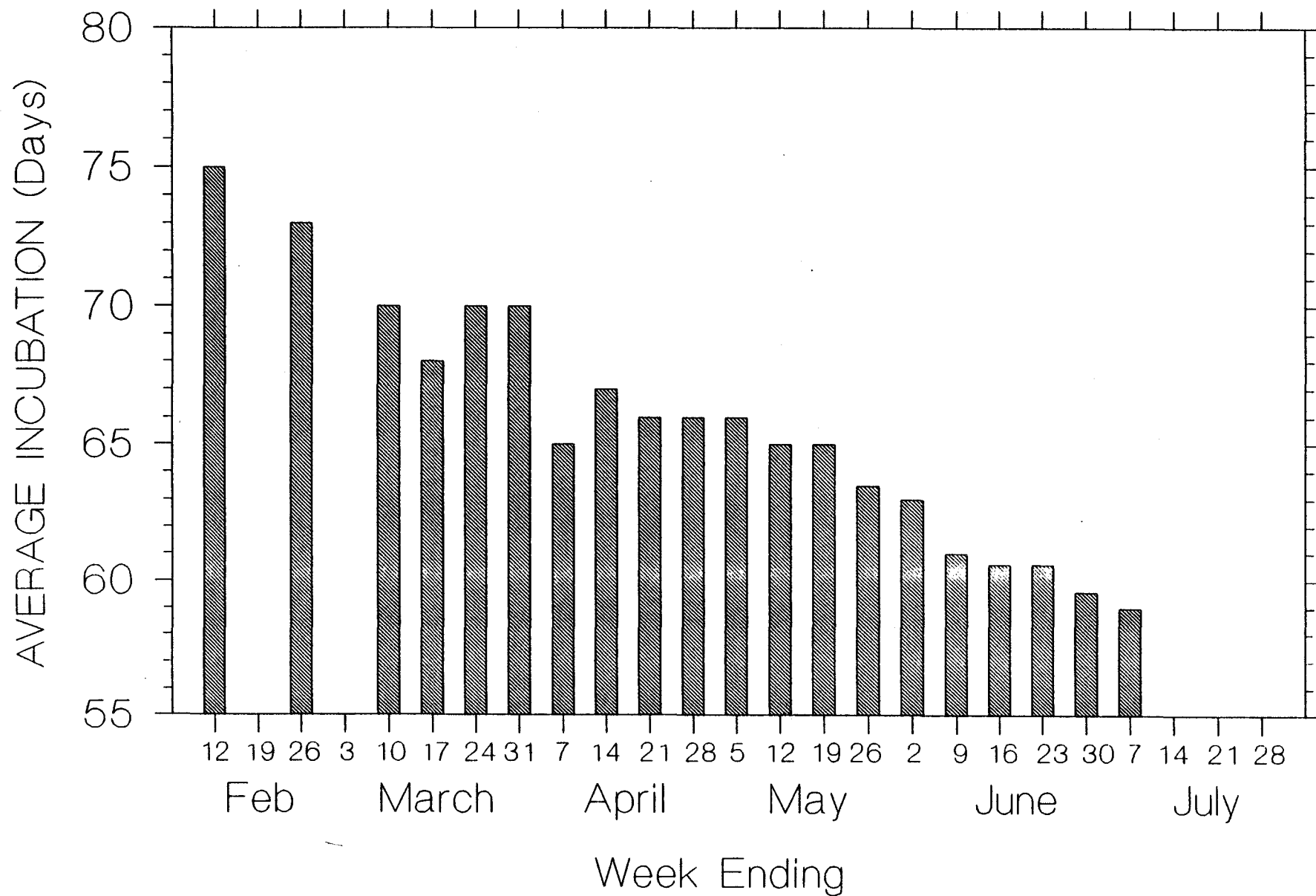


Figure 8. Average incubation period (days to emergence) of leatherback nests on Sandy Point, St. Croix during 1992.

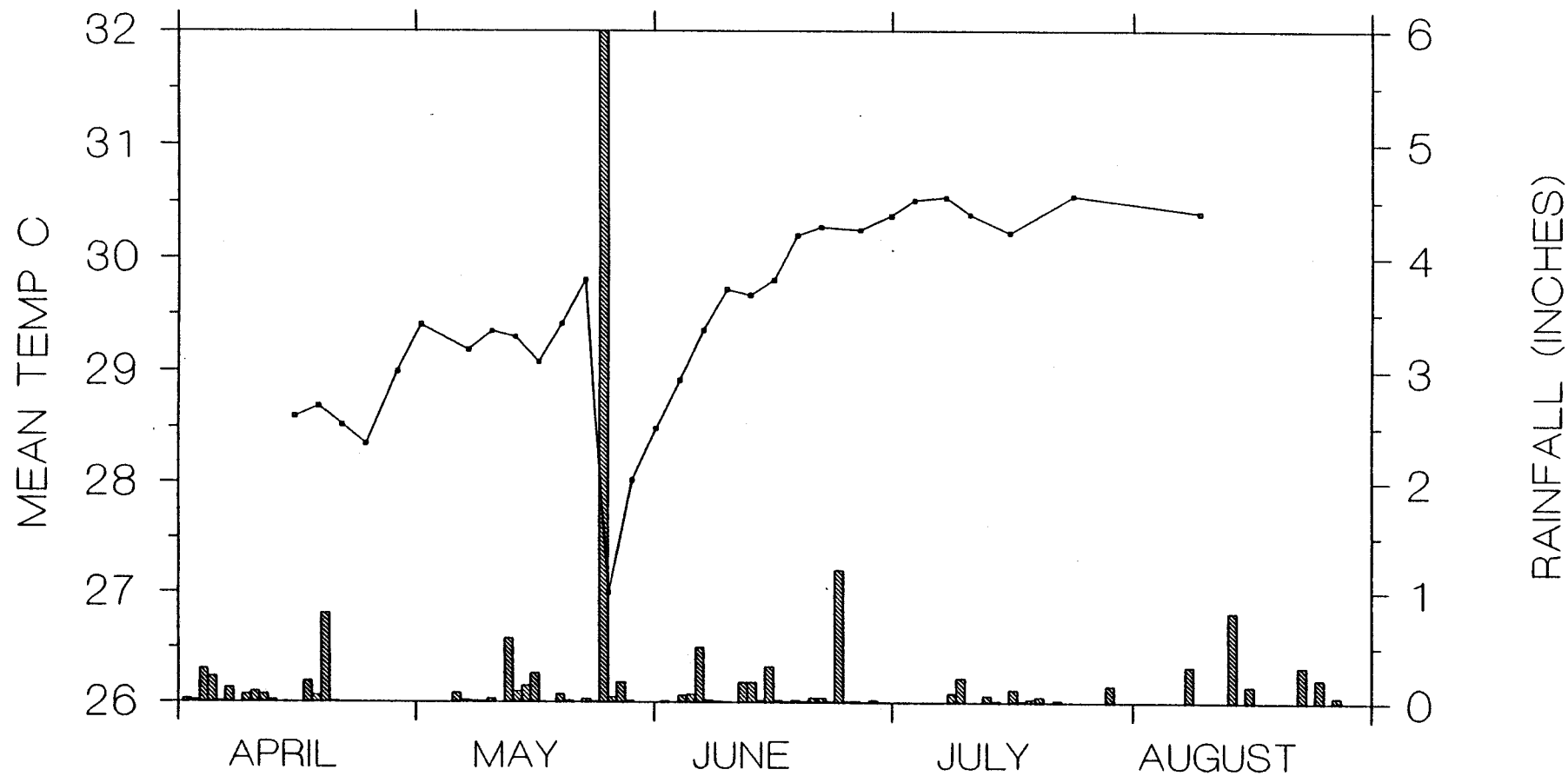


Figure 9. Average sand temperature at 70cm depth (line), and average daily rainfall (bar) during 1992 on Sandy Point, St. Croix.

Nest outcomes were defined as "known" and "unknown". "Known" results include all nests that were excavated as well as nests known to have been lost to erosion or inundation by waves. "Unknown" includes 42 nests that emerged (as evidenced by hatchling tracks) but were not excavated, and 34 for which we did not confirm emergence. Many of these likely emerged undetected, as heavy rains during the hatching season quickly obscured tracks. An additional 17 nests are listed as "unknown" as they had not hatched prior to our departure.

Of the 345 nests deposited, 294 provided known results (Table 3). Twenty one were lost to erosion, and 42 emerged but were not excavated (39 *in situ*, 3 relocated). We excavated 231 nests, for which mean overall hatch success was 66.3% (range 0 - 98.4%, SD=19.19). Actual mean emergence success (hatch success - dead hatchlings) was 64.3% (range 0 - 98.3%, SD=19.15). Hatch success was lower in relocated nests (61.3%, SD = 18.6, range = 0 - 96.7%, n = 123) than in *in situ* nests (72.2%, SD = 18.2, range = 0 - 98.4%, n = 108). Corresponding emergence success was 58.7% and 70.7%. This difference is statistically significant (t test $p < 0.05$). There was no significant difference in hatch success between the "grassy side" and the "sandy side" (t test $p > 0.05$ for both relocated and *in situ* nests).

For relocated nests, mean hatch success was higher in "natural" nests than in either "wide" or "narrow", but was lowest in "natural" with caved-in sides. Hatch success for "natural" relocated nests was not significantly different from *in situ* nests.

	wide	narrow	natural	natural (caved)	<i>in situ</i>
hatch					
success (x)	62.1	62.1	68.4	51.5	72.2
SD	20.1	14.8	10.2	24.6	18.2
n	43	45	15	20	108
range	0-96.7	24.5-94.8	45.6-82.5	3.3-82.4	0-98.4
emergence					
success (x)	59.5	59.1	65.6	49.9	70.7
SD	19.7	15.5	11.4	23.6	18.0
n	43	45	15	20	108
range	0-96.7	17.9-94.8	45.6-81.3	3.3-77.0	0-98.3

Three nests were washed over by high tides. Hatch success for two of these was 84.4% and 62.4%.

Using average clutch size of 78.3 and emergence success of 58.7% and 70.8% for relocated and *in situ*, respectively, we estimate the total number of hatchlings emerging at Sandy Point in 1992 to be 17,684. This is higher than in any previous year (Figure 10). Relocated nests produced 37.5% of the total.

Table 3. Final outcome of leatherback nests on Sandy Point from 1982 to 1992.

Year	Known				Unknown	Total
	Survive to term		Lost			
	n	% success ($\bar{x}$)	erosion	poaching		
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%) ¹	345
1991						
relocated	99	62.0	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						
reloc				0	0	54
in situ				0	13	89
total						143

1-2/year

'88 6/12 58 Total (nest DR 5-8)

'89 11/16 De activities / season

allow for DR to nest cahi

change due to Hugo

1988, 1989 / 1989, 1990 / 1991, 1992

2:1 / 4:1 / 2:1

can predict. or project

page + whether ↑ or ↓ or =.

'85 63 nest

'86 62 nest

'87 87 nest

'88 125 nest

'89 121 nest

'90 76 nest

'91 121 nest

1989						
relocat						
in situ						
total						7
1988						
reloca						45
in situ						7
total						42
1987						
relocat						35
in situ						26
total						171
1986						
relocat						37
in situ						45
total						82
1985						
relocate						120
in situ						122
total						242
1984						
relocate						88
in situ						53
total						141

1-2/year

'88 6/12

'89 11/16

'85 63 nest

'86 62 nest

'87 81 nest

'88 125 nest

'89 121 nest

'90 76 nest

'91 121 nest

'92

58 Total (nest DR 528)

De activities / season

allow for DR to nest ratio

change due to Hugo

1988, 1989 / 1989, 1990 / 1991, 1992
2:1 / 4:1 / 2:1

can predict or project
pigeon + whether P or ↓ or =

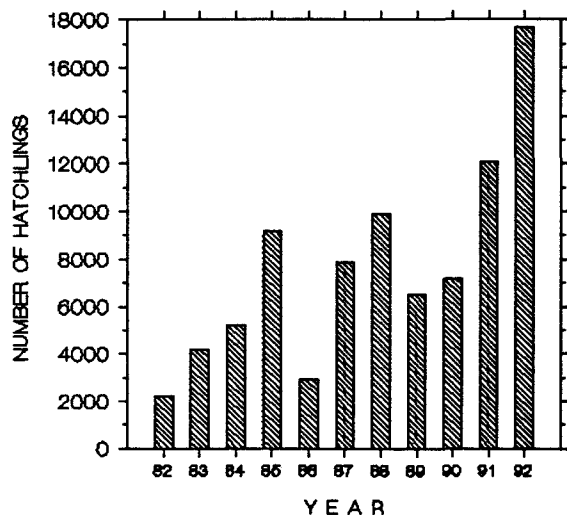


Figure 10. Total annual hatchling production from nests laid by leatherbacks at Sandy Point for 1982 to 1992

Thirty three nests contained at least one abnormality. Albinism occurred in four embryos. All were full-term and had deformed faces and lower jaws. There were two full-term unpipped two-headed embryos, and one set of Siamese twins. Fifteen embryos had deformed heads and/or jaws; three occurred in the same nest, and in two cases, two occurred in a nest that also contained an albino. Thirteen nests (3.8%) contained twins. Three nests, laid by the same turtle, had one, five and six sets of twins. Another nest had two sets of twins; the rest were single cases. Twins were at varying stages of development from pigmented eye to full-term unpipped, and in one case, one twin was alive when the unhatched shell was opened. In one nest, a very small full-term hatchling was found dead inside a hatched shell, indicating that one twin survived and emerged. In another case, a live but very small hatchling was found in the nest cavity. Based on its size as compared to the other hatchlings in the cavity, this may have been a twin (but was not recorded as a definite twin). One hatchling was found live in the nest cavity with a short right front flipper.

Injuries and Mortality

Females

There was no adult mortality at Sandy Point. Many of the turtles exhibited severe injuries, some apparently caused by sharks and some by boat propellers. Some shoulder injuries may be due to entanglement in ropes or cables in the water. Most of the injuries were healed; however, one turtle sustained severe injuries to the head and neck during the course of the season, and may eventually lose an eye due to infection. These injuries did not appear to hinder nesting. Even in cases where a female was missing a rear flipper, she was able to complete a nest cavity.

Eggs

Erosion continues to be the most significant natural threat to leatherback eggs on Sandy Point; however, due to the relocation effort, only 6.1% of the nests in 1992 were lost to erosion. This is higher than in the previous five years, due to the high number of pre beach patrol nests laid in erosion zones that were unable to be relocated.

Poaching has historically been a problem at Sandy Point, but nightly beach patrols and the occasional presence of Environmental Enforcement officers and the Refuge Manager has nearly halted this activity, and there has been no evidence of humans taking leatherback eggs on Sandy Point since 1985 (Table 3). However, poaching of other species, both adults and eggs, continues to be a problem on Sandy Point after the leatherback season, and year-round on other beaches on

St. Croix.

Hatchlings

Yellow-crowned Night Herons (*Nyctanassa violacea*) and ghost crabs (*Ocypode quadrata*) are the most significant predators of hatchlings on the beach. At least 20 nest sites showed evidence of heron predation in 1992. Dogs were seen on several occasions, and at least two nests had been dug to a depth of about 25 cm. It was not evident, however, that hatchlings had been taken. We also found mongoose (*Herpestes arropunctatus*) activity (tracks, digging) near some 30 - 50 nests. As with the dogs, they were probably unable to dig down to the nest cavity but could have encountered emerging hatchlings. A ghost crab was found in one nest cavity, along with a dead hatchling with neck wounds.

Roots of the common beach vines (*Ipomea* and *Canavalia*) continue to endanger both eggs and hatchlings by entanglement in the nest cavity. Upon excavation, eggs were found with roots of these vines growing through them, and hatchlings were found encapsulated in roots. Hatchlings, some covered with ants, were also occasionally found trapped in woe vine (*Cassythe filiformis*).

Other species

Hawksbill

Although we did not tag any hawksbills (*Eretmochelys imbricata*), we found four probable nesting activities this season, and saw one turtle do a "dry run".

Green

There were six green (*Chelonia mydas*) activities. At least two of these resulted in egg deposition. Both females, previously untagged, were observed and tagged. One nest, which was relocated, was excavated after emergence and had a hatch success of 69.4 (75/108). At least one of the nests was disturbed by humans, and all the eggs were taken.

DISCUSSION

The 1992 season was very successful, with record numbers of both turtles and nests. This resulted in more hatchlings emerging than in any previous year. The season extended from early February to July 27. With the addition of 38 new animals in 1992, a total of 270 - 280 individuals has been identified since 1977. Due to the relocation effort, only 6.1% of the nests were lost to erosion, whereas past history has shown that 50-60% might otherwise be lost.

Hatch Rates

As in past years, hatch success for relocated clutches was lower than for *in situ* nests. The contents of the relocated nests with poor hatch rate appeared to be compacted, and often nests would cave in prior to emergence. It appears 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 (our "natural" design). We will continue to experiment with different nest designs to

investigate their effect on hatch success. It has been suggested that hatch success on the grassy side is higher than on the sandy side (Basford 1988); however we found no significant difference for either relocated or *in situ* nests.

Temperatures and Sex Ratios

For leatherbacks, it has been shown that temperatures of 28.75°C and lower during the critical period (the middle third of incubation) will produce all males; 29.25°C produces 50% females, and 29.75°C and above produces 100% females (Mrosovsky et al. 1984). Based on average nest temperatures of 29.0°C in April, we estimate sex ratios to be 75-100% male in all of the 123 nests laid during February, March and April. Average nest temperature in May was 29.8°C, and as sand temperatures remained warm for the duration of the season, we estimate the sex ratios in the 227 nests laid during May, June and July to be 100% female. (Nests lost to erosion were not included.) This seasonal trend is consistent with findings from previous years (Basford 1988). Based on these data, we estimate that the overall sex ratio of leatherbacks produced at Sandy Point in 1992 was 30-40% male and 60-70% female. This is a higher proportion of males than in past seasons, and is likely the result of high rainfall during May, causing sand temperatures to remain cool for longer into the season than usual (Figure 9).

The significant difference in sand temperatures that we found for different areas of the beach has several management implications. Clutches laid closer to the water may be subjected to lower incubation temperatures than those higher on the beach. If so, relocated nests should be buried at varying distances from the water's edge to avoid the possibility of skewing the hatchling sex ratios. We may be adding to the female bias by moving all nests near the high water mark; this should be investigated in more detail in the future.

Other research

Preliminary studies using ultrasound imaging were started this season, when a veterinarian from Sea World used a portable ultrasound unit to image the ovaries, kidneys and circulatory system of five females. We plan to continue this work next season.

The blood samples taken from nesting females will be used for genetic and endocrinological studies in order to learn more about population structure and reproductive physiology in leatherbacks. Mitochondrial DNA analysis and hormonal assays will be conducted at Texas A&M University as part of Dutton's doctoral research.

Public awareness and education

Community support was evidenced by nearly 750 visitors to the project, the majority of which were local residents. Nine school groups visited Sandy Point, and many of the teachers expressed interest to further their involvement through school programs, volunteering on the beach when needed, and arranging for student interns. Other groups visiting the project included the Youth Multi Service Center, several church groups, and members of the St. Croix Rotary Club.

Two local high school students and one college student completed one week internships with the project.

A video film crew from Sea World completed a video news release showing all aspects of the project. The news release was broadcast on several news stations around the country. Footage taken during the filming will be made available to the U.S. Fish and Wildlife Service for educational purposes.

Management recommendations

Although illegal take of adults and eggs has virtually been stopped, there are other threats to leatherbacks on Sandy Point. Vehicles, horses and unauthorized visitors could all have detrimental effects on adults, nests, and hatchlings.

Increased road blocks erected by the Refuge Manager have mostly stopped vehicular traffic on the beach, although vehicles were able to occasionally skirt the blocks. Vehicle tracks were seen going directly over nests, but we could not determine whether it had any effect on productivity or emergence.

Although signs are posted prohibiting horses on the beach during nesting season, this continues to be a problem. Horse tracks were seen on all areas of the beach, including directly over nests. Emerging hatchlings can be crushed by horses, and hatchlings falling into tracks are unable to climb out, making them vulnerable to predators and heat exposure.

The Refuge is closed to visitors after dark, however, we often found people disregarding the signs. People on the beach can disrupt adult nesting activity and interfere with hatchlings on their way to the sea. Hatchlings are easily distracted and disoriented by lights, and flashlights will disrupt their progress. They are also difficult to see and easily trampled. On several occasions we found that visitors had built bonfires on the beach. Although they readily extinguished the fires when informed of the danger to the turtles, any undiscovered fire could be deadly to hatchlings.

Hatchlings were often found crushed just below the sand surface, particularly in the area between Stakes #1 - #7. There is high daytime human activity (recreational) on this part of the beach. People stay on the beach often until after sundown, and on several occasions we found hatchlings emerging under coolers, beach towels, and even under people standing or sitting on the beach. Hatchlings often emerged before sundown and people would interfere with them or dig into the emerging nest. Eight nests were tampered with upon emergence, and we do not know if the hatchlings were taken as "pets" or whether they were released. Quite often people are simply unaware that Sandy Point is a nesting beach, and do not know about sea turtles and their endangered status.

Another very significant threat to both adults and hatchlings is trash on the beach and in the water. Ingested plastics can kill an adult by impacting the digestive system. Trash on the beach impacts hatchlings directly by impeding their progress to the sea, and indirectly by attracting mongoose, ghost crabs and other potential predators.

We recommend several courses of action to reduce these threats. Increasing enforcement and issuing fines to violators could reduce the problems of vehicles, horses, trash, and after-hour visitors on the beach. This should be combined with increased public awareness and education efforts, perhaps including brochures and/or posters distributed to local businesses and schools. To protect hatchlings, beach access should be limited when nests begin emerging. Finally, we strongly

recommend a kiosk be placed at the entrance to the refuge, and signs in the parking areas, with bulletins clearly stating rules and the reasons for them, and including photographs and information on the turtles and other inhabitants of the refuge.

A final potential threat should be mentioned; hatchlings emerging from nests between stake #12 and #20 were often disoriented by the lights from the town of Frederiksted, primarily from the ballpark. We often found hatchling crawls extending almost 200 m from the nest site before they finally turned towards the sea or ended in heron tracks. We recommend that no nests be relocated to these areas.

CONCLUSIONS

This intensive research and conservation effort would not have been possible without the assistance of 720 Earthwatch volunteers who over the past ten years have contributed over 52,560 hours patrolling over 39,660 miles of beach. Continued commitment by Earthwatch, the Center for Field Research, and by the U.S.V.I. 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 developing recovery and management plans to help ensure the survival of this endangered species.

ACKNOWLEDGEMENTS

Funding was provided by the United States Fish and Wildlife Service under Section 6 of the Endangered Species Act, and by Earthwatch and the Center for Field Research (Watertown, MA). We would also like to express our deep appreciation and respect to the 720 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.

We would like to thank Greg Hughes, Refuge Manager at Sandy Point, William "Toby" Tobias, DFW, and Otto Tranberg for recording pre-season nesting activities. Much respect and appreciation go to Greg, 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. Thanks also to the Department of Planning and Natural Resources Environmental Enforcement officers, and to the Frederiksted Police for their surveillance of Sandy Point.

Thanks to Mr. Chuck Bolan and Cormetrics, for the generous loan of a portable ultrasound unit and battery pack, as well as for Mr. Bolan's expertise and assistance on the use of the unit. Thanks also to Dr. Sherm Mathey of Sea World for operating the unit and recording the videotape. Dr. Mathey was supported by Anheuser Busch, Inc., who also contributed the video news release. Thanks to Doug Hull of AVID for donating PIT tags, and Dr. David Owens, Texas A&M University for providing blood sampling supplies.

Among the many members of the community who helped with beach patrols, special thanks go to Amy Mackay and Thom Grace, who volunteered their help this season as in previous years. Robin, "Pete" Elden and the membership of the St. Croix Environmental Association were invaluable in scheduling and escorting visitors to the beach.

We would especially like to thank Ray and Deanne Norton, proprietors of Cottages-By-The-Sea, Frederiksted, for their constant support and for providing a friendly, comfortable base of operations for this project.

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APPENDIX I
Data Collection Form

i. original tag #: _____

ii. page: _____

1992 ST. CROIX LEATHERBACK PROJECT

Date: _____

1. Old tags: _____

2. New tags: _____

3. PIT tag: _____

4. Removed (or destroyed) tags: _____

5. Untagged turtles only! Tagged before? Yes _____ No _____

6. Activity: _____ 7. Time encountered: _____

8. Departure time (time turtle reaches water): _____

9. Result (circle one): Lay Dry run Reason: _____

10. Carapace measurements (over the carapace):

length notch-tip: _____ width max: _____

11. Nest and crawl diagram, comments:

12. Observations on nest: _____

13. Yolked eggs laid: _____ Yolked eggs reburied: _____

Yolkless eggs laid: _____ Yolkless eggs reburied: _____

Total weight yolkless eggs: _____ g

14. Yolked egg weights (g):

15. Nest depth: orig.: _____ cm relocated: _____ cm

Overburden: orig.: _____ cm relocated: _____ cm

16. Nest location: original: _____

relocated: _____

relocated
width

17. Relocation: Time laid: _____ Time removed: _____
Time relocated: _____

18. Site selection parameters (original nests only):

Water's edge to nest: _____ m

HWM to nest: _____ m Nest to vegetation: _____

19. Turtle observations:

Photography: _____

Ectobiota: _____

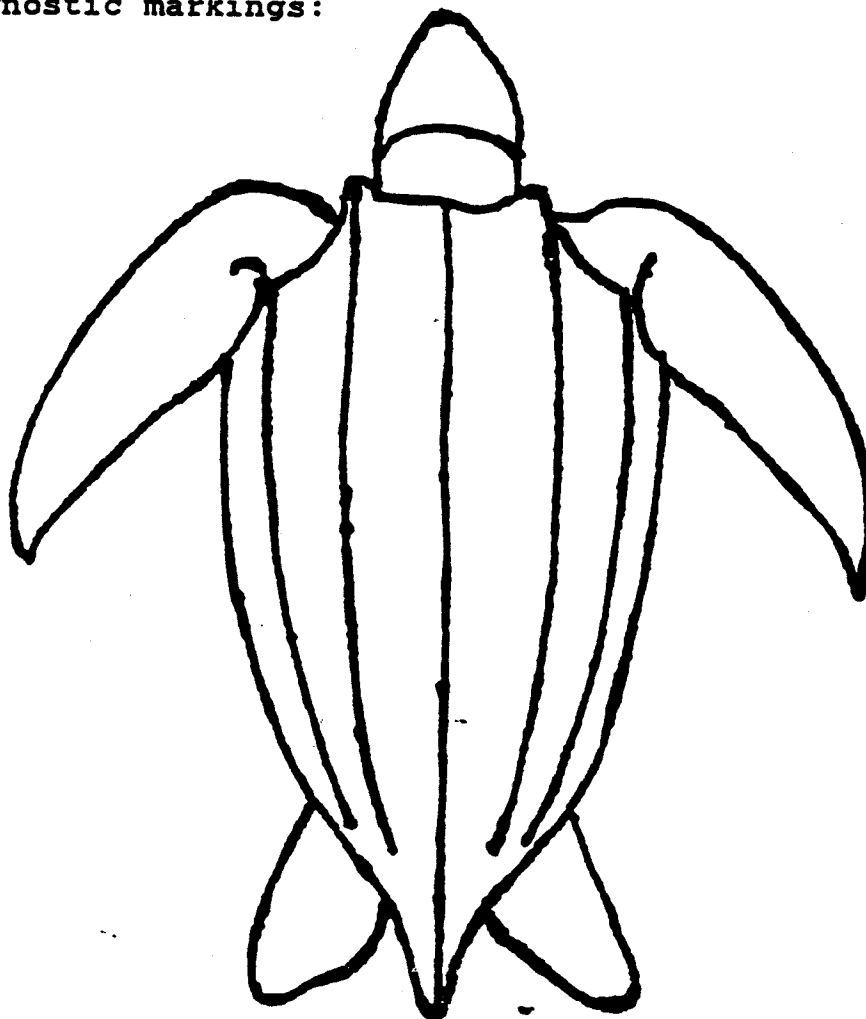
Blood samples taken? _____

Behavioral: Covering flipper (circle one): right left

Facing water Back to water water on left water on right

Notes on behavior: _____

20. Diagnostic markings:



21. Observers: _____

23. Females original tag no. _____ Date Laid _____
Nest type: IN SITU RELOCATED Location _____
Yolked eggs buried _____ Yolkless eggs buried _____
24. Weather at emergence:
Sky _____ Wind direction _____ Precipitation _____
Previous weather _____
25. Nesting results: Date emerged _____ Incubation _____ days
Time emerged _____ Date cleaned _____
Hatchlings released _____ Nesting success _____ %
26. Nest contents:
Live hatchlings _____
Dead hatchlings _____
Hatched deformed _____ Unhatched deformed _____
No embryo: Spotted/white _____
cream _____
Unknown _____
Embryos Unpigmented _____
Pigmented eye _____
Pigmented body _____
Fullterm pipped _____
Fullterm unpipped _____
Hatched shells _____
Yolkless eggs _____
27. Predation: eggs _____ hatchlings _____
28. Hatchling measurements:
Weight (g) _____
29. Notes & observations/ causes for poor hatch: