

**MANAGEMENT PLAN FOR LEATHERBACK TURTLES ON THE SANDY POINT
NATIONAL WILDLIFE REFUGE, ST. CROIX, U.S. VIRGIN ISLANDS,
WITH REFERENCE TO GREEN AND HAWKSBILL TURTLES**

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**Management Plan for Leatherback Turtles on the Sandy Point National Wildlife
Refuge, St. Croix, U.S. Virgin Islands,
with Reference to Green and Hawksbill Turtles**

1. Introduction

1.1. Background

The leatherback turtle, *Dermochelys coriacea*, is listed as Endangered by the International Union for the Conservation of Nature (IUCN) (Groombridge 1982). It 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 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). Many of these sites have experienced drastic decreases in numbers of nesting leatherbacks during the last few decades (Spotila *et al.* 1996). For example, Malaysian nesting beaches supported over 10,000 nesting leatherbacks per year during the 1950's; since 1990, the highest number has been 280 (Chan and Liew 1996). Bhaskar (1985) reported 13,000 nests on 17.8 km of coast in Irian Jaya in 1984; this number had declined by 75% in 1991 (Betz and Welch 1992). Annual numbers of nesting females on the Pacific coast of Mexico have declined from an estimated 30,000 in 1980 (Pritchard 1982) to less than 1000 during the mid-1990's (Sarti *et al.* 1996). In the Caribbean, nesting populations on St. John and St. Thomas have been exterminated, although the U.S. Caribbean still represents the most significant nesting activity within the United States (NMFS and USFWS 1992). Estimated numbers of nesting leatherbacks in the Caribbean and western Atlantic are given in NMFS and USFWS (1992). The Sandy Point National Wildlife Refuge (SPNWR) on St. Croix, USVI, supports the largest and best-studied nesting population of endangered leatherback turtles in the northern Caribbean, and although it is a relatively small population (18-55 females annually from 1981 to 1996, 119 in 1997), it appears to be stable. This is likely due to intense conservation and protection efforts, including purchase of the nesting beach and surrounding area by the U.S. Fish and Wildlife Service (USFWS) and establishing it as a National Wildlife Refuge.

Since 1981, a research project undertaken by the Virgin Islands Department of Planning and Natural Resources involving saturation tagging and consistent nightly patrols throughout the nesting season has yielded a comprehensive database on each female nesting at Sandy Point. In

addition to providing information on the biology of this species, this project was intended to aid regulatory agencies, including the U.S. Fish and Wildlife Service (USFWS), in forming management policies regarding sea turtles. However, a formal management plan for the Sandy Point population has never been developed, and much of the data that could form the basis for management policy have never been analyzed.

Beginning in 1991, this population has shown a steady increase over the previous ten years, both in numbers of turtles nesting and in numbers of hatchlings produced (see Boulon et al., 1996). In 1997, the number was over double the previous record. This increase presents new management considerations. Because of annual cyclic beach erosion and re-deposition, relocation of turtle nests laid in erosion zones has been an essential management activity. Its goal is to maximize hatchling production. In many years, nearly 50% of the nests are relocated to a section of the stable, northwest-facing beach. However, hatchling mortality in relocated nests continues to be higher than in nests left *in situ*, which could represent significant numbers of hatchlings (although without relocation, total loss of nests would be much more significant). Recreational use of Sandy Point may be at least partially to blame for this mortality. Most of the nests are relocated to areas of the beach with the highest traditional public use, and foot traffic over the nests compresses the sand and collapses the air space over emerging hatchlings. Ever-increasing numbers of people are interested in visiting Sandy Point. The Refuge is generally considered as having the best beaches on St. Croix and is a target for both government and private sector recreational development. Unfortunately, the most popular beach area for recreation is also the safest area in which to relocate nests because of the stability of the sand, and because of light disorientation in other areas. In many seasons over 100 nests (over 200 in 1997) may be relocated to this 260 m stretch of beach, in addition to the *in situ* nests, and this number will increase if present trends continue.

Light disorientation has been an ongoing problem, particularly when lights from the Paul E. Joseph Stadium in Frederiksted, about 6 km from Sandy Point, are on during hatchling emergencies. In an attempt to reduce light disorientation, the USFWS instigated the installment of baffles on the lights in 1997. The baffles redirect light down onto the playing field, and reduce ambient light over the town of Frederiksted. The effectiveness of this measure remains to be evaluated.

Further problems include increased predation by the mongoose, *Herpestes auropunctatus*, with eggs as well as entire nests of emerging hatchlings taken. Also, fish predation is extensive at times, and is probably increased by the high concentration of hatchlings due to relocation. Early

season tropical storms and hurricanes can severely impact nests, particularly on the southwest facing beach where erosion can be greatest. Finally, although public awareness and acceptance of the need for sea turtle conservation has increased over the years, poaching on all beaches on St. Croix continues to be a problem, and may be on the rise. The Refuge Manager documented 22 incidents in 1996 on Sandy Point alone. Many of these were directed at greens and hawksbills, and took place after the leatherback nesting season ended. It seems likely that this activity has always taken place and was simply noticed more in 1996 due to increased surveillance. However, three incidents of attempted poaching took place during leatherback nesting season, at night while researchers were on the beach. This is a new and disturbing development. Perhaps even more disturbing were the two incidents in 1997 of poaching of adult leatherbacks on the north shore of St. Croix. The turtles were killed and the heads, flippers, and insides were removed.

In summary:

- Increased numbers of turtles present new management considerations regarding relocating nests;
- Recreational interests are competing with nests for optimal beach areas;
- Light pollution causes hatchling disorientation;
- Mongoose predation is increasing;
- Fish predation impacts may be greater as more nests are relocated to stable areas;
- Projected increased period and intensity of tropical storm activity may be a problem;
- Pressure to develop areas adjacent to the refuge are continuing;
- Poaching still threatens marine turtles on Sandy Point.

The objective of this Management Plan is to review unpublished data from 1982 - 1997, published reports, and observations made by D. McDonald and P. Dutton to identify research priorities and management objectives. Detailed data analysis is beyond the scope of this Plan; however, the results of preliminary analysis will be summarized and the need for more detailed

analysis will be evaluated. The Plan focuses on the leatherback turtle, but is also relevant to green and hawksbill turtles.

1.2. Definition of the Management Unit

Leatherback turtle population structure is poorly understood. Nest site fidelity does not appear to be as strict in leatherbacks as in other species; both telemetry studies and tag return data show that leatherbacks often nest on different beaches both within a season and from season to season (see also Eckert et al. 1989). As tagging methods improve, the extent of migration by nesting females between beaches in Puerto Rico and St. Croix is becoming increasingly evident. Also evident is the fact that about half of the turtles nesting at Sandy Point are remigrants (McDonald and Dutton 1996), although this proportion may change if population growth evidenced in 1997 continues to increase. Recent genetic analysis has shown that the St. Croix nesting population is genetically distinct from those on Trinidad and other mainland South American locations (Dutton 1995, 1996). This is consistent with the theory of natal homing.

Dutton (1995) has proposed that the St. Croix nesting population is part of a regional population encompassing an area at least 400 km wide that includes nesting beaches in Culebra and other locations on the main island of Puerto Rico, the British Virgin Islands, probably other islands in the Antilles chain, and the Dominican Republic (Figure 1). The exact boundaries of this regional population are unclear; however, it is important to realize that while the Sandy Point population represents the most significant aggregation, the management unit extends beyond those females to at least include turtles nesting on other beaches around St. Croix (most notably Manchineel), Culebra and mainland Puerto Rico (Figure 2).

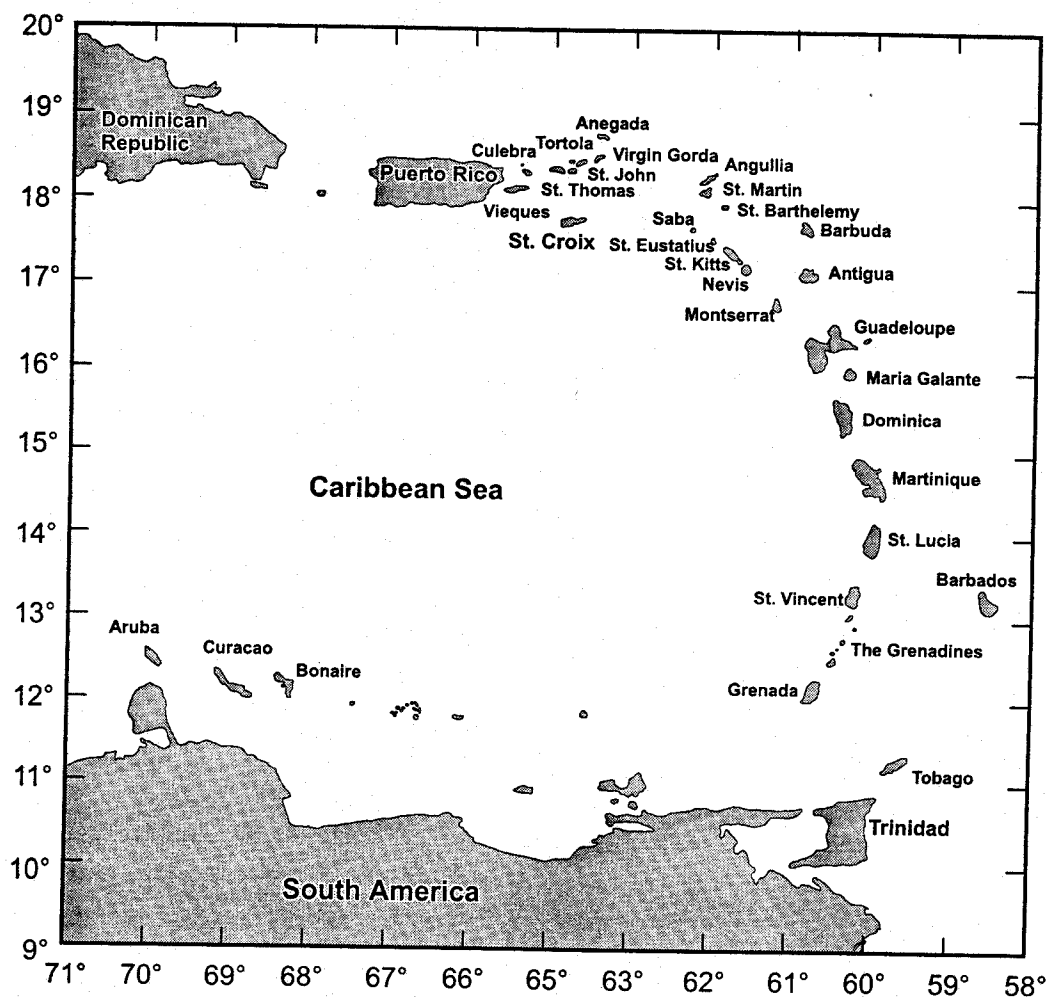


Figure 1. Map of West Indies showing known and suspected leatherback turtle nesting locations in the Caribbean.

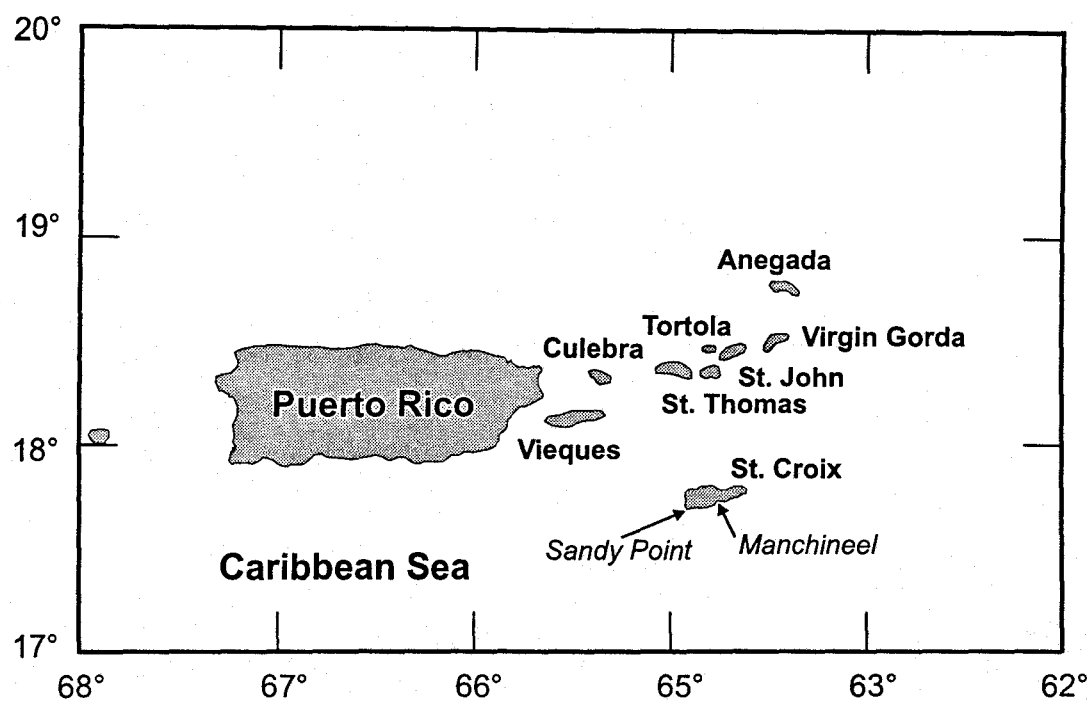


Figure 2. Nesting locations of leatherback turtles in the U.S. Virgin Islands and Puerto Rico.

2. The St. Croix Leatherback Turtle Research and Conservation Project

2.1. History

2.1.1. Classifications of Sandy Point

In 1978, the USFWS identified part of Sandy Point as "critical habitat" for the leatherback turtle. In 1979, the National Marine Fisheries Service listed the surrounding marine waters to the 100 fathom contour as Critical Habitat for the leatherback (USFWS 1992). In 1984, the 398 acre area became part of the USFWS's Caribbean Islands National Wildlife Refuge System. The Refuge boundaries are indicated by the shaded area in Figure 3.

2.1.2. Initiation of the Leatherback Project

In 1981, under the auspices of the U.S. Virgin Islands Department of Planning and Natural Resources, Division of Fish and Wildlife, research on the nesting ecology and population biology of the leatherback sea turtle at Sandy Point was initiated. Funding is provided through Section 6 of the U.S. Endangered Species Act and, since 1982, by Earthwatch and the Center for Field Research in Watertown, Massachusetts. Further information on the history of Sandy Point and the development of the Leatherback Project can be found in Eckert and Eckert (1985).

2.2. Goals

The main 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 increase hatchling production by protecting nests from erosion and inundation. Further goals include conducting research into the biology and behavior of the species. These objectives address tasks listed as Priorities 1 and 2 of the Recovery Plan for Leatherback Turtles, *Dermochelys coriacea*, in the U.S. Caribbean, Atlantic, and Gulf of Mexico (NMFS and USFWS 1992). Implementation of Priority 1 tasks is considered a criteria for delisting the U.S. population of leatherbacks.

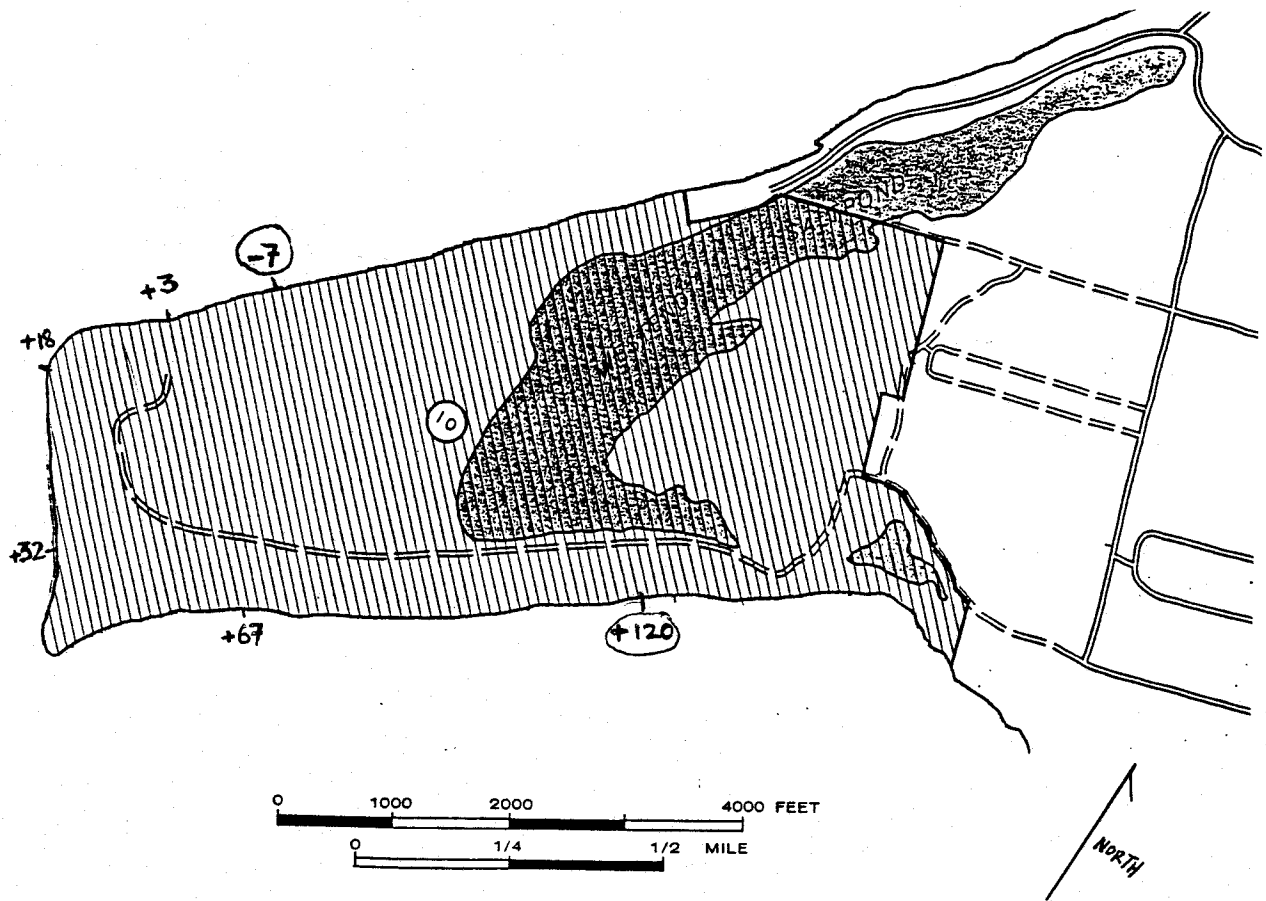


Figure 3. The Sandy Point National Wildlife Refuge. The boundaries of the study area are marked by stakes #-7 and #120.

2.3. Project Accomplishments

The scientific research conducted at Sandy Point has contributed much of what is known about the leatherback. Specifically:

- a. Saturation tagging has revealed that leatherbacks nest up to 11 times per season, and that remigration intervals can vary from two to five years (Boulon et al. 1996). Other insights have also been gained into the nesting ecology of this species (Eckert 1987; see review in Boulon et al. 1996).
- b. Telemetry studies done in 1985 revealed that leatherbacks can dive as deep as 1500 m (Eckert et al. 1986, 1989).
- c. Physiological studies have shown that leatherbacks store oxygen in blood and tissue during deep dives (Lutcavage et al., 1990).
- d. Satellite telemetry and direct observations have shown that leatherbacks sometimes travel between islands during interesting movements (Keinath and Musick (1993).
- e. Genetic studies have shown that the St. Croix nesting population is genetically distinct from other populations in the Atlantic, supporting the theory of natal homing (Dutton 1995, 1996). These studies have also resulted in a greater understanding of stock structure and mating behavior (Dutton 1996).
- f. Improved tagging and identification techniques such as PIT tags and photoidentification have resulted in more accurate estimates of population size and remigration (McDonald and Dutton 1996).
- g. Long-term effects of management are now beginning to be realized. While 1991 - 1996 showed greatly increased numbers of nesting leatherbacks, over twice the number of individuals of any past season were documented during the 1997 season.

In addition to research, because of management interventions the project has been able to accomplish its main goals of:

- a. documenting and tagging nesting adults
- b. protecting adults, nests and hatchlings
- c. increasing hatchling production by as much as 50% or more

2.4. Study Area

The study area is the 3.0 km beach within the Sandy Point National Wildlife Refuge (Figure 3). There are 128 numbered stakes placed at 20m intervals along the vegetation line for the

length of the study area, allowing exact measurement of nest locations. Approximately half of the beach faces northwest (stakes #-7 to 15), west (#16 to #19) or southwest (#20 to #50), is on the leeward side of St. Croix and is relatively wide (usually 10-50 m in late March, the beginning of the nesting season), with very little vegetation extending out onto the sand. It is referred to as the "sandy side". Erosion of the beach from stake #20 to #65 occurs during the nesting and incubation season, so that by July in some years only a 1-2 m wide strip of sand remains in some areas until accretion rebuilds the beach during the winter months. The southeast-facing beach from stake #51 to #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 most of its length. This side is referred to as the "grassy side".

Beginning on April 1, researchers patrol the entire study area nightly on foot from 2000-0500 hours. The beach is patrolled at one hour intervals. Since previous observations indicated that leatherbacks require at least 1½ hours to complete nesting, this ensures that all nesting turtles are observed and tagged. Earthwatch volunteers assist with patrols, observations, and relocations.

Each time a turtle is encountered, a separate data sheet is completed (Appendix I). Morphological, nesting, and behavioral data and nest parameters and location are recorded along with time and date of encounter. Nests are excavated after hatchlings emerge, and the contents categorized to determine hatching success. Other species of turtles are also documented.

2.5. Research Techniques and Methods

2.5.1. Timing of research activities

When a turtle is seen, researchers remain at a distance of at least 3 m (more on bright, moonlit nights), in a position behind the turtle, until it is determined that she is well into digging the nest cavity. Researchers remain seated so as not to present a large, dark profile. The exception is one person will unobtrusively approach the turtle *from behind* to ascertain that she is tagged, and to read tag numbers if it can be done without interfering with the turtle's behavior. During this time, lights are kept to an absolute minimum. One light is used for the few minutes it takes to read a tag, and while in use it is kept low and partially obscured by a hand. A light may also be used for the few minutes it takes to begin to fill out a data sheet, and in that case the researcher turns away from the turtle when the light is on. Turtles can be scanned for PIT tags during nest digging, as lights near the turtle are not necessary. However, a researcher never stands in front of a turtle during her approach or body pitting.

If a nest is to be relocated, after nest digging has begun researchers can approach quietly from behind and prepare to catch eggs. Most lights are still kept off, with a single low light aimed down into the nest cavity as it nears completion. As the turtle nears the end of the nest, digging will slow, with longer pauses between flippers. When she is finished digging, the turtle will cover the nest cavity with a flipper. At this point, a researcher slowly and gently moves the flipper aside and either props it on the side of a nest, or holds it while another researcher lies face down on the sand with hands cupped in front of the cloaca to catch eggs. Care is taken not to touch the cloaca.

Only after egg laying has begun can lights be turned on and the main data collection commence. At this time, turtles are measured and examined for diagnostic characteristics. Nest locations are measured. PIT tags are applied only during egg laying. Flipper tags are applied after egg laying is finished, as the rear flippers and surrounding area are extremely sensitive during egg laying, and tagging there could disturb the turtle.

While leatherback turtles usually do not disturb easily, particularly after egg laying has commenced, green and hawksbill turtles are much more sensitive. With these species, researchers must remain as quiet as possible (before egg laying, these species will often return to the sea at the mere sound of a human voice), and work with a minimum of light necessary to collect data. Even with leatherbacks, work should be done as quietly and unobtrusively as possible.

2.5.2. Tagging

2.5.2.1. Flipper tags

A Monel metal tag is attached to the trailing edge of a rear flipper on every untagged turtle, in the thin flesh between the flipper and the tail. In past years, titanium and inconel tags have also been used. Some turtles still retain these tags, but they have been mostly abandoned due to poor retention. Prior to 1995, turtles were tagged with at least two and sometimes three flipper tags, in both front and rear flippers. Although external tags are still applied to ensure identification of turtles that nest on other beaches, PIT tags (described below) have obviated the need for multiple flipper tags.

2.5.2.2. PIT tags

Each turtle is also tagged with a 14 mm long x 2 mm diam. glass-encased electromagnetically coded microchip, or Passive Integrated Transponder (PIT) tag. The PIT tag is injected directly into the left or right shoulder muscle of each turtle (usually the left), and are detected with a small battery-operated scanner (Dutton and McDonald 1994). The tags and scanners are manufactured by AVID, Inc. We recommend these scanners because they are easy to use and compatible with most other PIT tag manufacturers. The scanners operate on a frequency of 125 KHz, and are able to detect tags at up to 4 inches (older model: AVID-1001) or 8 inches (the heavier, weatherproof AVID-1003, Power Tracker II). AVID produces a smaller model scanner designed for home or veterinary use, but these are not as effective in detecting tags in the field. We use needles that are pre-sterilized and pre-loaded with PIT tags for ease of use in the field (AVID-2004, 14mm DNA), and to ensure that the tag is not contaminated before injection into the turtle. Preloaded tags are applied with a small, inexpensive tagging "gun" (AVID-3003, DNA injector), which is much easier to use than a syringe. The injection site is swabbed with betadine before injection, and direct pressure is applied after injection for approximately one minute to minimize bleeding. Turtles are PIT tagged only while in the process of laying eggs, as they seem to be under the influence of a "natural anesthetic" at this time and do not react to the injection. First applied in 1992, PIT tag retention appears to be 100% as of 1997. This is in striking contrast to flipper tags, of which approximately only 60% are retained through the first remigration interval (usually 2-4 years) (McDonald and Dutton 1996).

Hawksbill and green turtles are also tagged with metal flipper tags and PIT tags. In these species, PIT tags are injected into the interphalangeal muscle of a front flipper (usually the right).

2.5.3. Photography

The pineal spot ("pink spot") on the head of each female leatherback is photographed (see McDonald and Dutton 1996). Photographs are catalogued and compared with those taken in previous years. This serves as a secondary identification method to detect remigrants that lose all flipper tags between seasons. This technique has identified 27 remigrants (around 20% per season) that were mistakenly classified as "new" (McDonald and Dutton 1996).

Photographs are taken of each front flipper to document scars and notching and to help confirm pink spot identification. Injuries are also photographed.

2.5.4. Morphology

Curved carapace length (CCL) and width are recorded. Carapace length is measured from the anterior notch to the posterior tip alongside the vertebral ridge, on the side with the greatest projection of the posterior tip of the carapace. Width is measured across the carapace to each side ridge at the widest point, just posterior to the front flippers. Individuals are measured each time they are encountered, and the measurements averaged for the season.

Each turtle is examined for diagnostic markings, deformities and ectobiota, all of which are recorded on the data sheet. Diagnostic markings include bites and other wounds, scars, flipper notches, etc.

2.5.5. Nesting activity

Nest digging is observed whenever possible, and any abnormalities in digging or nest cavity structure are noted, as well as whether the nest cavity was excessively moist or dry. During egg deposition (sometimes) and relocation (always), yolked and yolkless (eggs containing only albumin, usually smaller, sometimes deformed) eggs are counted.

2.5.6. Nest location

The location of each nest is determined by measuring the distance from the center of the nest to each of the two nearest marker stakes. Nests are left unmarked so as not to attract the attention of poachers or predators. Distances from the nest to the vegetation line and to the high water mark are recorded.

2.5.7. Nest relocation

If a nest appears threatened at the time of laying by imminent erosion or inundation, if it is situated in a previously identified erosion zone, or if there is standing water in the nest, the eggs are collected upon deposition and reburied in a stable area of the beach (see section 5.3.1.1. Relocation criteria). Relocated nest depth and overburden (the distance from the top of the clutch to the surface of the sand) are recorded. Natural nests are duplicated as much as possible; see Section 5.3.1.2., Relocation techniques, for a detailed description. As with *in situ* nests, the relocated nest location is measured from the two nearest marker stakes, and nests are left unmarked. Relocated nests are designed to be as close to natural nest shapes and depths as

possible - see section 5.3.1.2. Relocation techniques.

2.5.8. Hatch success

The location and date are recorded for each emergence, with emergence time and number of hatchlings seen noted when possible. Disoriented hatchlings (i.e., those wandering in the vegetation or along the beach away from the water) or those trapped in vegetation are assisted to the water's edge.

After emergence, nests are excavated and their contents categorized to determine hatching (hatched shells/total yolked eggs laid) and emergence (hatched shells/total yolked eggs laid - dead hatchlings) success. Unhatched yolked eggs are opened to determine stage of development, using criteria described by Whitmore and Dutton (1985) (Appendix I). All abnormalities are described. Condition of the nest cavity is noted 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 relocated nests and in high public use areas, hatchlings trapped by root growth, etc. Any live hatchlings found in the nest are placed together in a confined area to stimulate movement, then released. Hatchlings with a protruding yolk sac are held until the yolk sac is fully absorbed, usually overnight.

2.5.9. Hatchling sex ratios

Sand temperatures were recorded at transects throughout the nesting season between 1987 and 1994 in order to estimate hatchling sex ratios based on pivotal temperatures for leatherbacks given in Mrosovsky (1994) and Dutton et al. (1985).

2.6. Results

2.6.1. Adults, nests and hatchlings

Results for individual seasons can be found in the annual project field reports on file at the Department of Planning and Natural Resources, Division of Fish and Wildlife in St. Thomas, USVI. Original data sheets for each season are also on file in the Division of Fish and Wildlife office. A comprehensive summary covering the period 1981-1995 can be found in Boulon et al. (1996), and further information on numbers of turtles tagged and remigration rates can be found in McDonald and Dutton (1996). About 360 turtles have been tagged from 1981 - 1997, with

numbers of documented turtles per season through 1997 ranging from 18 - 118 (Figure 4).

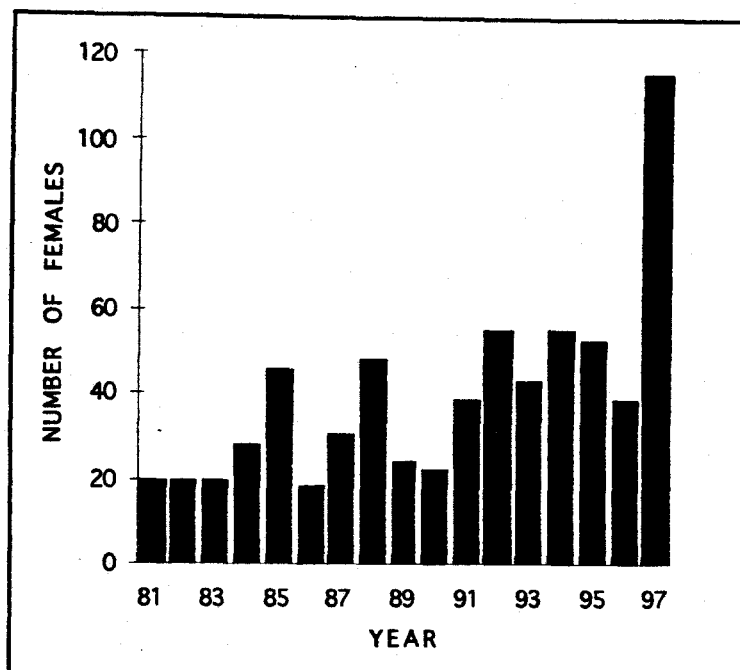


Figure 4. Annual number of female leatherbacks nesting at Sandy Point 1982-1997

Boulon et al. (1996) provide detailed morphological information. Carapace lengths ranged from 131.0-177.4 cm standard curved carapace length. Weights from 134 turtles ranged from 259-506 kg.

Clutch sizes averaged 79.2 yolked eggs and 38.8 yolkless eggs. Numbers of observed clutches per turtle ranged from one to eleven in one season, with a typical average of 6. The number of nests per season ranged from 82 to 675, with a total of 3852 from 1982 - 1997. Hatch success from 1991 - 1996 averaged 64.6% overall, 69.5% for *in situ* nests and 59.4% for relocated nests. From 1981 - 1996, 44.4% (1411) of the nests were relocated, representing about 66,000 hatchlings. In 1997, 34% (229) were relocated, representing about 10,700 additional hatchlings. Hatchling production from 1982 to 1997 ranged from about 2400 - 27,800 per season (Figure 5).

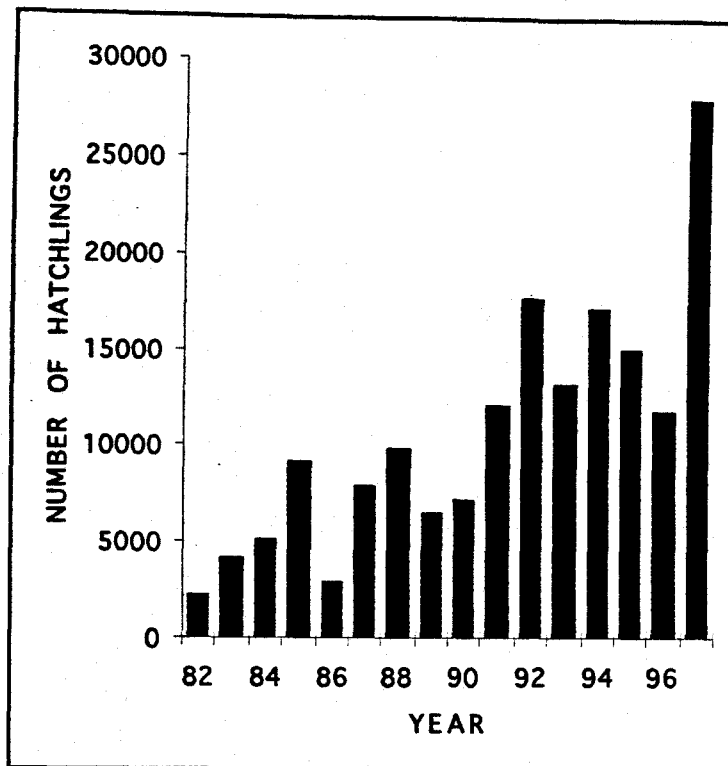


Figure 5. Total annual hatchling production from nests laid by leatherbacks at Sandy Point from 1982-1997¹ ('preliminary estimate)

2.6.2. Sex ratios

Sex ratios estimated from seasonal temperature profiles are strongly female biased (Basford 1988; McDonald et al. 1991; Dutton et al. 1992). Temperatures were significantly lower closer to the high water mark (HWM) than higher on the beach (Dutton et al. 1992). Still, even the coolest temperatures were above those that produce males, so the potential for masculinizing sex ratios through relocation is not of concern. However, relocation may be exacerbating the female bias for this population. Males are only likely to be produced at the beginning of the season, when nests laid before April are exposed to temperatures below 29.5 °C during the critical period for sex determination. During the transition period, at the beginning of May, nests laid near the HWM are likely to be cool enough to produce males, while nests higher on the beach are already too warm for males. A policy of relocating ALL nests laid near the HWM might inadvertently deprive this population of the opportunity to produce males, since not all nests laid near the HWM would be destroyed (see section 5.3.1.1. Relocation criteria).

2.7. Personnel

2.7.1. Staff

The staff structure for the Leatherback Project has been very effective in the past. However, if present population trends continue, this structure will need to be reorganized (see section 2.9). One of the three Principal Investigators is Endangered Species Coordinator for the Virgin Islands Dept. of Planning and Natural Resources (DPNR), Division of Fish and Wildlife. He is the liaison with the USFWS, and is responsible for administrative duties such as negotiating the grants between DPNR and the USFWS, contracts between DPNR and the Field Directors, and for hiring the two Field Directors to run the field operations. He has been involved with the project since its beginning, and provides continuity.

The Field Directors, who must have at least a Bachelor of Science degree, are also Principal Investigators. They train volunteers and assistants, and collect, manage, and analyze all data for the project. They write an annual Field Report at the end of each season. They are the main liaison with Earthwatch. Ideally, they are a couple who have experience working together, as the work can be stressful and exhausting, and leaves little opportunity for getting to know, and learning to live with, each other. It is very important that they be familiar with the project, so Field Directors should be prepared to stay involved for three or more years. This provides continuity, familiarity with the beach, turtles, and island, and greatly reduces errors in the database. New Field Directors should be trained by previous ones, preferably the season before they begin. If this is not possible, previous Field Directors should work with new ones for at least two full Earthwatch teams.

2.7.2. Earthwatch volunteers

The Leatherback Project is partially supported by Earthwatch and its Research Corps. Each season, eight teams of up to ten volunteers per team are trained to assist researchers on the beach. The volunteers range in age from 16 - 76 years, and most of them have never worked with turtles. Depending on the quality of the training, most volunteers learn quickly and after three or four nights of hands-on training on the beach, are able to perform many of the tasks unsupervised. Volunteers patrol the beach looking for turtles, record tag and nesting data, measure turtles, and collect eggs for relocation. Volunteers do not tag turtles or engage in any invasive sampling (e.g., blood or tissue extraction, etc.).

Earthwatch volunteers are an important part of the project. Training is extremely labor-intensive, but pays off in the long run, since there are often several turtles on the beach at once and the two Field Directors may be unable to get to them all. Volunteer duties are structured so that they are relatively "fool-proof", and all volunteer work (including data recording) is checked by other volunteers and by the Field Directors. Volunteer duties include:

- patrolling the beach looking for turtles
- recording date, time, activity, and tag numbers of all turtles encountered
- measuring turtles
- determining whether eggs should be relocated (they are given extensive instruction in this before each patrol)
- collecting eggs from nesting turtles
- measuring distances from nests to marker stakes
- excavating emerged nests and sorting contents (Field Directors count contents and open all unhatched eggs)

2.8. Funding

2.8.1. Earthwatch

Earthwatch and the Center for Field Research provides funding for housing and food for the Field Directors and volunteers, as well as the Field Directors' transportation to St. Croix. From 1982 - 1996, Earthwatch contributed \$586,562 in direct funding to the project. This does not include Earthwatch's overhead or money spent in recruiting volunteers, nor does it include the monetary value of the labor provided by the volunteers. The amount of funding Earthwatch provides per season depends on the number of volunteers participating. From 1991-1996, the Earthwatch budget for the season averaged approximately \$50,000. For 1997, Earthwatch decreased funding to \$45,000. Earthwatch funding will likely remain at this level.

2.8.2. U.S. Fish and Wildlife Service

Funding for the Field Directors' salaries is provided by USFWS, Section 6 funds through the Federal Aid grant program, and is administered by the Virgin Islands DPNR, Division of Fish and Wildlife. During 1991 - 1996, salary support increased from \$15,000/yr to \$19,000/yr. An additional \$1,000 for transportation (gasoline, vehicle maintenance) is also provided each season. From 1992 - 1996, a total of \$228,900 was spent on salary support and transportation for the

project. This figure does not include the salary or transportation for the Endangered Species Coordinator in St. Thomas, who travels to St. Croix at least four times each season.

The USFWS also provided a new van in 1996 for volunteer transportation in the field, and provides radios and a cellular phone for communication while on the SPNWR.

2.9. Project Personnel Requirements

There are a minimum number of people required to accomplish the main project goals. Prior to 1996, these goals could be accomplished by two Field Directors. Since 1996, an additional assistant was very useful and enabled more data to be collected. If the record high numbers of turtles in 1997 continue in future years, more people will be necessary. The following summarizes personnel requirements for the project if present trends continue. This does not include the Project Coordinator with the Virgin Islands Division of Fish and Wildlife.

Project Leader (paid position). Responsible for managing the project and directing research, managing the project database, data entry and analysis, report writing, supervising training of volunteers, liaising with the Project Coordinator and with Earthwatch.

April 1 - August 31: Two Field Directors (paid positions). These individuals will be responsible for all aspects of the project, and should be thoroughly familiar with the project's history and development and with leatherback biology. They will do all the tagging as well as any other invasive procedures such as blood sampling. They will train and lead all other personnel, and will be responsible for data collection.. They will supervise all nest relocations, and tally all nest contents. All decisions regarding personnel or procedures will be made by the Field Directors, under the direction of the Project Leader. At least one Field Director will be present on the nesting beach each night.

April 1 - July 31: One to two Field Assistants (paid positions). They should be familiar with all aspects of the project. With training, they will be permitted to tag and collect blood samples.

April 1 - July 15: Six to ten technicians (paid or volunteer). They will be trained in data collection procedures, and instructed in how to complete a data sheet, dig nests for relocations, and excavate nests and categorize contents. They will not tag or collect blood samples. From April 18 - July 15, these positions are currently filled by Earthwatch volunteers.

July 15 - August 31: One to two technicians (paid or volunteer). They will assist the Field Directors in excavating emerged nests.

April 18 - August 31: Education Coordinator (paid or volunteer). This person will schedule and organize visitor groups, give lectures to visitors on the beach, and chaperone all visitors.

This will allow a full team of two to three Field Directors or Field Assistants, with a team of at least four technicians, each night of the nesting season from April 1 - July 15, and allow for nights off for all personnel. After July 15, nesting is sporadic, and full teams are not necessary although emergencies are peaking. During August, there is very little or no nesting.

2.10. Communication with Other Researchers

Whenever turtles tagged on other nesting beaches are encountered, personnel from the specific project are contacted. For example, each season one or two turtles tagged in Puerto Rico (Culebra or main island beaches) nest on Sandy Point, and vice versa. A database of all turtles tagged on St. Croix beaches, including Buck Island, is filed in the USFWS offices on St. Croix and in Jacksonville, Florida, as part of this Management Plan. It is available to any researcher requesting it. It is being updated to include tag numbers from Brava and Resaca beaches on the island of Culebra, Puerto Rico.

Researchers from other areas are often invited to participate, either assisting with the project or conducting their own research. Researchers from Trinidad, Brazil, Mexico, Canada, the United Kingdom, and the U.S. have worked with the project. They bring valuable experience and insight from their own work, and gain experience by working at Sandy Point. This exchange of ideas and expertise benefits all projects involved, and is important to keeping techniques and ideas current. This practice should be continued, and possibly expanded. Scientific research goals can be addressed in a cost-effective way through collaboration with university or government scientists and graduate student involvement.

2.11. Dissemination of Information

Results from each season are reported in an Annual Report, on file at the Virgin Islands Department of Planning and Natural Resources, Division of Fish and Wildlife in St. Thomas. Results of specific aspects of the project are presented at the annual International Sea Turtle Symposium. Study results are also published in various scientific journals (see section 2.3. Project Accomplishments).

3. Patterns of Use

3.1. Turtles

3.1.1. Leatherbacks

3.1.1.1. Adults

Nesting Dates

Leatherback turtles begin nesting on Sandy Point as early as mid-February, but the main nesting season starts in early April and usually lasts through about mid-July. In 1997, a turtle nested on September 11, the latest leatherback ever recorded for Sandy Point. Nesting generally peaks May through early June, with 40-45% of nests being laid during that three to four week period. The overall nest:dry run ratio from 1981 - 1996 was 87.1% ("dry runs" here are all instances in which a turtle emerged from the water but returned without nesting).

Nesting Locations

Table 1 shows the total number of nests and dry runs recorded on northwest (#-7 - #15), west (#16 - #20), southwest (#21 - #50), and southeast (#51 - #120) facing beaches. The "grassy side" encompasses #51 - #120, and the "sandy side" #-7 - #50. The highest concentration of nesting activity, with 38% of the nests laid, is between #20 - #50, which is also the area of the sandy side most subject to erosion. Over 74% of nests laid in this area are relocated either higher up on the beach in the same area, or to the "stable beach area" (see 5.3.1.1. Relocation criteria)..

Table 1. Locations of leatherback activities on Sandy Point 1982 - 1996

Beach Area	Proportion of total beach represented	# Activities	# Nests	% Nests:Dry Runs	# Relocated to different area
-7 - 15	17%	1013 (24%)	832	82.1	142 (17.1%)
16 - 20	5%	404 (9.5%)	315	77.7	122 (38.7%)
21 - 50	23%	1591 (38%)	1207	75.9	894 (74.1%)
51 - 120	54%	1218 (29%)	791	64.9	249 (31.5%)

For purposes of relocation, the stable beach area is defined as the area between stakes #-7 and #15 (see section 5.3.1.1., Relocation criteria). Tables 2 a and b show the ratios of nests on the stable beach area to that of the refuge as a whole, and the percentage of leatherback nests relocated to this area.

Table 2a. Proportion of Total Nests in Stable Beach Area, 1981 - 1996.

Nests in Stable Beach Area			Total Refuge Nests	% Stable Beach Area Nests
<i>in situ</i>	relocated	total	3177	61.2
832	1112	1944		

Table 2b. Proportion of Nests Relocated to Stable Beach Area, 1981 - 1996.

Nests Relocated to Stable Beach Area	Total Nests Relocated	Total Refuge Nests	% of Nests Relocated	% Relocated to Stable Beach Area
1112	1410	3177	44.4%	78.9%

3.1.1.2. Hatchlings

Emergence dates and times

Incubation lasts 70 - 75 days for nests laid earlier than mid-April. As sand and air temperatures grow warmer, and depending on the amount of rainfall, incubation normally shortens to 60 days for the remainder of the season. Periods of heavy rainfall or unusually cool temperatures will slightly lengthen incubation period. The first hatchlings usually emerge in mid to late May or early June. By the end of June, depending on numbers of nests laid, there are nests emerging virtually every night.

Over 90% of observed nests emerged before midnight. The evolutionary advantage of emerging at night is probably more related to cooler temperatures and absence of sun rather than predator avoidance. While hatchlings emerging at dawn usually reach the water successfully, with no apparent disorientation, those emerging when the sun is higher often die before they reach the water. Hatchlings are sometimes found dead on the beach from sun exposure, with hatchlings strung out from the nest to the water's edge. The white areas on these hatchlings are usually tinted pink.

One adaptive advantage to emerging before midnight would be to give the entire clutch plenty of time to get to the water and far away from shore before the diurnal predatory reef fish become active. However, if the nesting beach is exposed to artificial light this can be a problem. On Sandy Point, the main hatchling emergence time coincides with the times the lights of the Paul E. Joseph stadium in Frederiksted are in use. Unfortunately this has resulted in mass disorientation, especially on moonless nights (a visible half-moon or larger partially offsets the effects of artificial light). This may result in hatchlings, once in the water, remaining over nearshore habitats and predators longer, and hatchlings have even been seen coming back out of the water onto lighted beachfront two or three kilometers away from Sandy Point. Hatchlings emerging at dusk, when there is still light on the horizon, are usually not affected by the stadium lights.

Hatch success

Hatch success, and corresponding emergence success, can be influenced by a number of factors. Extremely dry sand can result in low hatch success, both because the eggs need moisture to develop properly and because nests with very dry sand tend to collapse more readily as the

hatchlings emerge. Conversely, too much moisture can cause bacteria and mold to infect eggs and kill developing embryos. Prolonged inundation by salt water also reduces hatch success (although eggs can handle periodic inundation, so relocation is discouraged unless nests are laid in highly erosive areas or below the debris line marking the typical high tide - see section 5.3.1.1.

Relocation criteria). Sand redeposition after a hurricane sometimes occurs in layers, resulting in unstable nests that collapse easily. Further, high wave action mid-season can result in extra sand being deposited over nests, sometimes as much as 0.5 m. Finally, high foot, vehicular, or horse traffic over nests at the wrong time, during hatching but before emergence, can collapse the air space over a clutch of emerging hatchlings. This is a particularly vulnerable time, because the nests are undetectable and even if someone steps into one, they are not likely to notice, as the sand is normally very yielding.

3.1.2. Greens

Green turtle (*Chelonia mydas*) nesting at Sandy Point fluctuates widely from season to season. Its nesting season is not as discreet as that of the leatherback, and nests may be laid during almost any time of the year. Typically, however, the heaviest nesting is from late July through November. Monitoring for green turtle activity has not been consistent. One survey done in 1993 reported 46 activities, including 20 "judgment nests" (nests in which egg-laying was not observed, but was assumed) and 26 dry runs during August 1 to November 30 (Henry 1993). A 1995 survey showed 28 activities, including 14 judgment nests and 14 dry runs, for July 1 to December 31 (Mackay and Rebholz 1995). Data have also been collected when the beach is monitored during the leatherback nesting season from April 1 to August 31. From 1990 - 1996, 64 nests were recorded between stakes #-7 and #120. Egg laying was observed in 18 of these, and 46 were judgment nests. There were 33 known dry runs. Seven nests were relocated. Green turtles typically choose nesting sites deeper into the vegetation than leatherbacks, reducing the risk of inundation and obviating the need for relocation. As Table 3 shows, slightly more nests were laid on the grassy side than the sandy.

Table 3. Green and Hawksbill Activity at Sandy Point during the Leatherback Project, 1990 - 1996.

Location	Green		Hawksbill	
	No. Activities	No. Nests	No. Activities	No. Nests
#-7 to 15	10	8	22	11
#16 to 32	23	13	12	6
#33 to 50	11	7	13	9
#51 to 120	53	36	42	25
TOTAL	97	64	89	51

3.1.3. Hawksbills

Like the green turtle, the monitoring for hawksbill (*Eretmochelys imbricata*) activities has not been consistent. A 1993 survey reported 87 activities, including 56 judgment nests and 31 false crawls, for August 1 to November 30. A 1995 survey reported 70 activities, including 51 judgment nests and 19 false crawls, for July 1 to December 31 (Mackay and Rebholz 1995). Nesting is relatively rare during the main leatherback nesting season, and increases during July - November. As with green turtles, data have been collected when the beach is monitored during the leatherback nesting season. During 1990 - 1996, 51 nests were recorded, of which 36 were "judgment nests". There were 38 dry runs. Three nests were relocated. As with greens, hawksbill turtles typically nest deeper into the vegetation than leatherbacks, often among low bushes or against logs, so nests rarely need to be relocated.

Table 3 shows the location of hawksbill activities recorded during the Leatherback Project beach patrols. Sandy side and grassy side activities were similar in number.

3.2. Visitors

3.2.1. Visitor use prior to management

The current restrictions on visitors to Sandy Point has evolved over the years. In the early years of the project (1981 - 1986), beach access was unlimited. Although there are no figures for numbers of daytime visitors, researchers on the beach at night regularly encountered people fishing, camping (which involved the use of tents and large bonfires), and conducting other undisclosed activities. Most nighttime activities involved the use of lights, and it was common for

the researchers to encounter a turtle that was surrounded by people waving flashlights and cameras, and even climbing and/or riding on the turtle. Daytime use was heavy and constant, and often involved volleyball net supports and umbrella poles being driven several feet into the sand. People sometimes drove vehicles on the beach, crushing soon-to-emerge nests. Large amounts of trash on the beach was an ever-present problem.

In 1984, the USFWS purchased Sandy Point and established it as part of the National Wildlife Refuge System, protecting the habitat from development. However, there was no Refuge Manager, and hence no enforcement of refuge regulations, which included closure of the Refuge to the public after dark. As a result, visitors rarely observed the rules, and nighttime use of Sandy Point remained uncontrolled. The researchers attempted to inform people encountered on the beach at night that the area was a refuge, and that it was illegal to harass turtles. However, protection of the turtles and nests from harassment and poaching remained very difficult. Still, poaching of leatherback nests diminished to zero after several years of the project due to all season, all night presence of researchers and volunteers on the beach.

3.2.2. Current management practices

In 1992, the first Refuge Manager was hired for Sandy Point. This was the first step toward true protection of the turtles and nests. The Refuge Manager installed a gate on the only road into the Refuge, and regularly patrolled the Refuge both during the day and at night to enforce Refuge regulations. Whenever researchers encountered people on the beach at night, they had the protection and assistance of the Refuge Manager in explaining the restrictions. With an armed Refuge Manager on duty, turtles were left undisturbed, and the criminal activity on Sandy Point decreased. Nighttime visitors were limited to chaperoned groups brought out under the guidance of the Leatherback Project Field Directors. The constant presence of the Refuge Manager and Sandy Point's USFWS National Wildlife Refuge status are crucial to the integrity of the nesting beach and the safety of the turtles.

Patterns of Use and Numbers

During the day, visitors are only allowed on Sandy Point on weekends. Numbers of visitors from 1994 - 1996 are shown in Table 4. Due to accessibility and parking availability, the great majority of daytime visitors concentrate in the area from stakes #-3 to 8. Visitor numbers have decreased over the years due to greater restrictions in beach access. Abrupt drops in numbers evidenced in Table 4 reflect hurricane activity and beach closures.

Nighttime visitors are limited to chaperoned groups visiting the Leatherback Project. They are invited to observe the project at the discretion of the Field Directors, who also direct their actions on the beach. Group sizes are limited to 10, or in the case of school and youth groups, 20 children with 5 adults. They are carefully managed so as not to impact nesting turtles, nests, or emerging hatchlings. Their numbers are also shown in Table 4. Prior to 1994, nighttime chaperoned visitors usually numbered around 600 - 700 per season.

Table 4. Visitor Use on the Sandy Point National Wildlife Refuge. (Day use numbers from M. Evans, SPNWR Manager; night use numbers from Leatherback Project Annual Field Reports).

Month	1994		1995		1996	
	Day	Night	Day	Night	Day	Night
Jan	937	0	909	0	272	0
Feb	460	0	385	0	300	0
Mar	388	0	448	0	285	0
Apr-Aug	2287	500	2428	500	1515	260
Sept	195	0	95	0	187	0
Oct	332	0	287	0	200	0
Nov	435	0	222	0	274	0
Dec	284	0	96	0	330	0
TOTALS	4818	500	3837	500	3103	260

Effects on hatchlings

Preliminary analysis of unpublished data reveals no direct effects of visitor use alone on hatch or emergence success. Emergence success does not increase with distance from the highest-use areas, as would be expected if visitor use alone was a major factor. Likewise, the percentage of full-term pipped hatchlings (those that partially emerge from the shell, then die) does not consistently decrease with distance from the high-use area. However, caution must be used when interpreting these results. As previously mentioned, many factors influence emergence success, such as amount of rainfall, sand composition, etc. It is possible that excess foot traffic alone might not affect nest success, but when coupled with other exacerbating factors could have a greater effect than either factor by itself. To fully resolve this issue, detailed analyses of emergence

success, weather patterns, wave action, and relocated nest construction techniques must be completed.

Current Management Techniques

- A list of the beach regulations enforced by the Refuge Manager is shown in Appendix II.

Current management techniques include closure of the beach north of stake 15 to daytime visitors, to prevent visitor impacts on nests and hatchlings. Beginning of closure has varied over the years from July 25 in 1994 to April 27 in 1997 (see Table 5). In 1994, the entire Refuge was closed to the public from 25 July - 19 August. All visitors are closely monitored to insure they conform to the regulations. A volunteer group called the Friends of Sandy Point distributes literature, interacts with visitors on the beach, and explains the regulations and the reasons for them.

Table 5. Beach closure dates and locations, 1994 - 1997.

Closure Dates	Location Closed to the Public
July 25 - August 19, 1994	entire refuge
July 5 - Sept. 2, 1995	-8 - 20
May 4 - August 31, 1996	-7 - 21
April 26 - Sept. 13, 1997	-10 - 24

4. Threats and Problems

4.1. Poaching

In past years, the presence of researchers and volunteers on the beach seemed sufficient to discourage poachers during the leatherback nesting season. During the 1996 season, however, there were incidents of attempted poaching during night patrols while researchers were on the beach. This is disturbing, and must be addressed as it is a danger not only to the turtles, but a potential danger to the researchers as well. Poachers also come to Sandy Point during the day during leatherback season in search of eggs, usually during early morning hours after the researchers have left the beach. Poaching is also a problem during other parts of the year, with green and hawksbill adults and eggs targeted. There were 22 documented incidents of attempted poaching at Sandy Point in 1996, most directed at hawksbills and greens. At least one adult

hawksbill was killed, and several nests were taken. In 1997, on St. Croix's north side, two adult leatherbacks were killed, gutted, and their heads and flippers removed. Previous incidents of poaching of adult leatherbacks include one in 1988, and one possible in 1992, both on the north side of St. Croix.

While it appears that poaching of green and hawksbill turtles is on the rise, it is likely that this activity has always occurred at Sandy Point after the leatherback nesting season ends, but that it wasn't detected until the current Refuge Manager was appointed and began regular patrols of hawksbill and green nests. However, the increase in poaching during leatherback nesting season represents an alarming trend that must be reversed.

4.2. Unsupervised Visitors

Unsupervised nighttime visitors are relatively rare on Sandy Point. As before the Refuge was established and protected, their main threat lies in disrupting nesting turtles and collapsing emerging nests. Public education and the constant presence of the researchers has discouraged such overt activities as camping and bonfires. However, without an active protection program in place, the situation would likely revert to as it was in past years, with uncontrolled harassment of nesting turtles as well as nighttime camping, complete with bonfires and tent stakes driven into the sand.

The main threat from unsupervised daytime visitors lies in collapsing emerging nests, particularly in the "stable beach area". Horseback riders also pose a threat, as they ride over nest areas and the hoofprints in damp sand create traps that hatchlings fall into. Unlike the more agile green and hawksbill hatchlings, leatherback hatchlings are often unable to right themselves if flipped onto their back, so falling into even a shallow depression can kill a hatchling. Daytime visitors almost invariably leave behind large amounts of trash on the beach or in nearby parking areas, which attracts predators (mongoose and dogs) and blows into the water, creating a hazard for feeding turtles and other animals that may mistake the trash for food.

4.3. Erosion

Beginning around the end of April, changes in ocean currents result in erosion of the southwest (stakes #20 to #50) and southernmost southeast (#51 to #65) facing beaches. Beach width in this area is often as much as 50 meters from water to vegetation at the beginning of the nesting season. The extent of erosion is different each season, and it is difficult to determine at the

beginning of the season how much the beach will erode. However, by the end of June, this area is usually already heavily eroded, often to the vegetation line

4.4. Predators

There are no animal predators of adult leatherbacks on Sandy Point, although dogs occasionally harass them by barking. It might be possible for a large dog to kill a green or a hawksbill, but this has not been reported at Sandy Point or anywhere else on St. Croix. However, different species of predators are a threat to eggs and hatchlings.

4.4.1. Mongoose

Mongoose predation has been an increasing problem during the past ten years. Mongoose can easily dig into the shallow hawksbill nests, and they have recently learned to tunnel down into a leatherback nest and take eggs. More often, they dig into nests of emerging hatchlings, and in several cases nearly the entire clutch of hatchlings was taken. Although they are usually diurnal and prefer the cover of vegetation to the open sand, they seem to be adapting to a ready food source. They are often seen out on the beach at sunset and just after, and mongoose tracks can be found from the vegetation to the water's edge. In some seasons, over half of the nests on the sandy side showed evidence of digging by mongoose, and virtually all sandy side nests have mongoose tracks around them. Vegetation on the grassy side often makes it difficult to detect mongoose tracks if they are there.

4.4.2. Dogs

Nests occasionally show evidence of digging by dogs, but they rarely if ever reach the nest chamber. Dogs are more likely to attack emerging hatchlings. The amount of predation by dogs is currently probably minimal, but occasionally groups of dogs will frequent the area, resulting in surges of activity around nests, as evidenced by dog tracks. It is unknown how many hatchlings are taken during these times.

4.4.3. Ghost crabs

Ghost crabs (*Ocopode quadrata*) are a well-known predator on sea turtle hatchlings. They have been observed attacking hatchlings, and are occasionally found burrowed into nests when the nests are excavated. Dead hatchlings have been observed partially dragged into crab burrows. The

effect of crab predation on emerged hatchlings has not been quantified, since the vast majority of nests emerge unseen. However, it can be assumed that the impact on hatchling numbers is minimal, and it is not considered a major threat.

4.4.4. Night Herons

Night herons (*Nycticorax nycticorax* and *N. violacea*) opportunistically prey on sea turtles. Although the numbers of hatchlings taken by these birds have not been quantified, it is very common to find dozens of heron tracks mingled with hatchling tracks from a recently emerged nest. Researchers are often alerted to an emerging nest by the calls of night herons. However, night herons occur in limited numbers on Sandy Point, and are probably not a major threat to overall hatchling numbers.

4.4.5. Fish

Throughout the project, fish have been observed to prey on hatchlings entering the water off Sandy Point. This problem has been noticed more often on the sandy side between stakes #-7 and #20. Beginning in 1995, fish predation was virtually 100% from stakes #-7 to about #15 on bright moonlit nights. Fish were observed patrolling along the shore, and there was a feeding frenzy whenever a hatchling entered the water. The main fish species observed were crevalle jack (*Caranx hippos*) and horse-eye jack (*C. latus*). Snapper, tarpon, and small sharks are also likely predators. Fish predation is likely increased when hatchlings spend extra time near shore due to light disorientation (see section 4.5.1).

4.4.6. Other potential predators

Although cats have been seen on the refuge, there is no evidence that they disturb turtle nests. Cats have not been seen on the beach beyond the vegetation line, and no detectable tracks have been seen. Feral cats are not considered a threat to sea turtles on Sandy Point.

There has been no evidence that rats disturb turtle nests on Sandy Point. If rats do prey on hatchlings, it is probably only sporadically and is not considered a problem.

4.5. Human Development and Lighting

4.5.1. Light disorientation

Sometimes entire clutches of emerging hatchlings become disoriented by light from Frederiksted (or, occasionally, the rising moon) and crawl towards the vegetation, away from the ocean. This is usually a problem when hatchlings emerge before midnight between stakes #15 to #21, as lights from Frederiksted create a glow in the sky behind the vegetation, directly opposite the water.

Light disorientation could increase fish predation, as shown by Gyruis (1994), who found that fish predation on free-swimming green turtle hatchlings at Heron Island reef, Australia, was 93.6%, with the majority taken within 20 minutes of entering the water. Trials in which monofilament lines were attached to swimming hatchlings showed up to 85% fish predation. Most hatchlings were taken in shallow water (i.e. at low tide) as they crossed over the coral reef crest. Those crossing over at high tide, when the water was deeper, had a much better survival rate. Therefore a hatchling stands a much greater chance of survival the quicker it gets out into deep water. On beaches where there are nearby bright lights, hatchlings are more likely to swim toward the light, even after they enter the water. At Sandy Point, particularly on the northwest facing beach (stakes #-7 to #15) this would cause them to spend a much greater amount of time in shallow water, exposing them to even higher fish predation.

An estimated 40% of hatchlings per season were affected by light during 1991 - 1996, although mortality due to the disorientation has not been quantified. When the stadium lights were on during an emergence on a dark night, virtually every hatchling from stake # -7 (and northward) to #15 travelled directly toward the light. Many hatchlings were documented crawling over 200 m before the curve of the beach resulted in their reaching the water. Hatchlings were also documented leaving the water to move back up the beach toward the stadium lights. Hatchlings emerging from stake #16 to #21 or #22 crawled away from the water and directly into the vegetation. Any hatchlings not rescued by the researchers or volunteers died in the sun the next day or were killed by predators or ants. Baffles placed on the stadium lights in 1997 decreased this disorientation, but some disorientation was still observed.

4.5.2. Tourism

Sandy Point is under increasing scrutiny from government officials on St. Croix as an attractive tourist destination. It is widely thought that cruise ship business could be increased if passengers could be shuttled to Sandy Point during the day, and allowed to visit the Leatherback Project at night. Probable effects of this would include:

- (a) increased trash on the beach
- (b) increased fecal pollution of the beach; as there are no restroom facilities on the Refuge, visitors commonly use the bushes, resulting in feces and toilet paper being left on the beach
- (c) increased compaction of the sand over turtles nests and greater threats to emerging hatchlings, as the main area for tourists would be the area from stakes #-7 to around #20, which is also the area where the majority of leatherback nests are deposited
- (d) disruption of the conservation and research efforts of the Leatherback Project if more visitors are accommodated

4.5.3. Marina

Another project under consideration is the construction of a marina adjacent to the Refuge. This would involve dredging the Westend salt pond and opening a channel from the salt pond to the ocean. Probable effects of these actions would include:

- (a) destruction of the ecology of the salt pond
- (b) increased sedimentation in the adjacent ocean water, with resulting increased turbidity
- (c) alteration of longshore sediment transport patterns, with possible increased erosion or deposited sediments
- (d) injuries to sea turtles resulting from increased boat traffic
- (e) easier public access to Sandy Point, resulting in greater difficulty regulating unsupervised visitors to Sandy Point
- (f) disruption of movement patterns of nesting turtles by increased boat traffic
- (g) increased light pollution, resulting in increased hatchling disorientation

4.6. Fishing Activities

4.6.1. Fishing from boats

Turtles have emerged on Sandy Point with extensive propeller damage to the carapace, and it is impossible to say how many are hit that are killed by the impact. Fishing boats travel nightly from Frederiksted to fishing grounds south of Sandy Point at night. At least four or five boats are commonly seen on any given night, and as many as two dozen have been seen, many travelling without lights. Their proximity to shore - usually within a few hundred feet - makes them a hazard to turtles arriving and, particularly, leaving the nesting beach. Turtles leaving the beach surface quite often, commonly about every 20-30 seconds, on their way out to sea.

4.6.2. Fish trap and lobster pot line damage

Scars from fishing lines or, more probably, lobster pot or fish trap lines, are very common on Sandy Point leatherbacks. These scars show up as pink lines of varying widths encircling one or both front shoulders. Many are fresh wounds at the beginning of the season, and usually heal to pink scars during subsequent nestings. In one incident, a National Park Service employee and her assistant were called to assist a leatherback caught in a lobster pot line off Buck Island. They were able to free the turtle, which would otherwise have drowned (Z. Hillis, NPS, pers. comm.). They could see that it was tagged but were unable to read the tag. A few days later, a turtle appeared on Sandy Point with a tag on the indicated flipper and fresh shoulder wounds consistent with rope wounds, but it was impossible to determine if it was the same turtle. It is likely, however, that leatherbacks are affected by these lines throughout the waters surrounding St. Croix. This is a potential problem wherever fish traps are used near turtle habitat. In the mid-1980's, two turtles died in fish trap lines off the Puerto Rican islands of Culebra and Vieques (R. Boulon, DPNR, pers. comm.). Occasionally leatherbacks appear with extensive longitudinal, parallel cuts on the head and neck. While the cause is not certain, it has been speculated that the wounds could be caused by entanglement in wire fish traps.

4.7. Oil Developments and Activities

St. Croix is the location of Hess Oil, one of the largest oil refineries in the western hemisphere. The refinery is about 10 miles from the SPNWR. Although there is no oil drilling in St. Croix, there is considerable traffic of vessels carrying large amounts of refined and unrefined oil. An oil spill could severely impact adult and hatchling turtles at Sandy Point.

5. Management Strategies and Recommendations

5.1. Poaching

The presence of the Refuge Manager is the most important means of controlling poaching, which is listed as a Priority 2 task in the Recovery Plan for Leatherback Turtles (NMFS and USFWS 1992). In the past, the presence of researchers and volunteers on the beach seemed sufficient to deter poachers during leatherback nesting season. However, the incidents of attempted poaching during 1996 night patrols indicate that it is crucial that the Refuge Manager have a visible presence on the beach, and be available for "sting" operations to surprise poachers. While it is unreasonable and probably unnecessary for the Refuge Manager to be present each night, his occasional appearance at night is important and could help deter poachers. The "communication network" on St. Croix is remarkable - word gets out almost immediately whenever any action takes place that may have an affect on the local people. So it is almost assured that whenever the Refuge Manager confronts poachers on the beach, this incident is widely known by the next day. The stronger and more prevalent his presence is, the stronger the deterrent effects will be.

This Plan recommends that The Refuge Manager also have a Ranger help patrol the Refuge during the day, at unpredictable hours, as well as at night. Past experience has shown that trespassers on the Refuge are well aware of the researchers' normal patrol schedule, and often enter the Refuge (on foot or by boat) early in the morning just after the researchers leave the beach. A Ranger could be invaluable in controlling this activity. Other duties often call the Refuge Manager away from Sandy Point for long periods of time; during these absences in particular, there should be someone to maintain a law enforcement presence on the Refuge. In light of past and present drug activity at Sandy Point, it could also be important for safety reasons to have two USFWS agents on duty.

It cannot be over-emphasized that without the constant presence of a Refuge Manager on Sandy Point, poaching will become an increasing problem. On other beaches around St. Croix, it is not unusual for most or all nests to be taken. There is general feeling among the scientific community that Sandy Point is "safe" from poaching due to the presence of the researchers - this is incorrect, and poachers are getting more brazen at Sandy Point to the extent of looking for nests while researchers are on the beach. Green and hawksbill turtles are particularly vulnerable after the leatherback nesting season ends and the researchers are not patrolling the beach each night. Most

poaching activity is directed at these species, and given the high incidence of poaching on other beaches around St. Croix, it is likely that poaching on Sandy Point would affect most if not all nests without the protection of the Refuge Manager.

Stricter penalties for convicted poachers are needed, with higher fines and perhaps jail time imposed on those caught stealing eggs or killing adults. Currently, sentences vary with judges on St. Croix, with some being more strict than others. Sentences for poachers are currently not effective. In addition to criminal penalties, the Service should consider pursuing civil penalties against poachers.

The presence of researchers on the beach is still a deterrent to poaching. Green and hawksbill nests can be disguised by obscuring the adult tracks through trampling. When possible, patrol patterns should be unpredictable (as when a Field Director begins a patrol ahead of the rest of the team), and patrols should be done quietly and with a minimum of light so that it is not clear where the researchers are at any given time. At night, it is crucial that the researchers have cellular phones or radios capable of reaching police assistance if needed. Suspected poachers should not be approached on the beach at night by researchers working alone.

5.2. Unsupervised Visitors

Restriction of visitors is important, but relatively easy given the Refuge's status as part of the USFWS National Refuge System, and the only road in is protected by a locked gate. Due to the constant patrols, illegal visitors who walk in are quickly discovered and either escorted out or confined to supervised areas. As public education is a key goal of the Leatherback Project, whenever possible these visitors are given full explanations about the project and its practices, and allowed to observe nesting turtles. Scheduled visitors are closely supervised and chaperoned so as not to disturb the turtles.

Sandy Point is currently open to the public during limited daytime hours on weekends and holidays. Access to the nest relocation area (stakes #-7 to #15) is usually restricted during hatching season, with signs posted at the edge of the restricted area.

5.3. Erosion

5.3.1. Nest relocation

In general, *in situ* nests have higher hatch and emergence success than relocated nests. However, due to the very predictable erosion patterns on Sandy Point, an estimated 30-50% of nests laid would be lost without relocation, so relocation is considered critical to accomplishing the goals of the Leatherback Project. There are criteria to follow when relocating nests, and specific techniques that can insure the highest possible hatch and emergence success.

5.3.1.1. Relocation criteria

Any nest that appears threatened by inundation or erosion at the time of laying, or that has water in the nest cavity, is relocated to a stable beach area. As stated previously, for purposes of relocation, the stable beach area is defined as the area between stakes #-7 and #15. While the area between #15 and #19 does tend to accrete sand during the nesting season, this area is not acceptable for relocation. Lights from the city of Frederiksted create a glow over the vegetation directly opposite the water, causing serious hatchling disorientation. Also, by the time hatchlings emerge from nests laid early in the season (or from nests relocated here) in this area, they must travel across as much as 50 m of newly accreted sand, making them extremely vulnerable to predators, and subject to disorientation. Furthermore, when turtles attempt to nest on the newly accreted sand, the nest cavities usually fill with water, and the nests must be relocated

All nests laid on the southwest or southeast facing beach from stakes #20 to #65 after May 1 are relocated, unless the nests are situated at the vegetation line. Nests laid from stakes #35 to #50 are relocated regardless of proximity to vegetation. The portion of the beach from about #23 to #50 can also be low-lying, which generally results in water in the bottom of most nests dug here, so close watch must be kept as turtles dig so the eggs can be relocated if water appears in the nest during digging. Any nest laid in heavy vegetation, such as is found on some parts of the grassy side, should be relocated. Hatch success has been very poor in these conditions, as roots often grow into developing eggs, and also often trap entire clutches of emerging hatchlings.

Since hatch success is lower for relocated nests, it is important to leave *in situ* any nests that, in the best judgment of the Field Directors, has a reasonable chance for survival even if located near the high water mark. Nests can tolerate some washover and still have good hatch success. Furthermore, these nests may be the few that have the potential for producing males.

However, if nests are laid below the typical high water mark (usually indicated by a line of debris, above which the sand is dry), they must be relocated. If laid anywhere on or above the high water mark on a stable area of the beach (stakes #-7 to #19, #66 to #120), they can be left *in situ*. However, the beach from stake #50 to #80 usually experiences periodically heavy deposition of masses of seaweed, which traps emerging hatchlings, so nests laid here near the high water mark should be moved.

5.3.1.2. Relocation techniques

Many factors can influence hatch success of relocated eggs, including handling during collection, time between laying and collection, time and conditions between collection and reburying, and condition of the relocated nest cavity. Eggs should be handled gently to avoid damage, and hands should be free of oils or insecticides (insect repellants). Since development of the embryo starts within 24 hours of egg deposition, eggs should be collected at the time of laying. They should be caught by hand as they drop from the cloaca, and care should be taken to keep eggs as sand-free as possible. Eggs should be stored in plastic bags to preserve moisture, and carefully protected from rain and predators until reburied. No correlation has been found between length of time spent out of the nest (during the night they were laid) and hatch success; however, eggs should be reburied before dawn to avoid overheating and drying out. Eggs must not be relocated after embryo development has reached a sensitive stage (approximately 48 hours in leatherbacks). If unusual wave or tide activity exposes a developing clutch and the eggs must be relocated after the chorionic membrane has begun to attach, they must be handled extremely carefully, making sure that they are not shifted, jolted, or turned during excavation or reburial. This would break the membrane around the developing embryo and kill it.

Eggs are buried at a depth of 70 - 75 cm to the bottom of the nest cavity. Past research has shown that the great majority of *in situ* nests are 70 - 80 cm from the bottom of the nest cavity to the surface of the sand. As measuring an *in situ* nest cavity while a turtle is digging can be awkward, particularly when attempted by inexperienced volunteers, this measurement is usually no longer taken unless the nest seems particularly shallow.

The major factor affecting relocated hatch success seems to be shape of the relocated nest and compaction of the sand in the sides of the nest. Hatch success of relocated nests is on average approximately 10% lower than of *in situ* nests. Since mortality of full-term embryos, including those partially emerged from the egg, accounts for most of this difference, factors important in the late stages of development most likely are responsible rather than initial handling of the eggs.

These physical factors probably affect gas exchange and the thermal dynamics within the clutch, with physiological stress resulting from sub-optimal nests. In hatch success experiments during 1994, three different nest designs were used (Figure 6):

- a. wide - at least 40 cm wide, pouch shaped with no discernible cavity at the bottom
- b. narrow - less than 35 cm wide, with symmetrical cavity at bottom, like an upside-down light bulb
- c. natural - resembling a short-toed boot in profile, with an opening about 35 cm wide, with one side of the cavity sloping so that eggs collect into the "toe" of the chamber, which should be about 35 - 40 cm wide.

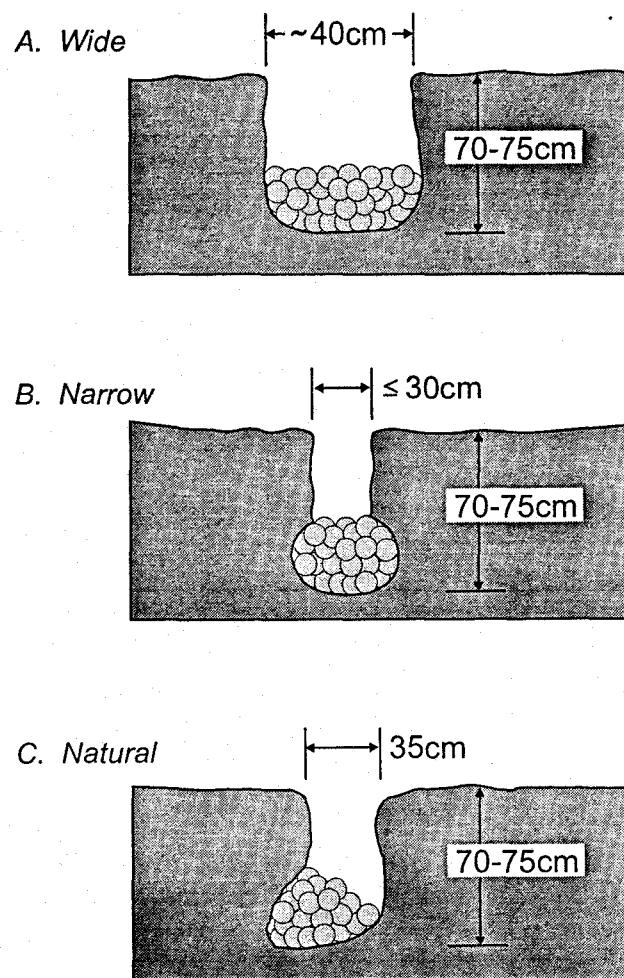


Figure 6. Experimental nest shapes for relocated nests.

The best hatch success was achieved with the "natural" shape. This may leave more of an undisturbed (solid) "roof" over the eggs which is less likely to collapse during hatching. It is important to insure that the sand inside the nest is as compact as possible, and that the sand is packed firmly around and on top of the relocated eggs; otherwise, the egg chamber has a tendency to collapse before hatchlings completely emerge from the egg. If the sand continually collapses while digging a relocated nest, it is best to move to another area and start over rather than continuing to dig it out. "Wide" nests with no distinct shape had the worst hatch success, and this can also be seen in *in situ* nests of a similar shape. Symmetrical, "upside-down light bulb" shapes also had low hatch success.

Nest sites should be routinely monitored beginning one week before expected emergence. If a caved-in area is detected as an indentation in the sand, the nest should be excavated. Hatchlings with no visible yolk sac can be released as soon as they begin moving vigorously. Unhatched eggs and hatchlings with an exposed yolk sac should be kept until they are ready for release (yolk sac very small or completely absorbed). Unhatched eggs should be kept in damp (i.e. from 30 cm below surface) sand, covered by about 15 cm of sand.

5.3.1.3. Styrofoam Boxes

Incubating eggs in Styrofoam boxes during the last week of their development results in excellent hatch success (Dutton and McDonald *in prep*). Although extremely labor-intensive, emergence success is usually nearly 100% with this method. Nests are excavated at around day 53 of incubation, and eggs are packed side by side into the box, one layer directly on top of another, being careful to maintain the same orientation as in the nest. A 1-2" layer of damp sand should cover the bottom of the box. Sand dug from about 1 foot below the surface should be used, rather than dry surface sand. After all of the eggs in a clutch are packed in, a layer of paper towels dampened with fresh water should cover the eggs, with a 1-2" layer of damp sand on top of that. The Styrofoam box lid should then be replaced.

The surface of the sand should be checked periodically to ensure that it doesn't dry out, and a spray bottle of fresh water should be kept on hand for re-wetting. Ideally, a temperature probe should be inserted into the middle of the clutch for continual monitoring - the incubation temperature should not rise above 32°C (due to metabolic heating at the end of incubation, the temperature may rise as high as, but should not exceed, 34°C). Good air circulation should be maintained in the room where the boxes are held. It is crucial to punch holes in the bottom of the

Styrofoam box to let out liquids from the hatching eggs, otherwise the emerging hatchlings will drown. Hatchlings should be released when their yolk sacs no longer protrude and after sunset when they are active.

Each clutch of eggs should be incubated in its own box, with the female's original tag number clearly marked on it, identifying it with the original data sheet. Date moved to the Styrofoam box should also be recorded, along with the number of eggs moved. Yolkless eggs do not need to be included.

This technique should be used mainly for relocated clutches, in order to improve hatch success. The once-popular use of Styrofoam boxes for the entire incubation period has been largely abandoned as a management technique due to problems associated with temperature-dependent sex determination, resulting in masculinization of embryos (Dutton et al. 1985). However, since Styrofoam box relocation at Sandy Point occurs during the last week of incubation, well after the critical period for sex determination, inadvertent alteration of sex ratios is avoided.

5.4. Predators

Predators affect both eggs and hatchlings. Hatchlings are rarely seen being taken by a predator. However, night herons can often be heard calling around a nest of emerging hatchlings. Whenever a nest is discovered this way, the hatchlings should be guarded from the birds (and other predators) until all hatchlings reach the water. Occasionally hatchlings are found trapped in vegetation, covered with ants. If found soon enough, the ants can be brushed off and the hatchling released. Hatchlings can also be recovered from ghost crabs, but usually the crab quickly disables the hatchling by cutting into its neck, effectively dooming it.

All hatchlings discovered dead on the beach should be buried so as not to attract predators or scavengers. Likewise, they should not be thrown in the water or they could attract large fish which may then prey on live hatchlings. Protection from predators such as mongoose can also be enhanced by keeping the beach free of trash that could attract predators.

5.4.1. Mongoose

There are several possible options for reducing the threat of mongoose predation on turtle nests. These include control (i.e. trapping), barriers (such as wire cages around nest sites), and

sterilization. Given that mongoose are an introduced species to St. Croix and are not endangered or threatened, control seems the most cost effective and successful of these.

Coblentz and Coblentz (1985) stated that when mongoose were eradicated from beaches on St. John at the beginning of the hawksbill turtle nesting season, the problem was virtually eliminated for the duration of the season. They found that an average of 86% of trappable mongoose were caught during the first five days of trapping in each trapped area. Studies undertaken on Sandy Point from 1991 - 1994 showed that mongoose tend to be territorial (R. Horst, pers. comm.). They stake out a home territory and rarely stray from it. Furthermore, there is little migration of new mongoose into an area. However, since mongoose can produce a litter of up to five pups every 6 - 12 months, they can multiply quickly.

Since mongoose predation on leatherback hatchlings is much more prevalent than on eggs, it would not be practical to put wire cages around nests, as the cages would alert poachers to the presence of a nest. Furthermore, hatchlings might emerge when researchers are not present to release them immediately. The most effective and economical way to handle this problem is predator control by trapping early in the season, followed by careful monitoring for signs of predation throughout the season. Additional trapping should be done at the first sign of egg predation, as mongoose learn quickly from each other.

5.4.2. Dogs

Dogs should be immediately removed from the Refuge whenever they are seen. Under no circumstances should visitors be allowed to bring pet dogs to the Refuge.

5.4.3. Ghost crabs

Rather than attempting to reduce the numbers of crabs on the beach, hatchling time on the beach should be reduced by avoiding relocating nests to areas of high accretion or to areas where hatchling disorientation due to light has been shown to be a problem.

5.4.4. Night Herons

Since herons are an endemic species to St. Croix, and since they probably have little impact on total numbers of hatchlings leaving the beach, it is not recommended that efforts be made to

remove these predators. However, they should be chased away from areas where hatchlings are emerging, and hatchlings should be protected until they reach the water's edge.

5.4.5. Fish

There are two options for dealing with this predator - control and avoidance. Control would involve intensive fishing from the sandy side, particularly during moonlit nights. Intensive fishing during the hatching season should be combined with sampling of fish stomachs, to determine (a) the extent of hatchling predation and (b) the effectiveness of fishing on hatchling predation. To avoid predatory fish, any hatchlings that are observed emerging from the sandy side north of stake #15 during moonlit nights, as well as hatchlings that have been held overnight for release the next day, should be transported for release to the grassy side, where fish predation is not as much of a hazard.

Relocation strategies may help reduce predation also. Whenever possible, nests relocated on any one night should be spread out over a wider area so hatchlings emerging on any given night are not so concentrated.

5.5. Hatchling Entrapment

When nests are excavated, a number of live hatchlings are usually found in the nest. These are animals that either emerged late from the shell, were too weak to dig their way out with the rest of the clutch, or are actually trapped by roots or debris in the nest. These hatchlings should be kept together in a hole or container until they are vigorous and active, then released near the water's edge. If any have protruding yolk sacs, they should be held overnight in a Styrofoam box with a light layer of damp sand on the bottom. The longer they are held in captivity, the less vigorous they become and the less likely are their chances for survival.

Any hatchlings found trapped in the vegetation are freed and released near the water's edge. The quicker they are discovered, the better their chances of survival. Trapped hatchlings are often killed by crabs, ants, birds, or (if they emerge near sunset or dawn) mongoose.

5.6. Human Development and Lighting

5.6.1. Light disorientation

Light disorientation is the biggest problem between stakes #16 and #20, as lights from Frederiksted create a glow in the sky behind the vegetation, directly opposite the water. The baffles erected on the stadium lights have reduced this ambient light; however, there is still a glow from the town, which will increase as the town and its businesses grow. Therefore, nests should not be relocated to this area. During hatching season (after the end of May), vegetation in this area should be regularly monitored for disoriented hatchlings.

On beaches where there are nearby bright lights, hatchlings are more likely to swim toward the light, even after they enter the water. At Sandy Point, particularly on the northwest facing beach (stakes #-7 to #15) light from Frederiksted might cause hatchlings to spend a much greater amount of time in shallow water, exposing them to even higher fish predation. For this reason, releasing hatchlings on the southwest or southeast facing beaches (stakes #21 to #120) may insure the best chance for survival.

5.6.2. Tourism

This Management Plan recommends against increasing tourism to the SPNWR. Sandy Point is a National Wildlife Refuge, as opposed to a National Park, and as such is mandated to protect wildlife and habitat, to the exclusion of visitors if necessary. Tourists should be accommodated only if they are involved in wildlife related activities (e.g., bird watching). If pressure to accommodate tourists increases, they should be allowed to visit the Refuge only under strict guidelines and only when the Refuge Manager or a Ranger is present. Guidelines should include:

1. Stay within areas designated for visitor use, so as not to impact turtle nests. During leatherback nesting and hatching season (April 1 - August 31), this would be limited to the area between stakes #20 and #120, and only after July 1. Prior to July 1, they should only be allowed from stakes #51 to #120. During years of unusually high nesting activity, restricted areas may be expanded.
 2. All tourists should transport their own waste off the Refuge.
 3. If hatchlings are encountered, the Refuge Manager or Ranger will be notified immediately.
- Other guidelines should be at the discretion of the Refuge Manager.

The Leatherback Project cannot accommodate tourists, as there is limited opportunity for people to visit the project and public education of St. Croix residents is the top priority. Occasionally, off-island visitors will be accommodated if arrangements are made well in advance of their visit.

5.6.3. Marina

This Plan recommends against construction of a marina adjacent to the SPNWR, for the reasons outlined in 4.5.3.

5.6.4. Land acquisition

This Plan recommends that the USFWS consider land acquisition of the remainder of the West End salt pond to ensure protection of sea turtles and other wildlife inhabiting the Refuge.

5.7. Fishing Activities

Slightly over half (56%) of turtles seen arriving are encountered before midnight. However, of the 1,789 documented departure times, 36% of those (647) are before midnight, and 64% (1,142) after. Departing turtles are more vulnerable to boats, as they spend more time at the surface. Therefore, it is most potentially damaging for boats to be travelling close to shore after midnight.

A possible strategy for dealing with the hazard of boat traffic to nesting leatherbacks is to designate a "safe" distance from shore, particularly after midnight when turtle activity is heaviest.

5.8. Oil Development and Activities

An Oil Spill Response Contingency Plan is currently under review by the USFWS. The Plan provides notification and response procedures in the event of an oil spill. Hess Oil already has a contingency plan in place that specifically addresses Sandy Point and sea turtles. This Plan was developed with the cooperation and advise of the SPNWR Refuge Manager.

5.9. Public Education

The importance of public education is specifically addressed in the Recovery Plan for Leatherback Turtles (NMFS and USFWS 1992). Public education has always been an important part of the Leatherback Project. Conservation of St. Croix's sea turtles must ultimately be practiced voluntarily by the residents of St. Croix, as the researchers are only on the island April - August, and the Refuge Manager cannot always be present. Therefore, it is important that the project have high visibility in the local community, and that local citizens feel like they have a stake in the turtles - they need to feel possessive and protective of the turtles. The establishment of a permanent interpretive center in Frederiksted would help provide a focal point for community involvement and public outreach (see section 6.4.1).

5.9.1. At Sandy Point

Each year during leatherback nesting season, a number of local visitors are allowed on the beach at night to observe the turtles and the Leatherback Project. There is often extensive interaction between the visitors, the Earthwatch volunteers, and the Field Directors. In past seasons, tourists were also allowed to visit the project. However, the main purpose of having the visitors is to educate the public about the need for conservation. Because the numbers of visitors the project is able to accommodate (without disturbing the turtles and the data collection) is limited, it is most important to target those individuals most likely to have an impact on the turtle population. Therefore, current (and recommended) practice is to limit access to local visitors except in special circumstances, with priority given to school and youth groups and teacher groups. If off-island visitors are accommodated, they should be limited to youth and school groups that make arrangements before arriving in St. Croix.

An Education Coordinator is responsible for recruiting, scheduling, and chaperoning visitor groups. The Education Coordinator gives each group a presentation on the history of the project, the biology and behavior of leatherbacks, and the rules for conduct on the beach and around a turtle. When with a turtle, visitors are encouraged to ask questions, and limited participation such as helping to measure a turtle or determine nest locations increases understanding and interest.

It is important that visitor groups not interfere with data collection or training of volunteers. Therefore, visitor groups must not be scheduled during training nights, typically, the first and second nights of a new team of volunteers.

5.9.2. In schools

Presentations in schools are an effective way to reach students that cannot visit the project at night. Teachers on St. Croix are very amenable to researchers giving presentations on sea turtles, and will cooperate with assignments and other activities to reinforce the presentation. This should be a regular practice during leatherback nesting season. Ideally, there should be an Education Coordinator separate from the Leatherback Project Field Directors that can make contacts and give presentations, and this person should also arrange nighttime visits to the project and supervise visitors.

5.9.3. Earth Day

Earth Day is another good opportunity to reach people that cannot visit the Leatherback Project. Hundreds of local visitors typically gather in Frederiksted for the annual event, with school groups making up the majority of these visitors. A representative from the Leatherback Project has presented slide shows at Earth Day for the past few years, and this could be expanded to include turtle-related activities for the students such as songs, plays, lectures by the students themselves, and arts and crafts projects. As with in-school presentations, the main goal should be to encourage the local people to feel possessive and protective about sea turtles, and give them a sense of pride about Sandy Point and its resources.

5.10. Research policies

Due to the relatively small numbers of sea turtles, Sandy Point should remain a research center for non-invasive research only. This includes research in which turtles and their eggs are not harmed or killed, or their movements on the beach restricted for longer than it takes to tag them. Flipper tags may be applied after the turtle completes egg-laying or, in the case of a dry run, just before she reenters the water. PIT tags should only be applied during egg-laying. Other equipment designed to remain on the turtle after the nesting season ends should not be used unless it has been proven to be non-detrimental. Techniques causing stress (indicated by a change in the animal's movements or behavior) or physical damage to the turtle should not be used.

5.11. Special use policies

"Special use" includes photography and filming. There are a number of requests each season from production companies to film and/or photograph leatherbacks. Projects range from televised nature shows to educational shows for children to book projects. Over the years, a large quantity of video footage has been collected on Sandy Point leatherbacks and the project. This is stored in a variety of formats, including broadcast quality in both U.S. and European formats. This footage is available for use by production companies, and is intended for that purpose. When requests are made, companies should be encouraged to use existing footage. Footage is stored at the USFWS office on St. Croix.

When this is impossible, film crews and photographers should be strictly supervised and must follow these guidelines:

- a. Do nothing to obstruct the turtle's progress on the beach
- b. Use low intensity lights whenever possible
- c. Do not shine lights or use a camera flash directly into the turtle's eyes
- d. No filming with lights or flash photography until egg laying is established
- e. If a turtle shows evidence of disturbance (such as a change in behavior), all lights must be extinguished
- f. The number of people around a turtle should be kept to the absolute minimum required to complete the project
- g. All film and photographic personnel are under the direct guidance of the Leatherback Project Field Directors, Project Coordinator, or the Sandy Point Refuge Manager at all times, and will follow their instructions exactly

In addition to these guidelines, a Special Use Permit must be obtained in advance from the Sandy Point Refuge Manager for any activity taking place on the Refuge. Copies of video footage should be provided to the USFWS for future use.

6. Future Priorities

6.1. Research

Future research priorities should focus on relocation sites and techniques, evaluating influences on hatch success, and on cooperation among those working on other leatherback nesting beaches in order to standardize techniques and improve communication about tag returns and remigrants. Priorities should also include increasing knowledge on the biology and population dynamics of this species such as age at maturity, fecundity, recruitment of new individuals, and mortality. Only with long-term saturation tagging can we begin to answer these questions. Because of its capability for saturation tagging, the Leatherback Project is in a unique position to provide this information, which very few projects are able to do due to the numbers of nesting turtles and the size of the nesting beaches. With its research and conservation priorities, the Leatherback Project addresses many of the tasks listed in the Recovery Plan for the Leatherback Turtle in the U.S. Caribbean, Atlantic, and Gulf of Mexico (NMFS and USFWS 1992).

If present trends continue and the population continues to expand to the extent that there are not enough funds available to continue the Leatherback Project as presently conducted, then beach patrols should be devoted primarily to recording activities and identifying (i.e., tagging) and measuring individuals, with nest relocation being conducted only on those nests absolutely certain to be doomed, and only if patrols can be continued during the relocation efforts. Saturation tagging should continue to be a priority.

6.1.1. Relocation

6.1.1.1. Relocation techniques

Aside from preventing poaching, relocation of nests has probably been the most important conservation measure taken by this project. However, the techniques need improving (see section 5.3.1.2. Relocation techniques). Techniques are needed for digging nest cavities that do not collapse during incubation or hatching. Although hatch success does not appear to be affected by beach location, disorientation of emerging hatchlings certainly is. Nests should only be relocated to areas where light disorientation has the least detrimental effect, between stakes #-7 and #15. Nests can also be relocated near the vegetation line between #31 and #35 until May 1.

To properly evaluate factors affecting hatch and emergence success, detailed analyses of sand moisture and composition should be made, and air temperature and rainfall should be taken into account for each season. In a preliminary analysis of hatch and emergence success taking only location into account, different years yield slightly different results. Furthermore, different techniques for digging relocated nests from year to year make direct comparisons between years very difficult if, as is likely, the shape of the relocated nests affects emergence success. A consistent protocol should be developed, with the same researchers digging all of the nests to be evaluated and compared.

6.1.1.2. Relocation locations

Relocated nests should be spread out on any given night, and a system developed to reduce the likelihood of digging into an existing nest. Especially if present trends in numbers of turtles continue, an easy reference system for keeping track of previously relocated nests will become increasingly important. As the traditional "relocation area" becomes increasingly crowded during high nesting years, it may be necessary to expand this area or explore other options for relocation areas. Also, during years with extremely high nesting like 1997, greater leeway can be taken with respect to relocation, with only those nests certain to be washed away being relocated. Marginal nests that stand a chance of surviving should be left *in situ*. This is important also to allow an opportunity for males to be produced.

6.1.1.3. Creation of hatcheries

This Plan recommends against the creation of hatcheries to incubate clutches for the following reasons:

- a. Relocated clutches have lower hatch success
- b. A hatchery would be extremely labor-intensive, requiring 24 hour supervision in order to protect eggs and hatchlings from predators, to protect new nests from poachers, to protect dawn-emerging hatchlings from the sun, and to release emerging hatchlings
- c. Political pressure to move all nests to the hatchery in order to make the beach available for recreation would likely increase

6.1.1.4. Creation of nursery areas

One manage option that has been discussed is expanding available relocation sites by clearing brush behind the stake line on the sandy side and possibly certain regions of the grassy side. Disadvantages to this are:

- a. The extremely dry sand conditions found in most seasons behind the stake line (i.e., in the vegetation zone) are not conducive to good hatch success
- b. It would place emerging hatchlings quite a distance from the sea, with increased danger of becoming entangled by surrounding vegetation

If numbers of nesting leatherbacks at Sandy Point continue to increase, so that additional relocation areas become necessary, it will be important to first thoroughly study conditions such as the effects of brush clearing on erosion patterns at Sandy Point; sand moisture, composition, and temperature at the potential sites; and ease of hatchling access to the sea. The area would have to be tilled to a depth of at least one meter to remove all roots. In any event, if this option is undertaken, a small experimental plot should be attempted before any large-scale clearing is done.

It should be emphasized that this should only be done as a last resort, if attempts to leave marginal nests *in situ* result in the majority of those nests being washed away.

6.1.2. Cooperation with other researchers

Leatherbacks nesting on St. Croix appear to be part of a larger regional population of turtles that nest on beaches on neighboring islands. Therefore, researchers from the Sandy Point Leatherback Project should establish regular communication with researchers on other beaches, in order to compare trends in numbers of turtles, poaching activity, hatch success, and other aspects. Given the extent of migration documented between beaches in Puerto Rico and St. Croix, management efforts in these regions should be coordinated under a single management plan, and research techniques standardized. This should include a standardized data sheet. The tagging database developed in conjunction with this Plan will help insure quick identification of original tag numbers and tagging locations. This will facilitate communication between researchers, allow more complete biological histories to be developed of individual turtles, and provide better understandings of interesting movements.

6.1.3. Surveys for green and hawksbill turtles

Surveys for green and hawksbill turtle activity should be conducted in the early morning at least every 3 days from August 1 - November 30. Night patrols should be conducted every few days, primarily to deter poachers. As these species are able to nest outside the boundaries of the Leatherback Project study area, patrols should be conducted along the entire beach area within the SPNWR boundaries.

6.2. Sources of Support

6.2.1. Funding

Although Earthwatch has been a valuable source of support for the project, since 1995 the number of participants (and hence the amount of funding provided by Earthwatch) has been lower than previous years. In fact, contract commitments to Cottages by the Sea have barely been met. For 1997, Earthwatch reduced the project's budget from over \$50,000 to \$45,000. Rental of Cottages must be arranged before the season starts, and payment must be made whether or not the teams fill. If current trends continue, the project may not be able to depend on Earthwatch for funding support. Other options for housing may also have to be explored. The USFWS should consider the construction of barracks-type housing on the Refuge for Leatherback Project staff and volunteers.

6.2.2. Personnel

The project has evolved from a staff of two Field Directors and one Project Coordinator to additional staff including assistant team leaders and an Education Coordinator. If Earthwatch volunteer numbers continue to decline while turtle numbers increase, more staff will be needed to collect essential nesting data. This is especially important given the trends in numbers of turtles. In 1997, there were many more individual leatherbacks nesting than in any previous season (119 females). It may be necessary to hire a team of researchers to work all or most of the nesting season along with the Earthwatch volunteers. This would reduce the number of Earthwatch volunteers needed, thereby reducing the project's financial commitment to Cottages by the Sea for housing.

6.3. Public Education

6.3.1. Visitor center

There are often more people interested in visiting the Leatherback Project than can be accommodated. Other people are interested in the leatherbacks, but are unable or unwilling to travel to Sandy Point because of the late hours, the bad roads, the distance, or because of the Refuge's reputation for being a high-crime area. The ideal solution for being able to provide access to the leatherbacks would be a Visitor Center with posters, slide and video presentations, models of adult and hatchling sea turtles, and perhaps a gift shop with proceeds to benefit the project. Possible sites are currently being explored, and should be aggressively pursued. This would be an excellent way to cater to the increasing demands of tourism, and to involve larger numbers of local residents, without disturbing the turtles at Sandy Point. It would raise awareness of the project and the need to protect turtles, as well as possibly bring new revenue to the community.

7. Summary List of Priorities

The following priorities are considered critical to insure continued success of Sandy Point as a sea turtle nesting beach. Numbers 1 -6 address tasks listed as Priority 1 in the Recovery Plan for the Leatherback Turtle in the U.S. Caribbean, Atlantic, and Gulf of Mexico (NMFS and USFWS 1992):

1. Continue the Leatherback Turtle Research and Conservation Project
2. Continue the presence of a USFWS Refuge Manager
3. Allocate USFWS funds to hire a Ranger to assist the Refuge Manager
4. Prohibit development on the SPNWR
5. Strictly limit or prohibit development adjacent to the Refuge
6. Conduct early morning surveys for green and hawksbill nests, with sporadic nightly patrols to check for poachers, from August 1 - November 30

The following are considered desirable to enhance the success of Sandy Point as a sea turtle nesting beach. They all address tasks listed as Priority 2 in the Recovery Plan for the Leatherback Turtle in the U.S. Caribbean, Atlantic, and Gulf of Mexico (NMFS and USFWS 1992):

1. Reduce predation both on the beach and in the sea
2. Establish a Visitor Center in Frederiksted, with slide presentations and information leaflets
3. Continue to combat light pollution at its sources
4. Purchase of the remainder of the West End salt pond by the USFWS
5. Allocate USFWS funds to hire two seasonal field technicians

Scientific research priorities include:

1. Define the limits of the regional population and model mortality, recruitment, and population trends
2. Optimize relocation / incubation techniques
3. Evaluate hatchling disorientation
4. Determine the effects of sand compaction (e.g., foot traffic, beach usage) on hatch and emergence success
5. Determine regional stock dynamics
6. Evaluate factors affecting hatchling sex ratios

Management research priorities include:

1. Determine extent of fish predation on hatchlings
2. Determine "safe visitor use" areas that will not impact turtles
3. Measure sand erosion and redeposition

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APPENDIX I

i. original tag #: _____ ii. page: _____

1997 ST. CROIX LEATHERBACK PROJECT

1. Date: _____
2. Time encountered: _____ 3. Activity: _____
4. Old tags: (LR): _____ (RR): _____
(LF): _____ (RF): _____
5. New tags: _____
6. Old PIT tag: (LF): _____ (RF): _____
7. New PIT tag: _____
8. Removed (or destroyed) tags: _____
9. Untagged turtles only! Tagged before? Yes _____ No _____
10. Departure time (time turtle reaches water): _____
11. Result (circle one): Lay Dry run Reason: _____
12. Carapace measurements:
length (notch-tip): _____ width (max): _____
13. Number of unsuccessful nest cavities: _____
14. Yolked eggs laid: _____ Yolked eggs reburied: _____
Yolkless eggs laid: _____ Yolkless eggs reburied: _____
15. Relocated nest depth: _____ cm Width: _____ cm
Overburden: _____ cm
Shape: _____
16. Nest location: original: _____
relocated: _____
17. Site selection parameters (original nests only):
HWM to nest: _____
Nest to vegetation: _____
18. Relocation: Time laid: _____ Time removed: _____
Time relocated: _____

19. Turtle observations:

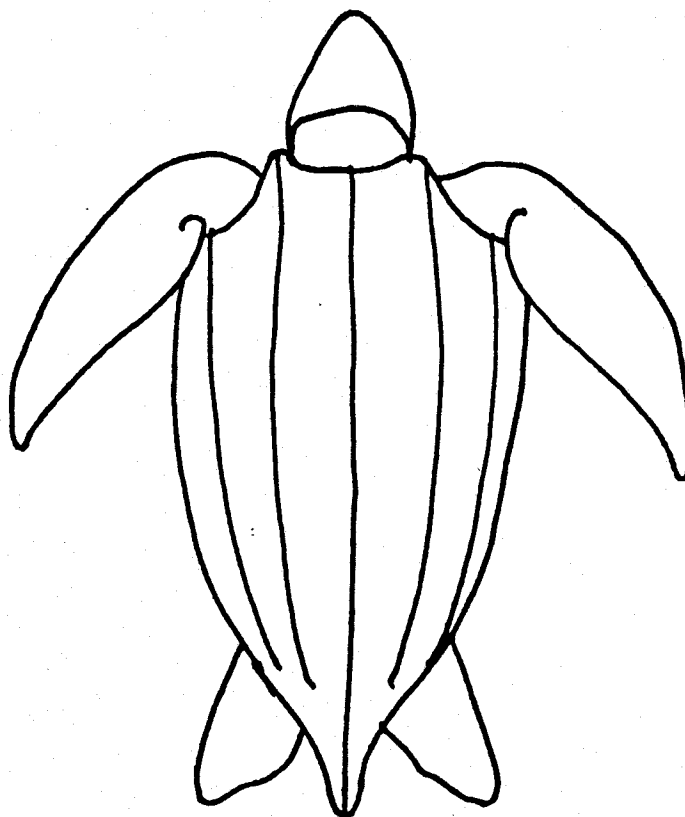
Photography: _____

Ectobiota: _____

Blood sample taken? _____

Notes on
behavior: _____

20. Diagnostic markings:



21. Beach profile:

22. Notes on nest and crawl: _____

23. Observers: _____

1997 Hatching Data

24. Female original tag no. _____ Date laid _____

Nest type: In Situ Relocated Location _____

25. Weather at emergence:

Sky _____ Precipitation _____

26. Nest results:

Date emerged _____ Incubation _____ days

Time emerged _____ Date cleaned _____

Hatchlings released _____ Emergence success _____ %

27. Nest contents:

Live hatchlings _____ Dead hatchlings _____

Hatched deformed _____ Unhatched deformed _____

No embryo: Spotted/white _____

Cream _____

Unknown _____

Embryo: Unpigmented _____

Pigmented eye _____

Pigmented body _____

Fullterm pipped _____

Fullterm unpipped _____

Hatched shells _____

Yolkless eggs _____

28. Predation: eggs _____ hatchlings _____

29. Hatchling weights (g):

30. Notes and observations:

30. Original nest at emergence: HWM to vegetation _____

APPENDIX II

Refuge Regulations

- Open Saturdays and Sundays ONLY
10:00 AM to 4:00 PM
Closed Monday through Friday
 - All vehicles restricted to access road and parking area
 - Horses prohibited
 - No fires, tents or camping
 - All plants and animals are strictly protected
 - Violators are subject to fines or arrest
 - LEAVE NO VALUABLES in your vehicle
-

Refuge Beach Regulations

- Open Saturdays and Sundays ONLY
10:00 AM to 4:00 PM
Closed Monday through Friday
 - All vehicles and horses are prohibited
Boats are prohibited from landing on refuge beaches
 - Objects such as umbrellas, poles and stakes must be modified so they do not penetrate the sand
 - No fires
 - Beach areas may be seasonally closed,
do not enter areas posted as closed
 - Violators are subject to fines or arrest
-

Green Cay National Wildlife Refuge

Closed to the public, DO NOT ENTER

For more info call 809-773-4554

Sandy Point

National Wildlife Refuge