Tagging and Nesting Research on Hawksbill Turtles (*Eretmochelys imbricata*) at Jumby Bay, Long Island, Antigua, West Indies

2003 ANNUAL REPORT

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Jumby Bay Island Company, Ltd.

By

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Wider Caribbean Sea Turtle Conservation Network (WIDECAST)

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ABSTRACT

Research continued on the reproductive biology and population ecology of the critically endangered hawksbill sea turtle, *Eretmochelys imbricata*, for the seventeenth consecutive season at the Jumby Bay nesting site on Long Island, Antigua, West Indies. Since 1987, consistent hourly patrols (with saturation tagging of all nesting females) have been maintained for 154 consecutive nights during the nesting season, yielding a comprehensive database of information on the Pasture Bay population, as well as on each individual female. 2003 Field Directors Allison Parrish-Ballentine, Keri Goodman, and Ian McIntoch, were responsible for conducting the research and for completing more than 1,300 hours of beach patrols.

The 2003 season began the evening of June 15th and ended the morning of November 16th, consistent with past seasons. Forty-nine nesting hawksbills were observed and tagged during the patrol season, the second highest number of individuals documented in a single season (the record season being 2002, with a total of 50 individuals). Twenty-nine of the 49 turtles were remigrants. Remigration intervals (elapsed time since previous appearance) ranged from 1-8 years, with an average remigration interval of 3.3 years. With the addition of 21 neophytes in 2003, a total of 222 hawksbills have been tagged on Jumby Bay since the project's inception in 1987.

The number of clutches per female ranged from 1-6, with an average of 4.08 clutches per turtle. Activity levels increased during the months of August and September, with the peak productivity week being August 24–30, resulting in 16 nests. Nesting activity was highest from August 24 to September 30, approximating a peak in the nesting season with 16 nests deposited during these seven days. A total of 188 nests were deposited on Long Island during the patrol season. The estimated average of number of eggs per clutch was 143, for an estimated total of 26,884 (188 x 143) eggs deposited on Long Island during the 2003 season. Of the 102 nests analyzed, mean overall hatch success was 72.6%.

The Jumby Bay Hawksbill Project is an initiative of the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), a region-wide scientific network and Partner Organization to the United Nations Caribbean Environment Programme. WIDECAST embraces the largest network of sea turtle research and conservation projects in the world, providing a unique framework that enables Caribbean nations to collaborate in the collection, sharing and use of research and management information. The Jumby Bay Hawksbill Project has been privately funded since its inception by the homeowners on the island, who have shown deep and abiding concern for these gentle reptiles.

2003 Annual Report:
Jumby Bay Hawksbill Project

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I. INTRODUCTION

Turtles, according to the fossil record, first appeared on land more than 200 million years ago during the Triassic period. The oldest sea turtle fossil is *Santanachelys*, dating back some 112 million years ago during the Cretaceous period. Turtles continued to evolve through the rise and fall of the Age of Dinosaurs and the emergence of mammals. Unfortunately, due to only the recent interactions with a single species of mammal, the primate *Homo sapiens*, turtle populations across the globe are collapsing. All seven species of sea turtles are currently listed as “Endangered” or “Critically Endangered” by the World Conservation Union (IUCN 2003).

Many Caribbean nations, including Antigua and Barbuda, still allow harvesting of hawksbills and other sea turtles for domestic use during part of the year, despite their depleted status. Amendments to national legislation are necessary in order to protect locally occurring sea turtle species, at least in their breeding stages. WIDECAST has made similar recommendations to the Division of Fisheries (Government of Antigua and Barbuda), most recently in September 2002. Effective protection of these migrating species requires international protection policies, and these policies need to begin at the local level. Success in restoring native sea turtle populations will require a commitment to public awareness programs, population monitoring, habitat protection, and law enforcement.

Though perseverance in protecting the Critically Endangered hawksbill, *Eretmochelys imbricata*, continues on Pasture Beach, Long Island, long term protection of this and other sea turtle species around the world is still in many ways in its infancy. To see trends in the life history of long-lived species, such as sea turtles, field studies must span over several decades and maintain the same level of data collection each year. After 17 years and over 20,000 hours of regular patrolling Pasture Bay Beach, important demographic trends are only now starting to become apparent.

The ongoing study of hawksbills at this ideal location for 17 consecutive seasons has unlocked numerous prospective directions for future research. The foundational work of nocturnal patrol and tagging, however, will remain the cornerstone of the project’s contribution to global science. “An understanding of reproduction and nest biology is essential for recovery and management of sea turtle stocks. Without this knowledge, well intentioned but ignorant conservation efforts can be detrimental to sea turtles” (Richardson 1999).

The importance of our demographic research on this regionally and globally important population of hawksbills is reflected in advances made in understanding hawksbill life history characteristics, including adult female recruitment and survivorship, annual lifetime fecundity, and other reproductive behavioral patterns. This information is not only critical to management decisions in Antigua and Barbuda, but offers a foundation for management and policy decisions made throughout the region. The project is also examining nesting habitat preferences with the intent of applying this understanding to beach restoration initiatives. Public outreach is an equally important component, and Field Directors regularly lead educational turtle watches for residents and tourists, as well as visit Antiguan schools.

While planning for future research ventures, which hold great potential, the project has sought to maintain and expand on this foundation of nesting dynamics. This expansion has occurred both with developing conservation methods on the part of our seasonal teams, as well as with the addition of guest researchers. The Jumby Bay site provides a wealth of opportunity for researchers at all levels to mine the dataset in pursuit of knowledge. This season, for example, we were fortunate to host Dr. Fiona Glen from the University of Toronto and the newly formed RoSTI research team from Dominica, West Indies. These exchanges create new knowledge, as well as emphasize the project's role as a mentor for fledging projects elsewhere in the region.

This Annual Report includes a list of recommendations for project improvement and a summary of the information collected during the 2003 field season.

II. STUDY SITE

The study site, Pasture Bay Beach, is on a small island, known as Long Island, located 2.5 km off the northern cost of Antigua, West Indies (see Appendix I). Long Island is privately owned and the site of the Jumby Bay Resort, as well as some 20 residential estates. As a windward-facing beach, Pasture Bay collects sand through natural processes. It was historically covered with thick mangrove forest and coastal shrubs, making it a prime nesting site for hawksbill turtles, a species that prefers to lay its eggs in the shelter of beach vegetation. The native population of hawksbills has probably been visiting the Pasture Bay nesting ground for centuries. Since the island was privatized over three decades ago, the Pasture Bay nesting ground has been inaccessible to mainland turtle hunters, largely accounting for the survival of this small, remnant population (while mainland populations have declined).

Pasture Bay Beach is divided into 32 beach sectors by numbered stakes placed along the vegetation line at 10-15 meter intervals to help in describing nest locations. The beach can also be divided into three vegetation zones that differ in nesting habitat quality.

- The northeast facing-section (stakes 22-31, and sector 31+) is relatively narrow, with mixed shrubs and sparse mangrove. There are no man made structures on this portion of the beach apart from a road that runs parallel with the coastline on the backside of the vegetation.

- The middle, north-facing section (stakes 8-21) is characterized by wide open sand expanses. Much of the native vegetation has been cleared, and the current vegetation line is set 30-40 meters back from the surf. A marsh lies behind the beach in this section and is separated by a thin vegetation line, except at the road entrance where there is no segregation between beach and swamp. In a proactive measure to encourage nesting in this zone, several islands of vegetation have been cultivated by islands landscapers and turtle project staff. These vegetation islands when measured at the end of the 2003 season, consisted of mostly shrubs approximately 1 meter in height.

- The northwest facing third (stakes 7-1, and sector -1) includes three private homes. The beach is narrow with a thin row of vegetation adjoining lawn areas. Prominent limestone shelves exist at the shoreline between stakes 1 and 2. Beyond stake 1 is an additional section of beach approximately 40 meters long. Sand has been added here, creating new nesting habitat which is now referred to as sector -1.

Pasture Bay beach has been the main focus of our sea turtle study for nearly two decades. However, recent seasons have experienced noteworthy activity on two other autonomous beaches close to Pasture Bay: Pond Bay Beach, behind privately owned villas, and Carisbrooke, a man-made beach on private property. In addition, several crawls and a nest hatching were reported to have occurred on Hawksbill Cove, a newly constructed beach this season. We predict that secondary beaches will play an increasingly important role in data collection in the future as more Pasture Bay turtles select them for nesting, and as more pocket beaches are constructed with new private homes (see Management Recommendations).

III. METHODS

Study Area Coverage

To achieve the project's scientific goals, Pasture Bay is patrolled from dawn to dusk for 154 nights during each nesting season (15 June through 16 November). As in past seasons, the beach is patrolled hourly, on foot, to ensure that all nesting turtles are observed and identified. The project represents a survey in excess of 20,000 hours of intensive beach coverage unique among nesting hawksbill studies, and Jumby Bay is known internationally both for the intensity and longevity of its survey.

Patrol protocols follow standard guidelines, set by both previous project staff and following international norms (cf. Eckert et al., 1999). Previous observations indicate that the hawksbill nesting process usually takes 1.5 hours to complete, thus we can be assured that every nester is observed by patrolling hourly. Each nesting female is identified by a tag number; her nesting activity is monitored and recorded throughout the season. Individuals identified as "quick nesters" are noted in the database, and the beach patrolled at shorter intervals when they are due for egg-laying.

During the 2003 season, Pond Bay Beach and Carisbrooke were checked once at the end of each night around 0530. Hawksbill Cove was checked less frequently due to the infrequent activity. Logistically the team could not fully cover these beaches and complete the hourly patrols on Pasture Bay Beach. There were also certain times when the researchers are restricted from patrolling. Therefore, most nesting events (at these sites) were not observed and the identity of any nesting female remained unknown. The result is a series of "holes" in the crawl chart, where individual turtles were not seen on Pasture Bay Beach for a mid-season nest.

From data available we could infer that turtles with "holes" in their nesting record had deposited eggs on one of these new beach sites when a gap in their nesting chart coincided exactly with an unidentified nest deposited at one of the new beach sites. Females with a penchant for nesting at multiple sites were identified, and the frequency of patrols on satellite beaches was increased when they were expected to return. Our efforts proved successful in some instances and unsuccessful in others. To maintain the credibility of the Jumby Bay dataset in international conservation efforts, creative solutions to dealing with greater dispersal in the distribution of nesting activity will need to be defined (see Management Recommendations).

Data Collection

Data collection procedures were followed in accordance with the methodology of previous seasons. Turtles were processed (tagging, measuring, photographs, etc.) only while egg-laying and were generally not interrupted while approaching, searching, digging, or concealing. The Jumby Bay population of turtles is relatively skittish and every effort is therefore taken to ensure that the nesting process remains as natural as possible. In only a few, isolated cases were turtles handled or approached outside of the egg-laying stage to check the identity of a "fast-nester" (a female found already covering or concealing) or when a turtle needed to be redirected for safety reasons. Similarly, eggs were left *in situ* whenever possible, and hatchlings were allowed to emerge and disperse to the water in a natural manner without intervention.

The Master Tag List, a tag history reference tool, aided field data collection. This list contains the status of every tag ever issued to the project. Every nesting turtle observed on Long Island since the project's inception can be cross-referenced by any of the tags she has ever carried and/or supracaudal drill pattern (see Drilling). Neophytes are defined as nesting turtles never before seen on Jumby Bay; they are considered new individuals to the nesting population. Their assigned tags and drill pattern are added to the Master Tag List.

The availability of the Master Tag List ensures that remigrant turtles are not misidentified and that neophytes are recognized as genuine first-time nesters on Pasture Bay Beach.

For every crawl encountered, an individual crawl sheet was completed (see Appendix II). Crawl location was recorded, along with an exact time or estimated time in cases when the action was not witnessed and only tracks were seen. For nesting turtles, we also noted morphological and behavioral observations, nest location and habitat, and the time and behavior ("action") of the animal when first encountered. A hatchery record sheet was completed for each nest observed on Long Island that had the potential to hatch prior to season's end. Nests were excavated after natural emergence, and contents were categorized according to the guidelines on the back of the hatchery record sheet.

Methods used to collect data were as follows:

• Morphology: We recorded curved carapace length, also called an "over-the-curve" (o.c.) carapace measurement. Carapace length is defined as the distance from the nuchal notch, along the middle of the carapace, to the posterior tip of the longest supracaudal. When barnacles along the midline affected the accuracy of the measurements, this was noted. Curved carapace width was also recorded. Individuals were measured each time they were encountered. We examined each turtle for diagnostic markings, deformities and injuries; drew a barnacle pattern; and photographed the carapace (posterior, right and left sides).

• Tagging: We attached one Inconel tag (size 681, National Band & Tag Company) through the first most, proximal scale on the trailing edge of the front flipper of every untagged turtle. Untagged turtles were thoroughly investigation for previous tag scars to assure that the individual was a true (first time) neophyte and not another turtles returning without her tags. Each turtle was given a tag in both front flippers, and the lower tag number was assigned as the turtle's "original tag number" (her permanent research identity) in the Master Tag List. We retagged turtles that had lost one or both of their tags, careful not to pierce the tender scar tissue from previous tags. In some instances it was necessary to tag in the second most proximal pad. These instances were noted in the Mater Tag List.

We routinely applied tags shortly after the onset of egg-laying, following deposition of approximately 10 or more eggs, to ensure that the turtle was fully into her "nesting trance". In some instances the turtle flinched mildly and we continued tagging application. In rare instances the turtle flinched heavily and shifted from her centered position over the egg chamber. In these rare cases we felt that a second tag application could jeopardize the clutch and, therefore, we waited to apply the second tag during a subsequent nesting visit (hawksbills typically nest at 14-15 day intervals).

• Drilling: Using a battery powered hand drill, a unique pattern of holes is drilled through the inert posterior marginal edge of the supracaudal scutes of each turtle in the Jumby Bay population. Neophytes are given patterns selected from available patterns noted in the Master Tag List. The drill pattern is used as an additional identification method and can often be read without undue distraction to the turtle. Turtles can often be approached cautiously while in late stages to read the drill pattern by candling or shining a flash light up through the supracaudals. Early identification is an advantage when several turtles are active on the beach at once, and priority levels of data acquisition need to be assessed.

The drill holes are known to "migrate" to the distal edge of the supracaudals with carapace growth and wear from abrasion. The pattern of holes placed 12-15 mm or more from the posterior marginal edge of the supracaudals will remain readable for a minimum of 4-5 years (Richardson, Bell and Richardson 1999). When returning turtle (remigrants) exhibited a drill pattern closer than 12-15mm to the edge, a repeat pattern was re-drilled higher on the supracaudals to assure the pattern would be readable for her next nesting season. Sometimes it was necessary to "clean" holes throughout the season for easier visibility.

• False Crawls: This designation is used for turtles that crawl onto the beach and then return to the sea without laying eggs. We recorded the exact time of the encounter if the turtle was seen, or an estimated time (i.e., 2200 +/- 30 minutes) if the crawl occurred between patrols. When possible, we recorded the time of emergence and return to the sea when a false crawl was witnessed, along with notable behavioral data. We recorded the crawl location in respect to the two nearest numbered stakes (1-31) identifying the beach sector (1-2, 2-3, …30-31). We identified the emergence and departure points by drawing arrows on the map of Pasture Bay Beach located on the back of each crawl sheet.

False crawling turtles were checked for identification when the consequential disturbance to the turtle was assessed to be negligible. We identified a false crawl turtle by feeling for the diagnostic supracaudal drill pattern during moments when the turtle was inactive by shining a flash light up through the supracaudals. Most false crawls were never witnessed, and, therefore, these events were recorded # 9999 in place of a tag number on the data sheets.

• Nest Location: Nests were mapped using stake location, distance from the high water line (*HWL*), distance from the nearest vegetation edge (*VE*), and by triangulation to distinct natural landmarks. Flagging with the deposit date and turtle's identity was inserted into the nest cavity for identity confirmation upon excavation. Contrary to the experience of some previous years, poaching did not present a threat on Long Island during 2003; nevertheless, efforts to conceal the exact location of the nests were maintained. We used flagging labeled with the deposit date and original tag number as a point of the triangulation or directly over the nest site when the fagging would be relatively inconspicuous. This flagging proved especially valuable in "hot spots" where two or more nests coexisted several inches from each other.

• Egg Counts: An exact egg count (clutch size) was taken when nests had to be relocated. This count enabled us to measure our accuracy in estimating clutch size at the time of excavation when nest contents were analyzed following natural hatching and emergence. During the 2003 season, egg counts occurred infrequently due to the fact that the collection of other data (tag numbers, carapace lengths, etc.) took precedence over egg count information.

• Emergence and Excavation: Hawksbill nests typically have a 60-day incubation period between egg-laying and hatchling emergence. We monitored nests nightly for several days prior to the expected emergence date. Nests that showed no signs of activity at approximately 65 days were excavated carefully to determine their status. For those nests that successfully emerged, we recorded the location, date, estimated time of emergence, and number of hatchlings seen, if any. We assisted disoriented hatchlings (i.e., those attracted to artificial lighting) and those trapped in vegetation to reach the water's edge.

We noted conditions of the nest cavity such as roots, large rocks, or hard substrate, and recorded nest depth. Nest contents were categorized to estimate a hatching success rate; hatched shells were counted and unhatched eggs were opened to determine the stage of development. Stages were categorized using the criteria outlined on the back of the hatchery data sheet (see "Nest Contents Evaluation Sheet; Appendix III). We further delineated embryos into late, mid, and early term categories defined as followed: embryos larger than the placental sack were classified as late term embryos, embryos smaller than the placental sack with well-defined features were classified as mid term embryos, and very small embryos ("pinkies", less than 1 cm in length) with undistinguishable features were classified as early term. We also described all hatchling abnormalities. We added a separate category for live and dead “pipped”, those hatchlings that had begun to break through their shell but had not yet completely emerged. For live and dead pipped hatchlings, the shell and hatchling were counted together, as one unit.

We released any live hatchlings found in the nest; usually setting them at the vegetation line and letting them crawl to the water. When hatchlings were not yet ready to leave the nest (usually in the “live pipped” category), they were kept for a day or more before releasing them. We placed these animals in a container with moist sand taken from their nest, draped with a damp cloth. The container was stored in a warm, dark place to simulate the natural nest environment.

- Managed Hatching and Relocated Nests: When a nest was deposited perilously close to the high water mark, we collected the eggs upon deposition and reburied them in a safer area of the beach. We tried to select comparable habitat; for example, if the nest was deposited in open sand, we relocated the clutch to a safer area in open sand. In several instances nests were relocated because the chamber had not been dug large enough to hold the entire clutch and eggs were in danger of being crushed during the tamping process. We observed that these instances were isolated to neophytes. Clutch size was recorded, and nest depth and shape was recreated according to that of an average chamber (depth=50cm). If a nest site was determined to be prone to hatchling disorientation due to artificial lighting or another anthropogenic effect, such as close vicinity to a road, we constructed a barrier around the nest near the time of hatching. The hatchlings were collected in a container, counted and released in a safer area.

IV. RESULTS

Recruitment

Forty-nine adult hawksbill females were observed on Pasture Bay Beach during the 2003 nesting season, including 28 remigrants (previously tagged turtles) and 21 neophytes (previously untagged turtles) (Fig. 1) This is the second highest seasonal cohort value, next to the 2002 season record of 50 individuals.

Remigration

Of the 28 remigrants, one had a remigration interval (elapsed time since previous appearance) of eight years, five had an interval of five years, five had an interval of four years, six had an interval of three years, and 11 had an interval of two years (Fig. 2). The mean remigration interval for the 2003 remigrant cohort was 3.3.

Fig. 1 Total Nesting Females, Remigrants and Neophytes from 1987 to 2003 for Jumby Bay, Antigua

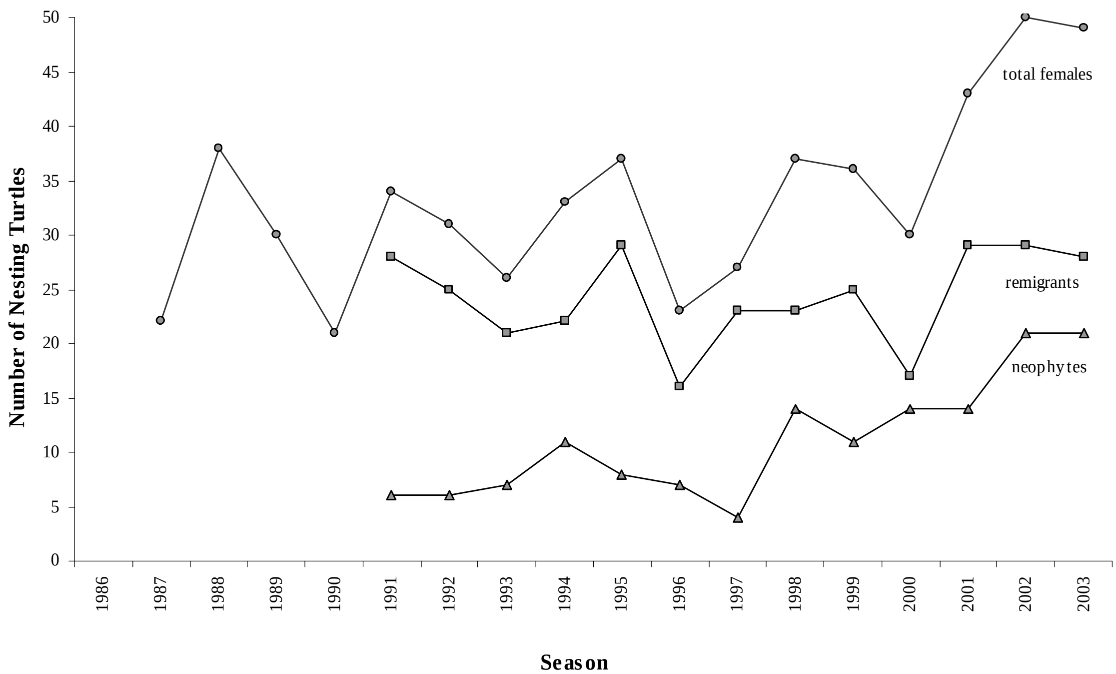
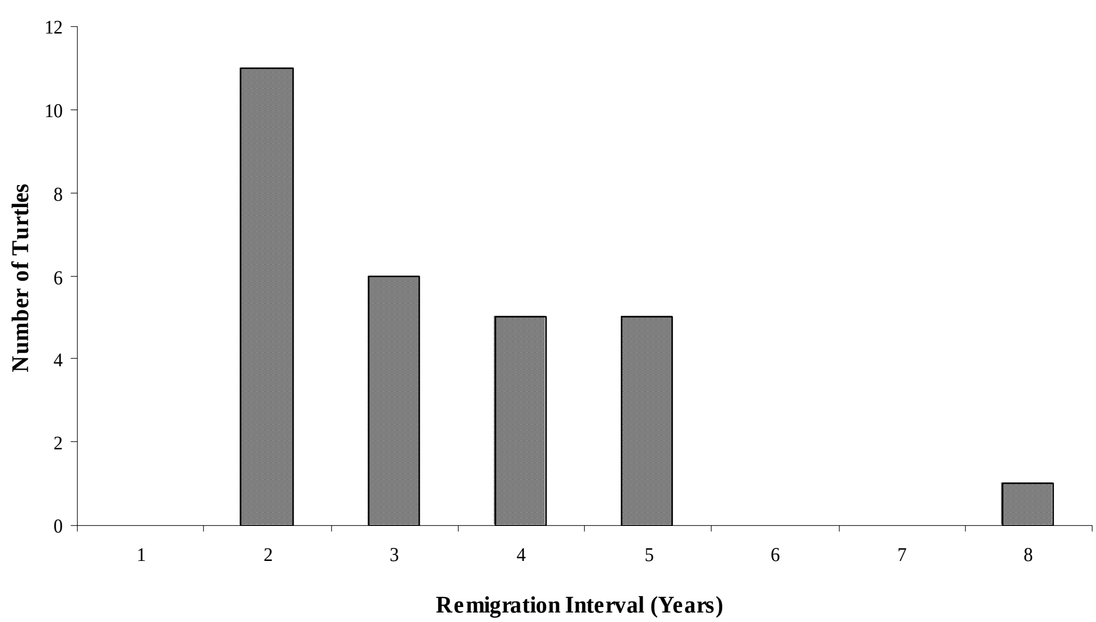


Fig. 2 Frequency Distribution of Remigration Itervals for the 2003 Jumby Bay Season



Fecundity-clutch size

Clutch size was estimated at the time of excavation (yolkless eggs were not included). Data from 111 nest excavations was used to estimate clutch size and emergence success. Clutch size ranged from 78 to 211, with an average size of 143 (Fig. 3). In order to check accuracy of estimations, egg counts were taken whenever possible at the time of deposition. Our estimated totals deviated +/- 12 eggs from actual counts.

Fecundity-clutch number

The number of documented nests per female ranged from 1-6, with a mode of 5 and an average of 3.69 for neophytes and 4.47 for remigrants (Fig. 4). To determine the frequency distribution of the number of clutches per turtle, we restricted our sample to individuals whose documented first visit occurred between July 3 and September 15. In this manner individuals that may have begun their nesting cycle before our season patrol began or finished their cycle after the season patrol ceased, were not included in fecundity analysis, thus reducing error.

Fig. 3 Frequency Distribution of Estimated Clutch Size (determined at time of nest excavation)

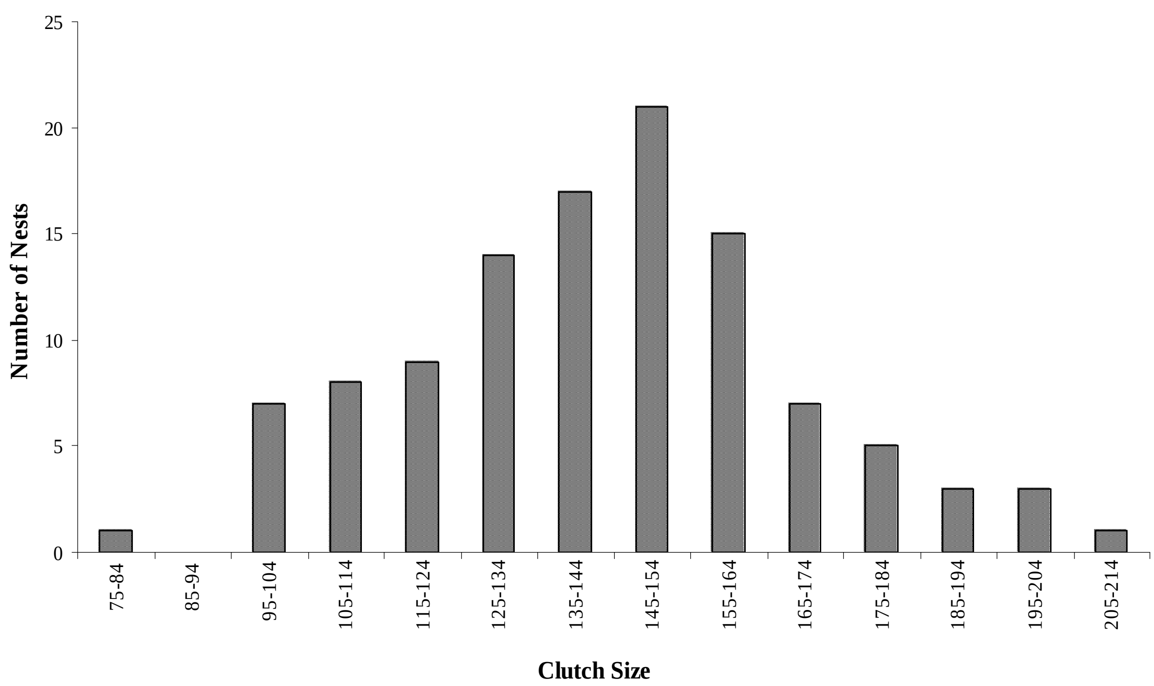
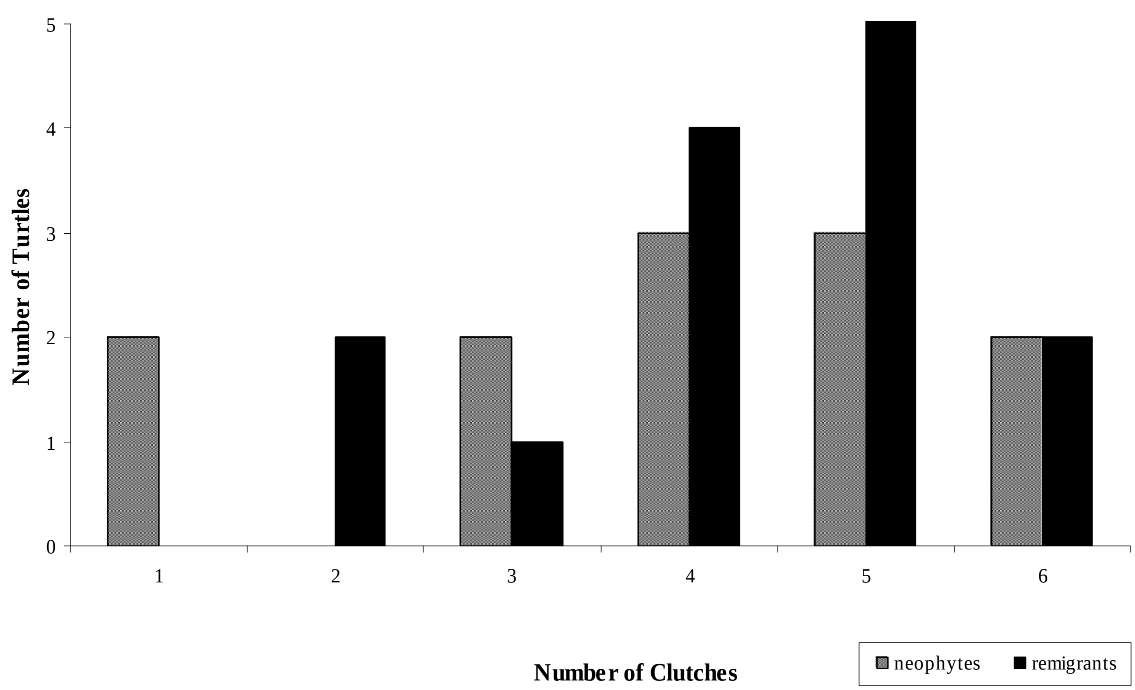


Fig. 4 Frequency Distribution of the Number of Predicted Clutches per Turtle for the 2003 Jumby Bay Season



Though the beach is patrolled hourly during the entire season, “holes” appear in the crawl chart where a turtle may have nested on another beach on Long Island or even visited a neighboring island. The number of predicted nests for each turtle was estimated after filling these gaps, and this number was used to determine the mean number of clutches for the 2003 season. Predicted nest numbers were derived by assuming that blanks in the crawl chart between two observed visits approximately 28 days (or two average nesting intervals) apart, or a false crawl that was not followed up by a documented nesting visit, indicated that the turtle had nested unobserved by the Field Directors. Using this method we were able to expand our sample size to include 31 individuals (12 neophytes and 19 remigrants).

Season Activity Levels

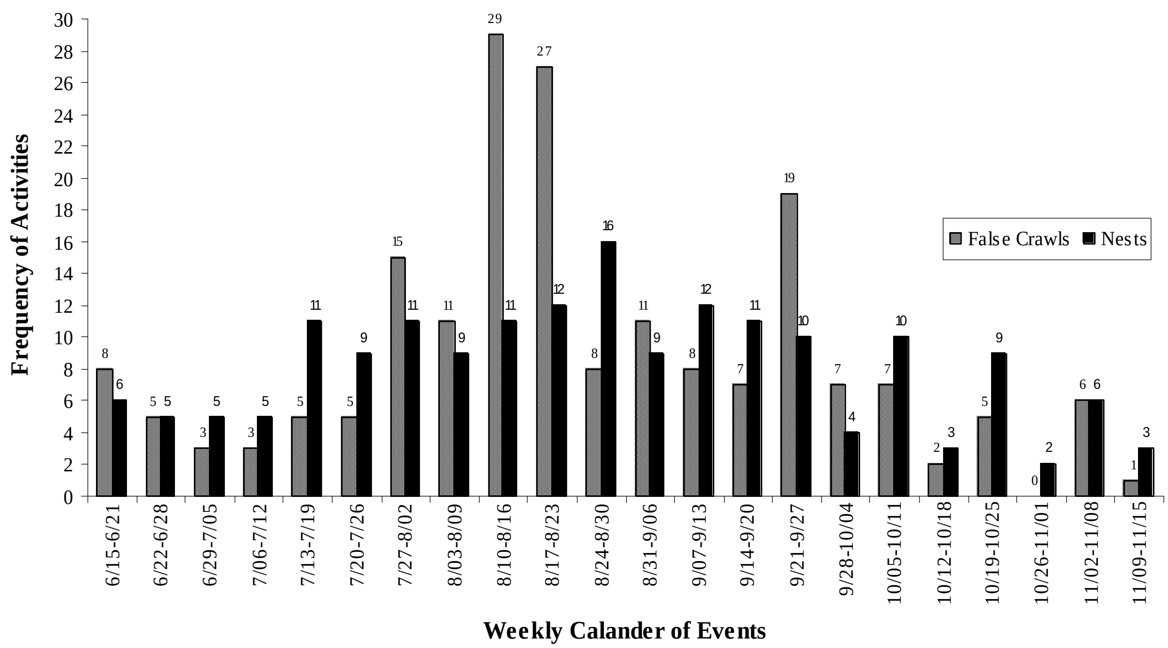
During nightly patrols from June 15 to November 16, a total of 432 activities were recorded on Long Island, including 244 false crawls and 188 nests (Fig. 5). Sixty-one additional activities were recorded during regular patrols, once each night, of Pond Bay Beach and Carisbrooke Beach. The first observed nest for the season was recorded on June 16; the last on November 12. Activity levels increased during the months of August and September, with peak productivity during the week of August 24–30, resulting in 16 nests.

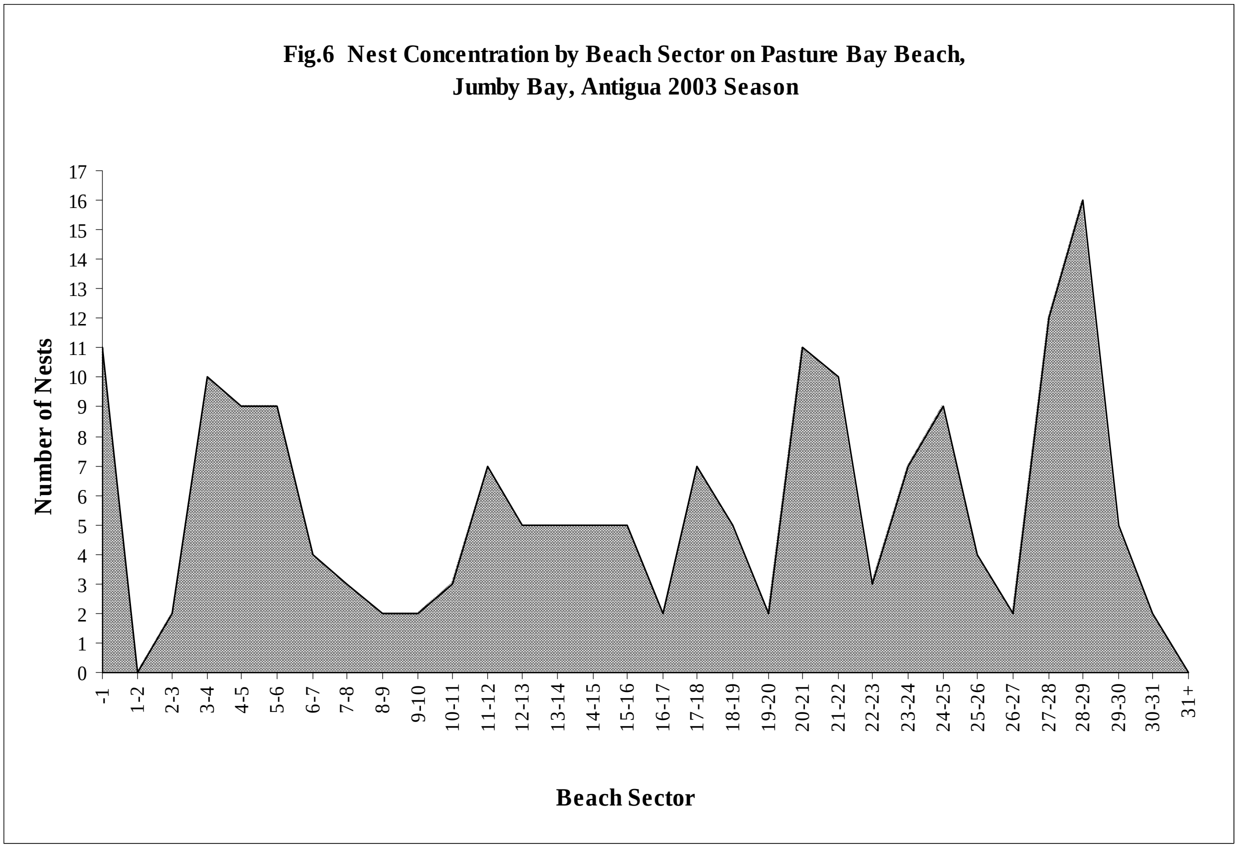
A total of 14 pre-season nests were first discovered upon emergence and recorded with hatchery record sheets labeled as such. Excavations were preformed on all but three of the pre-season nests when the source could not be located. This brings the total number of known hawksbill nests deposited on Long Island in 2003 to 202. Interestingly, this number is considerably higher than the prior 2002 season total of 167 known nests.

Nest Density by Beach Sector

Nest density by beach sector was determined for Pasture Bay Beach (Fig. 6). The highest concentration of nests occurred between stakes 28 and 29, as was also the case in 2002. This is one of the most densely vegetated and least developed sectors of the beach. A mangrove tree overhangs the water at this point and may act as an attraction to turtles searching along the surf for signs of vegetation. No nests were deposited between stakes 1 and 2. There is a prominent limestone shelf at the surf in this area that may inhibit turtles from coming ashore. The sand is also very thin in this area and quickly gives way to rocky soil, which usually prevents turtles from successfully digging a nest chamber.

Fig. 5 Total Number of Nests and False Crawls Made Each Week by Hawksbills on Pasture Bay Beach During the 2003 Nesting Season





Frequency of False Crawls verses Nests by Beach Sector

Of the 432 activities recorded on the whole of Long Island, 244 were false crawls (56.5%) and 188 were nests (43.5 %). When looking only at statistics for Pasture Bay Beach, we recorded 371 total activities, with 192 false crawls (52%) and 179 nests (48%). The percentage of false crawls verses nests was considerably different for the two peripheral beaches studied. Carisbrooke Beach had 37 false crawls (82.2%) and only 8 documented nests (17.8%). Likewise, Pond Bay Beach had 15 false crawls (93.8%) and only 1 documented nest (6.3%).

The area beyond stake 1, referred to as sector -1, is comprised of two private beaches where sand has been added to create new nesting habitat. This section of the beach had 11 nests (6.1% of the total 179 nests deposited on Pasture Bay Beach) and 27 false crawls (14.1% of the total 192 false crawls recorded on Pasture Bay Beach). Sector 28-29, described as one of the most densely vegetated and least developed sectors of the beach, had 16 nests and 4 false crawls. That is 8.9% of the total nests and only 2.0% of the total false crawls recorded on Pasture Bay Beach.

Please see the Discussion section on *Creating and Maintaining Suitable Nesting Habitat* for further comparison of beach sector habitat to nesting success.

Fig. 7 Frequency of Fasle Crawls vs Nests by Beach Sector on Jumby Bay, Antigua 2003 Season

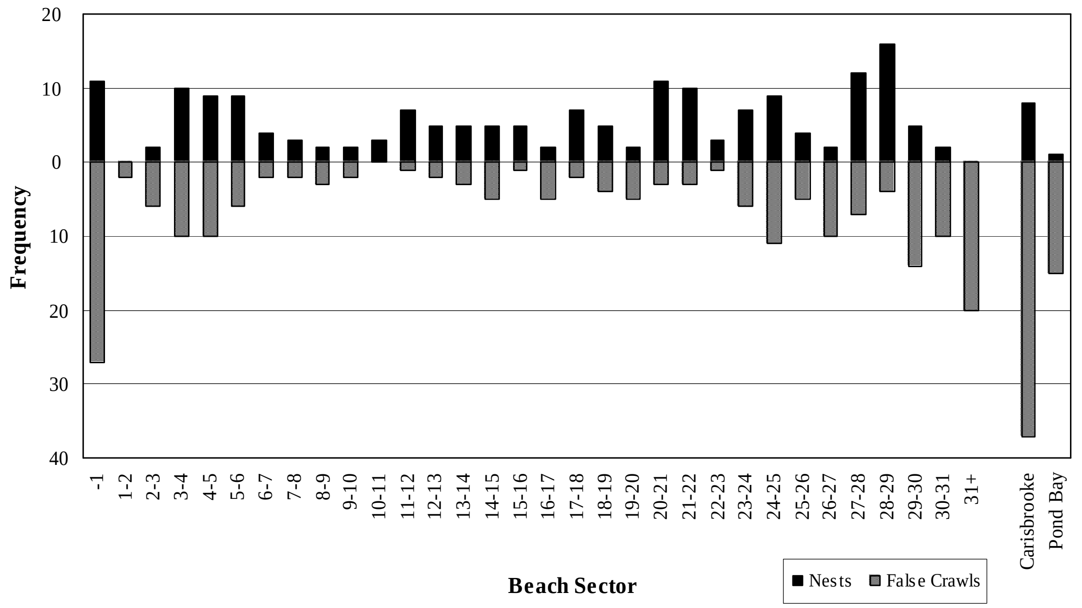
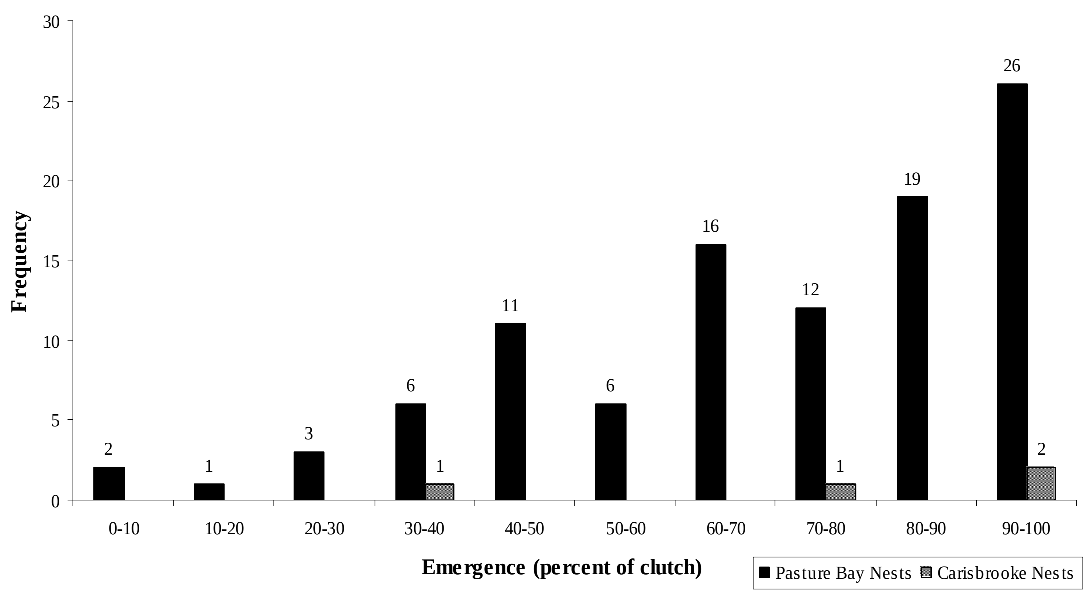


Fig. 8 Frequency Distributin of Estimated Emergence Success for Pasture Bay Beach and Carisbrooke Beach, Jumby Bay, Antigua 2003 Season



Emergence Success of Naturally Deposited Nests

The average production rate of hatchlings per nest (hatched shells minus live and dead hatchlings in nest chamber divided by the total number of yoked eggs) on Pasture Bay Beach was 72.6% for 102 nests sampled (Fig. 8). Success rates ranged from 0% to 97.7%. The average success rate for 4 nests sampled from Carisbrook Beach was virtually the same as that figured for Pasture Bay Beach.

Relocated Nests

A season total of three nests were relocated. All three of these nests were deposited on Carisbrooke Beach and were likely to be naturally destroyed due to a high water table and/or a shallow nest chamber. One of these nests was transferred at the time of egg-laying and two were and relocated to Pasture Bay Beach when they were found. The emergence success rates of two of relocated nests were 56.4% and 0.0%. The second nest with 0.0% hatchery success rate was discovered the next day after it was deposited and was most likely relocated too late, causing harm to the embryos by shifting the eggs. The third nest was due to hatch after the season ended. These nests were recorded as *managed hatching* and were not included in determining the frequency distribution of emergence success.

V. DISCUSSION

Public Awareness and Education

Public outreach is an essential component of the Jumby Bay Project. Only through long-term public support will sea turtle populations worldwide have a chance at survival and recovery. The 2003 research team maintained the project's dedication to increasing awareness through turtle watches and presentations.

In addition to visiting local schools, this year's team performed educational seminars for summer camps and after-school programs, such as the Girl Guides of Antigua. The team was able to reach approximately 265 local children during the span of the season through such activities. The team also constructed a PowerPoint presentation to educate local professional groups and was able to present this show to the Rotary Club of Antigua. Unfortunately, a number of additional planned presentations were cancelled due to government strikes and inclement weather.

The 2003 team, in keeping with past seasons, hosted "Turtle Watches" through the Environmental Awareness Group of Antigua, a member of the WIDECAST regional network. Gaining local support for sea turtles is imperative for sustaining conservation efforts at Pasture Bay, and these turtle watches function to provide an opportunity for Antiguans to learn about one of their native species of sea turtle. An EAG representative supervised groups of up to eight people on Friday nights from July 18 to October 31, from 7:00 PM to 1:00 AM. The project hosted a total of 86 EAG guests during this period.

The Jumby Bay Hawksbill Project is in a unique position to educate people at an international level, as well. In addition to local public outreach, the project reaches people from all over the world during their stay at the Jumby Bay Resort. Over the course of the 2003 nesting season, project Field Directors hosted approximately 190 resort guests, treating each of them to informative and memorable turtle encounters on the beach.

Sea and Learn Conference

This year's team was invited by Sea Saba, the Ecolodge Rendezvous and other participating members to the first annual Sea and Learn Conference held during the month of October in Saba, Netherlands. The month was engaged with lectures by esteemed scientific experts from around the world conducting research on different topics. Research support from ex-field director Peri Mason allowed our team to attend and give two seminars to local Sabans and international visitors, describing the present conservation effort and research project on Jumby Bay. A follow-up article entitled "Sea and Learn experts give lectures on turtles, forest" was published in St. Marrten's Daily Herald on Thursday October 23 (see Appendix IV).

Visitors

Thanks to the new and larger "Turtle House" provided for the project, the 2003 team was able to host several Guest Researchers. Sharing knowledge, skills, and data with other researchers and dispersing this information to the international community of sea turtle researchers is imperative to improving conservation efforts. The Jumby Bay Project offers an extensive, highly regarded dataset for other researchers to employ in the pursuit for greater knowledge of sea turtle biology. The Project also has amassed a profuse amount of knowledge in field research techniques in the 17 years that it has been running and has been used as a model project for new, developing projects. By functioning as part of the international society of sea turtle conservationists, we can further the knowledge of sea turtle biology and contribute to conservation efforts worldwide.

The 2003 team hosted guest researcher Dr. Fiona Glen from the University of Toronto from June through August, during which time she conducted a study on incubation temperatures for Pasture Bay Beach in regards to the influence of temperature on sea turtle embryonic sex determination. Temperature-dependent sex determination (TSD) in sea turtles produces females at higher temperature and males at lower temperatures. Dr. Glen used temperature probes in selected nests and control sites along the length of Pasture Bay to record nest chamber temperatures and beach temperatures. She aimed to predict sex ratio produced on Pasture Bay Beach by comparing incubation temperatures to the known "pivotal temperature" for hawksbills (29.32ªC).

Dr. Glen also attached time and depth reorders (TDRS) to four adult females to look at their behavior and diving physiology during their 14-day inter-nesting interval. Little is known about the behavior of adults while at sea during their internesting intervals. It is important to know where turtles are keeping offshore, in order to design and implement effective legislation. Dr. Glen is currently analyzing her data and her findings will be published and available to the international sea turtle research community, as well as to Jumby Bay homeowners and other supporters.

In October, we felt privileged to host four community-based researchers from RoSTI (Rosalie Sea Turtle Initiative), a newly formed WIDECAST project in Dominica. Four gentlemen, leaders in their community (one a Village Council Head), participated in four nights of patrolling at Pasture Bay Beach in order to learn hands-on research and conservation methods. This training session provided the RoSTI team with invaluable practical knowledge surrounding contemporary WIDECAST conservation efforts. As well, coming from a disappointing season with few turtle sightings due to previous years of mass poaching in Dominica, their experience here heightened morale among the men for sustaining their local efforts.

VI. ACKNOWLEDGEMENTS

Funding is provided by the Jumby Bay Homeowners Association through annual grants to WIDECAST, Inc. (Wider Caribbean Sea Turtle Conservation Network). The consistency in the availability of funding from the homeowners is reflected in the unique and remarkable quality of the dataset, making the Jumby Bay project a leading source of information on the nesting ecology of critically endangered Caribbean hawksbills sea turtles.

We would also like to thank the Jumby Bay Resort and the Jumby Bay Island Services Department for the many services they provide to the research team, from ferry transportation to the mainland to providing telephone and Internet access on the island. Our deepest gratitude also goes to the many resort and Island Services employees who have assisted the research team in so many ways over the years.

A special thanks to Security Guards Wendell and James, Chef Lawrence Wallace, and Mr. David Stubbs on behalf of turtles PPN047, WE373, and WE376 for their assistance in rescue operations. Without their heroic support it is likely that these three turtles would have perished or would have been more seriously injured during the 2003 season.

Many thanks to our volunteers: Mrs. Corina Sealy-Edwards for her support with educational outreach programs, Mr. Alan Shoal and Mr. Leopold Jarvis for their help hosting EAG turtle watches from the mainland, and Mr. Jepson Prince. Mr. Prince volunteered over 350 hours with the Project during the 2003 season and was invaluable in providing assistance with beach patrol, nest excavation, and public Turtle Watches. Without the enthusiasm and unwavering support of these volunteers, the 2003 research team would not have been so successful in public outreach and awareness, or with basic research tasks.

Our deepest gratitude, as well, to John and Sarah Fuller who provide a “home away from home” for the research team each year and a great deal of invaluable management assistance from Antigua.

Dr. James I. Richardson (Scientific Director for the Project) and Dr. Karen L. Eckert (Executive Director of WIDECAST) reviewed the manuscript and provided administrative assistance and advice during all phases of the project. The success of this project is due to the loyalty of the individuals mentioned above and the combined efforts of many others.

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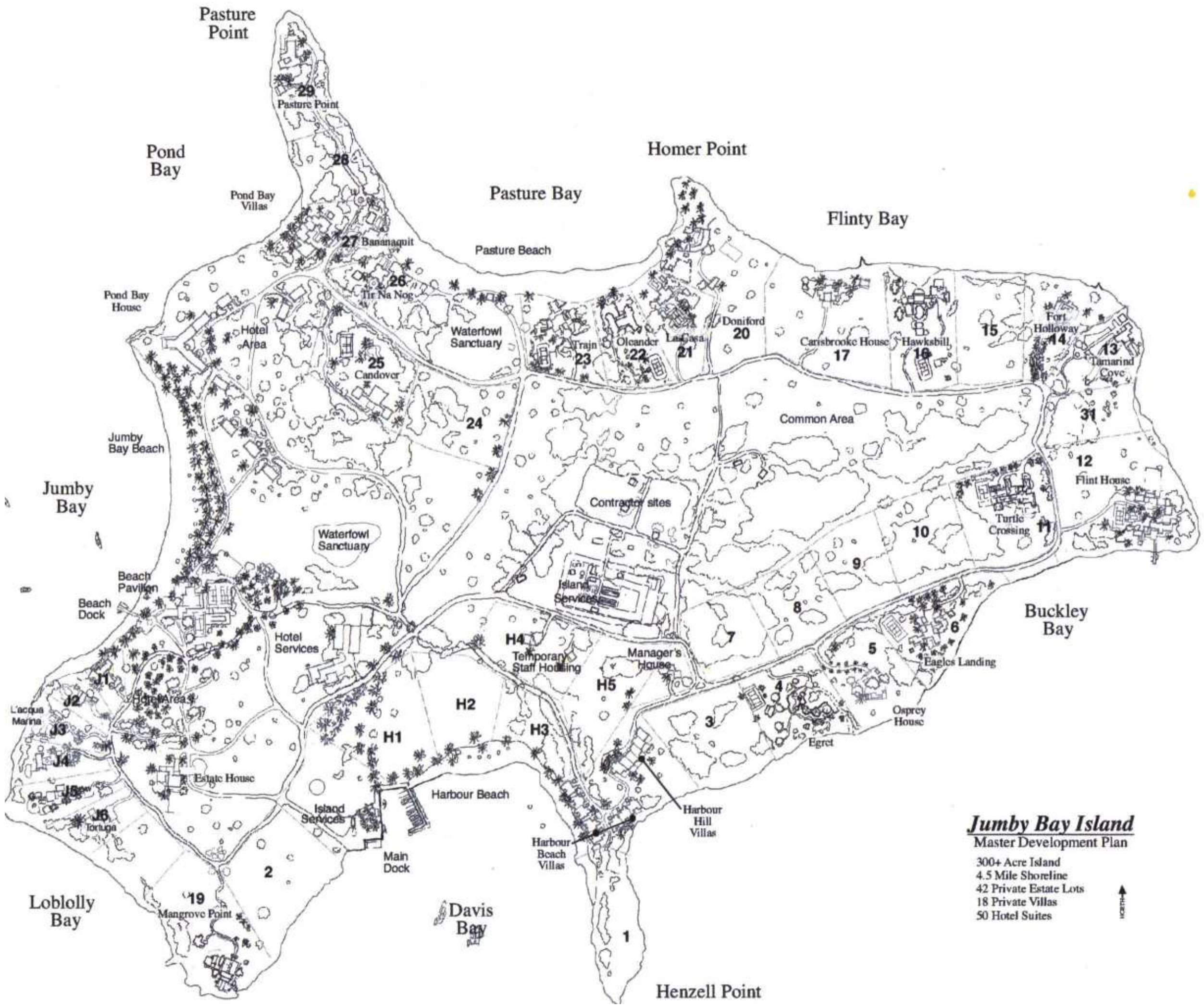
APPENDIX I



Map of Jumby Bay Island, and the Pasture Bay Beach study site.

APPENDIX II

APPENDIX III

APPENDIX IV

"Sea and Learn Experts give Lectures on Turtles"

Used with permission of Suzanne Nielsen and The Daily Herald, St. Maarten

(as corrected in December 2003, and posted to www.seasaba.com)

Saba -- Guest lecturers Keri Goodman and Ian McIntosh of Antigua's Jumby Bay Turtle Project spoke to a packed house at Swinging Doors Tuesday.

The lectures are being given in the framework of the month long Sea and Learn project in schools and other locations on the island.

Goodman and McIntosh, who are co-directors of the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) project at Jumby Bay -- a project sponsored by the island's homeowners -- said that all seven species of sea turtles are endangered. The two young scientists monitor the behaviours of nesting turtles and attach identification tags to them. Sea turtles of about 25 years always return to the place where they were born to deliver their eggs. So far this year, Goodman and McIntosh have observed 49 turtles in Antigua, 21 of which were new returns.

The animals are tagged and measured, the nests counted, locations noted and nesting behaviours observed. Turtles lay about 150 eggs per nest and nest 3-5 times a year. However, only about one in 1,000 eggs results in a mature turtle. Not much is known about the migration patterns of the babies, except they can travel up to 1,000 miles from their beach of origin.

As Saba has not beaches it does not provide a nesting environment, but Saba's National Marine Park is known by divers for its sea turtles, especially hawksbill and green turtles.

WIDECAST, a regional scientific network operating in partnership with UNEP, has national coordinators and projects throughout the Caribbean Region. The WIDECAST national coordinator in Saba is David Kooistra, Manager of the Saba Marine Park.