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

2005 ANNUAL REPORT

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By

Seth and Carol Stapleton

2005 Field Directors, Jumby Bay Hawksbill Project
Wider Caribbean Sea Turtle Conservation Network (WIDECAST)

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ABSTRACT

Hawksbill sea turtle (*Eretmochelys imbricata)* nesting research was conducted on Jumby Bay, Long Island, Antigua, West Indies, for the 19th consecutive year in 2005. Saturation tagging based on hourly patrols conducted for 154 consecutive nights remained the cornerstone of the project's research on reproductive biology and population ecology of the hawksbill. We also continued genetic sampling for haplotype analysis, incorporated new methodologies including GPS and quantification of habitat measures, and worked closely with the EAG to conduct and develop new outlets for community outreach.

Sixty-three (63) nesting hawksbills, including 23 neophytes, were observed and tagged on Long Island during the patrol season, exceeding by more than 20 percent the previous recorded high of individuals documented in a single year. A total of 195 nests were deposited on Pasture Bay Beach during the patrol season (15 June – 16 November 2005), and an additional 26 nests were documented on peripheral beaches. Activity levels peaked from July to early September, approximately 2 to 4 weeks earlier than in previous years. Turtles made use of nearly all sectors of Pasture Bay Beach and continued use of peripheral beaches such as Pond Bay. Remigration intervals ranged from 2 to 7 years, with an average remigration interval of 3.1 years. The number of observed clutches per female ranged from 1-6, with an average of 3.4 clutches per turtle and a mode of 4 clutches. Estimated average number of eggs per clutch was 142, and mean hatchling release success was 78.4%. We found no difference between neophytes and remigrants in curved carapace length or curved carapace width.

The hawksbill population on Long Island continues to show signs of long-term growth. Given the observed early peak in nesting activity and the abundance of nests deposited prior to June 15th, we suspect that some additional individuals may not have been documented and thus suggest that future teams begin the field research season prior to June 15th. Furthermore, hawksbill use of private peripheral beaches continued, and we recommend that access to these beaches continue to be granted when possible. With population growth we have also witnessed the selection of identical nesting sites by turtles more frequently, suggesting that nest sites are becoming more limiting and that peripheral beaches may become increasingly important to the nesting colony. Finally, public outreach remains an essential component of successful conservation efforts. We encourage future researchers to continue pursuing creative outlets for outreach programming.

2005 Annual Report:
Jumby Bay Hawksbill Project

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I. INTRODUCTION

Sea turtles fulfill an integral role in marine ecosystems, functioning as both predator and prey to a host of other marine species and contributing to the diversity and overall stability of marine ecosystems. In addition to intrinsic value, sea turtles maintain well-established cultural significance in the Caribbean and throughout the world. Despite an impressive fossil record that dates the earliest modern sea turtle ancestor *Santanachelys* to the Cretaceous period, most modern populations are declining. Sea turtle populations today face massive obstacles in regards to their survival worldwide, and all six Caribbean species are listed as either “Endangered” or “Critically Endangered” by the World Conservation Union (IUCN 2004).

Human activities, both legal and illegal, pose a major threat to sea turtles. Decades of over-harvest of large juveniles and adults, collection of eggs for human consumption, accidental deaths through fisheries by-catch, and the degradation and loss of suitable nesting habitat (e.g., beach development, erosion) are some of the major factors contributing to the current depleted status of global populations. In addition to centuries of harvest for its meat and eggs, the hawksbill (*Eretmochelys imbricata*) has been slaughtered for its carapace (shell), which has traditionally been used to make tortoiseshell jewelry and trinkets. In the Caribbean and across the world, overcoming such threats is complicated by the migratory nature of sea turtle species, inadequate management regimes, insufficient political commitment to coastal zone planning, lack of public awareness, and deeply rooted traditions surrounding the use of turtle parts for consumption and trade.

The Nation of Antigua and Barbuda, like many of its Caribbean neighbors, still permits the seasonal harvesting of hawksbills and other sea turtle species for domestic use. Effective protection of long-lived, migratory species requires the enforcement of international protection policies and a commitment to sea turtle management and conservation at the local level. Continued research (e.g., population monitoring), public awareness programs, habitat protection, and law enforcement are all vital components of a successful effort to restore native sea turtle populations.

Population monitoring and demographic research is most useful if it spans several generations and maintains consistency in data collection such that data can be used to assess life-history trends. In long-lived species such as sea turtles, generation length dictates that research encompasses several decades of work. For nearly two decades, the Jumby Bay Hawksbill Project (JBHP) has conducted research addressing demographics and nesting ecology of hawksbill turtles on Pasture Bay Beach, Long Island, Antigua. This study has led to important advances in understanding life-history characteristics including adult female recruitment and survivorship, annual and lifetime fecundity, and reproductive behavioral patterns. However, even with nearly two decades completed, biologists are just beginning to understand long-term population trends. Many questions remain and, as research progresses, additional questions arise. The resulting ecological information is critical to management decisions in Antigua and Barbuda and offers a foundation for management and policy decisions made throughout the region.

The current status of global sea turtle populations illustrates the necessity of long-term demographic and nesting ecology research. Therefore, the Jumby Bay Hawksbill Project continued its standardized protocol: saturation tagging based on nocturnal, hourly patrols, thereby permitting the tagging of all females nesting on Pasture Bay Beach. We continued genetic sampling for haplotype analysis and increased quantification of habitat measures to minimize the presence of observer bias (i.e., subjectivity) in the data. Recognizing public outreach as an essential component for successful conservation initiatives, the project hosted Jumby Bay residents and resort guests on the beach, led educational turtle watches for groups from mainland Antigua, developed new outlets for educational programming, and conducted presentations for school children.

This report includes a summary of the information collected during the 2005 field season as well as project and management recommendations.

II. STUDY SITE

Pasture Bay Beach is an approximately 450 m long beach located on the northern side of Long Island, a 120 ha privately owned island several kilometers off the northeast coast of Antigua, West Indies (see Appendix I). Long Island functions as the site of the Jumby Bay Resort and some 30 residential estates. Pasture Bay Beach lies on the windward side of the island, thus collecting sand through natural processes. Hawksbill turtles have probably been nesting at this site for centuries where, historically, thick maritime forest and coastal shrubs covered the beach. Since this species prefers to lay eggs adjacent to or under the shelter of vegetation, such an environment provided prime nesting ground for hawksbills. Although island development cleared much of the natural vegetation in years past, vegetation islands of scaevola and seagrape shrubs have been planted specifically to improve conditions for hawksbill nesting.

Numbered markers placed along the vegetation line at 10-15 meter intervals along Pasture Bay Beach divide the beach into 36 sectors. Characterization of the beach into three zones also helps to describe the study area.

The northeast-facing section (stakes 19 to 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 to 18) is characterized by wide expanses of sand. Portions of the natural vegetation have been cleared, but vegetation islands have been planted in recent years to supplement existing nesting habitat. A marsh lies behind the beach between stakes 8 and 14, separated by a thin line of vegetation.

The northwest facing sector (markers –1 to –5 and 0 to 7) represents a diverse area. The beach between stakes 2 and 7 narrows and contains palm trees and numerous sea grape and Scaevola bushes. Prominent limestone shelves exist at the shoreline between stakes

0 and 2. Markers –5 to 0 include three private residences, with primarily open, sandy beaches and thin rows of vegetation adjoining the properties.

Pasture Bay Beach has been the main focus for the duration of the project. However, nesting activity on nearby peripheral beaches continued this season as in recent years. Beaches upon which nesting activity was noted include westward facing Pond Bay Beach, lying behind privately owned villas, and private beaches lying east of Pasture Bay (i.e., beaches of Doniford House, Carisbrooke, Hawksbill Cove, and the property under construction lying to the east of Hawksbill Cove).

III. METHODS

Patrols

As in previous seasons, we patrolled Pasture Bay Beach hourly, on foot, from dusk to dawn for 154 consecutive nights during the designated nesting season (15 June through 16 November) to ensure that all turtles nesting on Pasture Bay Beach during this period were observed and identified. Previous observations indicate that the hawksbill nesting process typically occurs within a 1.5-hour time frame. Hourly patrols therefore ensure that every nesting turtle is observed. Patrol protocols follow standard guidelines set by previous project staff and adhere to international sea turtle research norms (see Eckert *et al.* 1999).

Pond Bay Beach was patrolled an average of 2-4 times nightly depending on anticipated activity levels, and the beach at Doniford was patrolled at sunrise. Hawksbill Cove was patrolled infrequently, but some activity was reported by the homeowners or the guests staying on the property.

Data Collection

Data collection procedures were followed in accordance with the methodology of previous seasons. We made every effort to ensure that all phases of the nesting process remained as natural as possible and typically processed turtles (e.g., tagged, measured, photographed) only during egg-laying. We left eggs in situ and allowed hatchlings to emerge and disperse to the water without intervention whenever possible.

In a few instances we handled turtles outside of the egg-laying stage. When necessary, individuals located during the covering or concealing phase of nesting were approached to collect data. We also redirected disoriented turtles and released those hindered by vegetation.

<u>Tagging</u>

We applied tags shortly after the onset of egg-laying, following deposition of 5 or more eggs to ensure that the turtle was fully in the nesting trance. In some instances the turtle flinched mildly, and we continued tag application.

We attached an Inconel tag (size 681, Caribbean Marine Turtle Tagging Centre) to the first most proximal scale on the trailing edge of each front flipper of every untagged turtle. We thoroughly investigated untagged turtles for tag scars and remnant drill patterns to differentiate between neophytes (first-time nesters) and remigrants (returning nesters) that had lost tags. When neophytes were tagged, we assigned one tag as the turtle's permanent identification number. Remigrants missing tags were identified using any remaining tags and / or the drill pattern and subsequently retagged. In some instances, we were compelled to tag individuals on the second most proximal pad because of tears or other abnormalities on the first pad. Finally, if old tags were not securely attached, we added an additional tag on the adjacent pad.

Drilling

Using a battery powered hand drill, we drilled a unique pattern of holes through the inert posterior marginal edge of the supracaudal scutes of all previously unmarked individuals. Drill patterns served as an additional identification method and frequently permitted identification of an individual outside of egg-laying without disrupting the turtle.

Drill holes "migrate" to the distal edge of the supracaudals as a result of carapace growth and wear. 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 *et al.* 1999). Therefore, we placed the holes as far anterior as possible while still remaining in inert tissue to maximize the life of the pattern. When remigrants exhibited a drill pattern closer than 10-15 mm to the edge, a repeat pattern was re-drilled higher on the supracaudals to ensure the pattern would be legible for as long as possible. Additionally, some patterns were cleaned or enlarged throughout the season to enhance visibility.

Morphology

We recorded curved (over the curve) carapace length and maximum curved carapace width for nesting individuals when possible. Carapace length is defined here as the distance from the nuchal notch along the middle of the carapace to the posterior tip of the longest supracaudal. We recorded and mapped barnacle positions, deformities, injuries, and unique markings (e.g., chips from carapace) and photographed individuals when conditions permitted. When possible, we removed any barnacles that lay along one of these measurement trajectories, obtaining both a pre- and post- removal measurement to assess the utility of barnacle removal.

Genetic Sampling

Using a razor knife sterilized with isopropyl alcohol, we cut a small piece of tissue (approximately 5 mm long) from a natural outcropping of skin on the turtle's rear flipper. Sampled individuals did not show a response to or awareness of the process. The sample was immediately placed in a tube of ethanol labeled with the turtle's original tag number and date. We then gently macerated the tissue to ensure percolation of the preservative and applied pressure to the wound with cotton wool.

Nest Location

We mapped nests using the markers and measurements from adjacent landscape features (e.g., distinctive tree trunks, large branches). We also used colored flagging directly over or close to the nest site when it would remain inconspicuous. Labeled flagging was inserted into the nest cavity to confirm nest identity upon excavation. Nest positions were recorded with a GPS (Global Positioning System) unit (eTrex Vista Personal Navigator, Garmin International Inc., Olathe, KS). We obtained measurements of distance to vegetation edge, distance to high water line, and used a spherical densiometer to quantify canopy coverage. We attempted to conceal nest locations and crawls to minimize the risk of poaching. We conducted checks on each nest approximately once a week to document predation or other disturbance.

Egg Counts

When time and conditions permitted, we took an exact egg count by tallying eggs as they were deposited into the nest chamber. We took additional egg counts of relocated nests. These counts enabled us to assess how accurately we estimated clutch size from nest contents during post-emergence nest excavations. As in previous seasons, egg counts occurred infrequently as the collection of other data (i.e., tagging, measurements, genetic sampling) took precedence.

Emergence and Excavations

We closely monitored nests for several days prior to the expected emergence date. We documented the date, estimated time of emergence, and any hatchlings seen for each emergence. We guided disoriented hatchlings (i.e., those attracted to artificial lighting) and released trapped hatchlings (i.e., those tangled in roots of the nest chamber). Because of the high volume of nesting activity and other factors (e.g., exceptionally high tides of 15-17 October), we were unable to excavate all nests deposited on Pasture Bay Beach. On Pasture Bay Beach, hawksbill nests typically exhibit a 55 to 60 day incubation period between egg-laying and hatchling emergence. When possible, nests that did not show signs of emergence after approximately 65 days were carefully excavated to assess status.

We recorded nest depth and noted nest cavity characteristics such as root structure, large rocks, and unusual or hard substrate. Nest contents were categorized to estimate clutch size and hatchling release success rate. Hatched shells were counted, and unhatched eggs were opened to determine stage of development when mortality occurred. We categorized eggs according to categories outlined on the hatchery data sheet. On a few occasions, we encountered hatchlings not ready for release due to excessive lethargy. We kept these individuals in a container filled with moist sand and draped with a damp cloth. The container was stored in a warm, dark place for 1 to 2 nights before we released hatchlings.

Managed Hatching and Relocated Nests

We relocated nests deposited at or below the high water line. Depth and shape of the reburied nests adhered to the approximate dimensions of a natural nest (50 cm average depth). We partially relocated additional nests because the original chambers were not large enough to hold the entire clutch. Finally, if a nest site was susceptible to hatchling disorientation due to artificial lighting (see Witherington & Martin 2000) or other anthropogenic effects (e.g., close to road), we constructed a barrier around the nest in an attempt to contain the hatchlings until they could be guided in the appropriate direction.

False Crawls

We additionally recorded false crawls (i.e., unsuccessful nesting attempts) by documenting time of observation, location, behavioral or morphological observations, and potential causes of the failed attempt. Most false crawls could not be associated with an individual. Occasionally, however, we identified false-crawling turtles by discrete observation of the supracaudal drill pattern while the turtle was digging. Otherwise, we did not collect measurements or other data from a false-crawling turtle.

Data Analyses

We summarized data assessing annual cohort size and recruitment, seasonal and geographic distributions of nesting activities, remigration intervals, fecundity (i.e., number of clutches, clutch size, and estimated hatchling release), and individual size. To assess size, we tested two null hypotheses: 1) no difference is present between pre- and post- barnacle removal measurements using a paired *t*-test ($\alpha = 0.05$), and 2) neophytes and remigrants do not differ in standard size measures using *t*-tests ($\alpha = 0.05$). Additional results are presented graphically with appropriate summary statistics.

IV. RESULTS

Recruitment

Sixty-three adult female hawksbills (40 remigrants and 23 neophytes) were observed on Long Island during the 2005 nesting season (Fig. 1). This figure includes 1 remigrant documented only on Pond Bay Beach and 1 neophyte documented only on other peripheral beaches. The 2005 season's cohort represented more than a 20% increase in the previous seasonal highs, surpassing the 2004 season total of 51 and the 2002 season total of 50 individuals. Cohort composition is comparable to the 2004 season; the percentage of neophytes represented in the 2005 nesting cohort (31.8%) is similar to the 2004 cohort (29.4%).

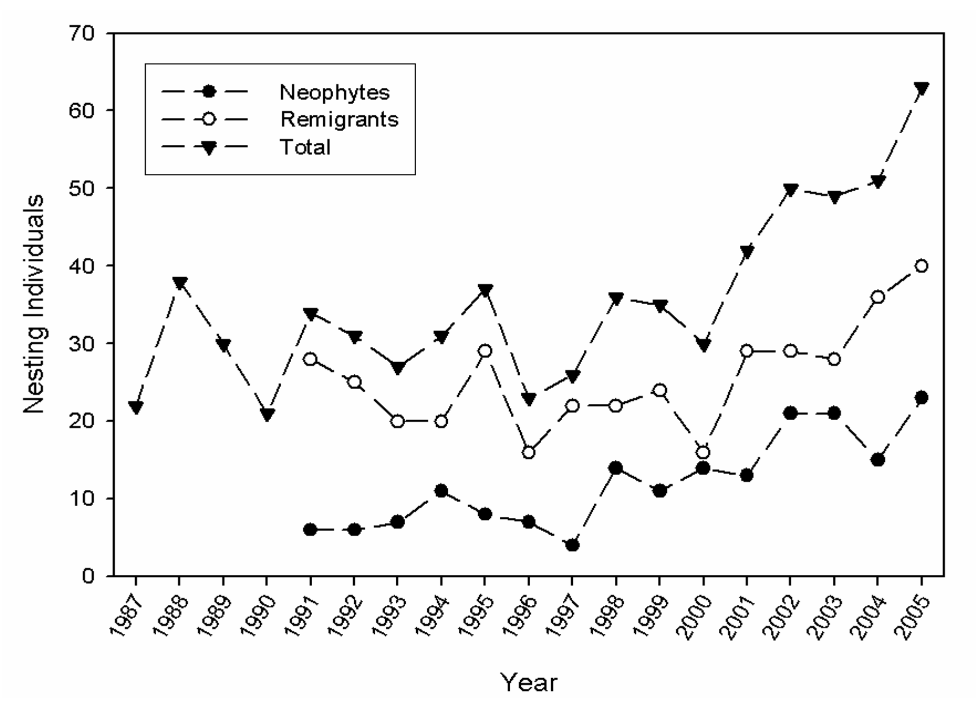

Figure 1. Neophytes, remigrants, and total nesting females documented on Long Island, Antigua, West Indies, during monitoring from 1987 to 2005.

Seasonal Activity Levels

We documented 162 false crawls and the deposition of 195 nests on Pasture Bay Beach (Fig. 2). Additionally, 23 false crawls and 11 nests, totaling 34 activities, were documented on Pond Bay Beach. Nine activities were recorded at Doniford (3 nests and 6 false crawls), and 20 activities were documented on other peripheral beaches (12 nests, 8 false crawls). As in 2004, monitoring activity on Pond Bay Beach was complicated by an extremely high water line that, at times, may have erased evidence of nesting turtles.

Nesting activity was greatest during the period from early July to early September (Fig. 2). Total activity on Pasture Bay Beach peaked during the weeks beginning July 27th (19 nests and 13 false crawls), with an 3 additional activities recorded on Pond Bay (1 nest, 2 false crawls); August 10th (18 nests and 14 false crawls), with 8 activities on Pond Bay (2 nests and 6 false crawls); and September 7th (16 nests and 16 false crawls), with 1 nest and 5 false crawls recorded on Pond Bay. The highest single night of activity was documented on September 12, with 9 false crawls and 7 nests documented on Pasture Bay Beach and 1 false crawl on Pond Bay. Activity declined markedly in October. For the final six weeks of the season, only 12 nests and 17 false crawls were recorded on Pasture Bay Beach, and no nests were documented in the final week (November 8-15) of the season.

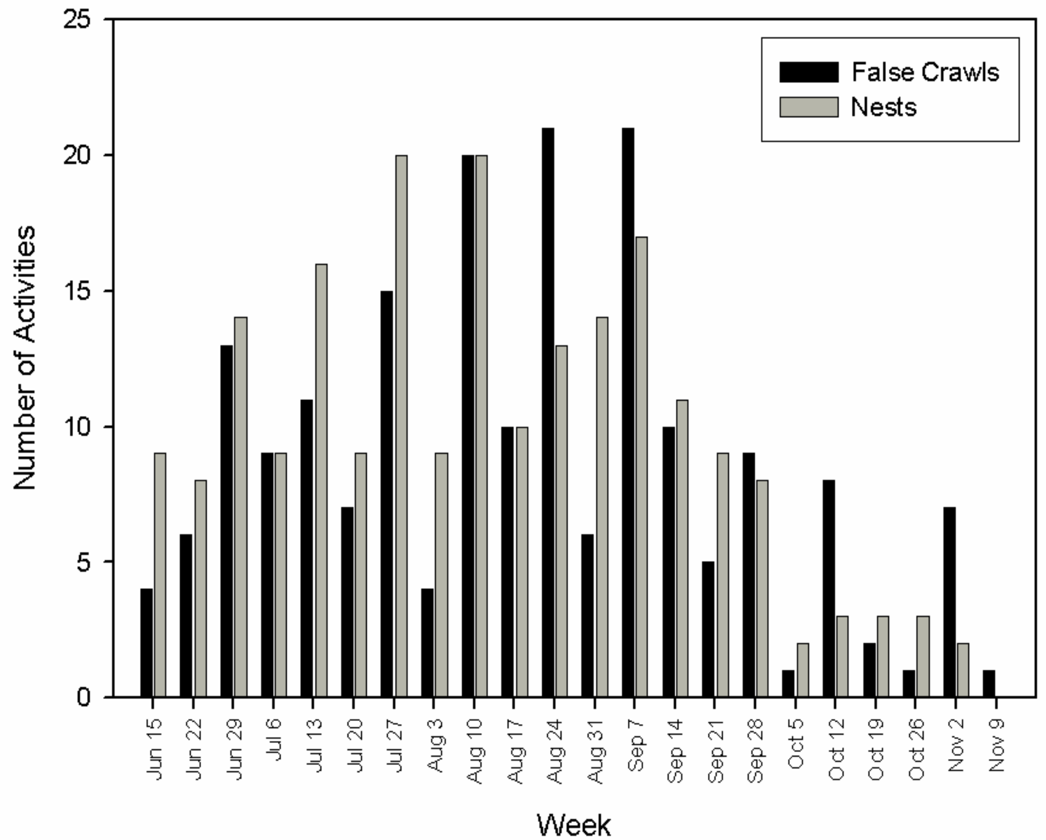

Figure 2. Number of nesting activities recorded on Pasture Bay, Pond Bay, and Doniford Beaches on Long Island, Antigua, from June 15 to November 16, 2005. The date signifies the week beginning on that date.

The 2005 peak in nesting occurred approximately 2 to 4 weeks earlier than the 2004 nesting season (Fig. 3). Nesting in 2005 took place at a much greater rate early in the season than it did in 2004. However, 2004 nesting continued at a more consistent rate throughout October and November than did nesting in 2005.

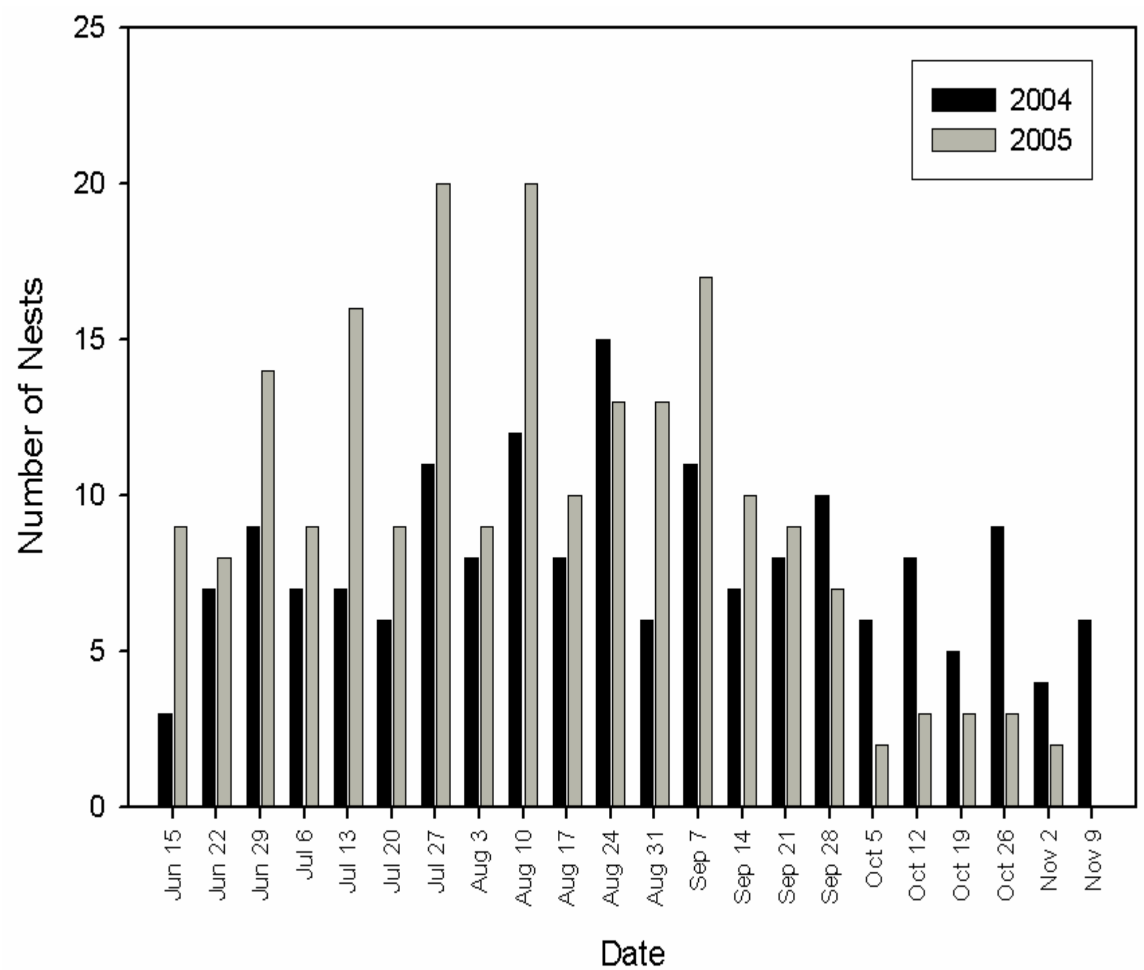

Figure 3. Number of nests recorded on Pasture Bay and Pond Bay Beaches on Long Island, Antigua, from June 15 to November 16, 2004 and 2005. The date signifies the week beginning on that date.

Nesting Activity by Beach Sector

Nests were deposited along nearly all sectors of the beach including the far eastern portions of Pasture Bay Beach adjacent to La Casa and Doniford properties (Fig. 4). More than twice as many nests (23) were deposited in sector 4-5 as any other beach segment. Only sectors 0-1, 1-2, and the extreme northern extent of Pasture Bay Beach beyond marker 31 contained no nests.

The greatest discrepancies between nests deposited and false crawls occurred at 30-31, with 15 more false crawls than nests, and 4-5, with 13 more nests than false crawls (Fig. 4). An additional measure, percentage of total nesting activities that resulted in a nest, identifies sectors 29-30 (90%), 7-8 (87.5%), and 8-9 (87.5%) as those regions in which individuals had the greatest probability of nesting successfully

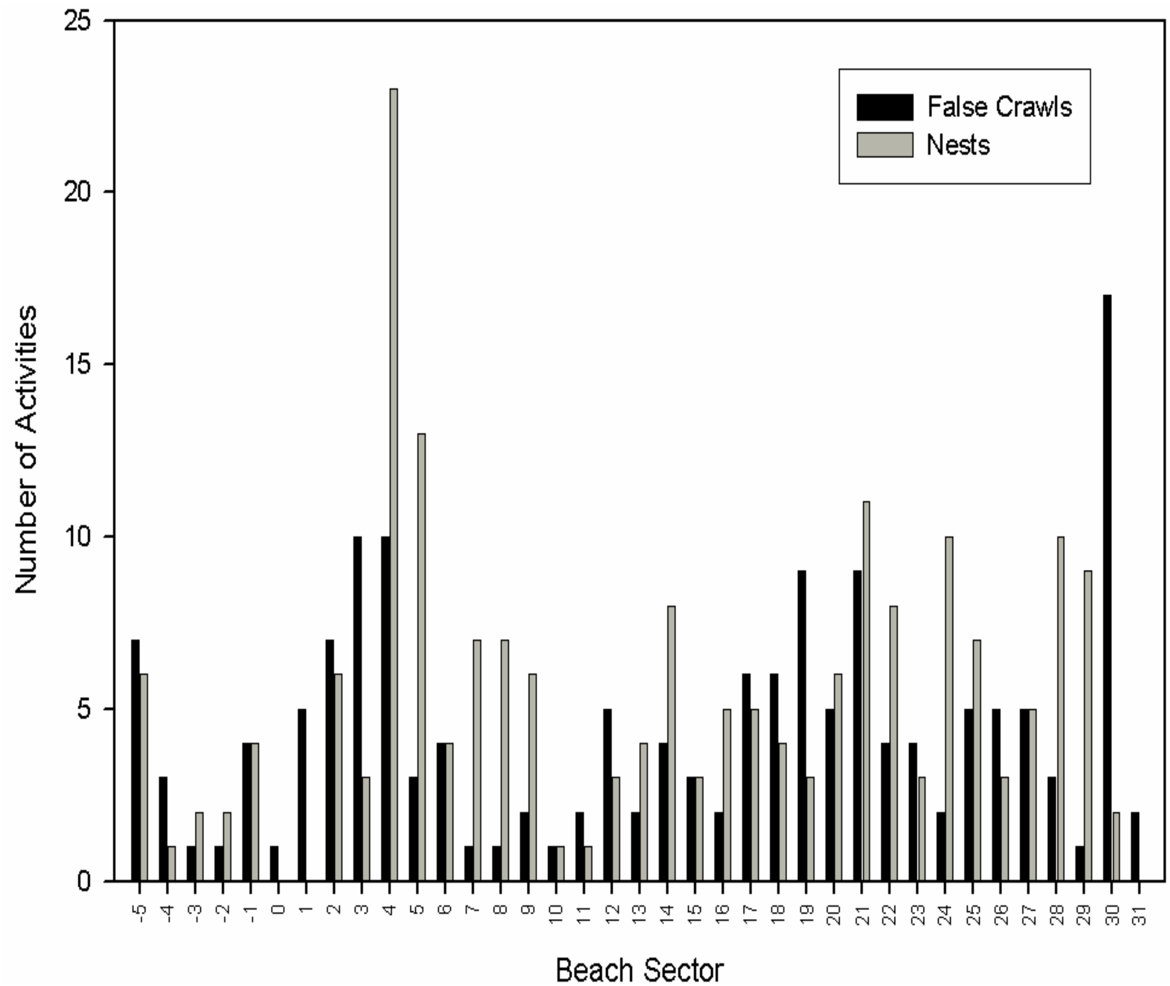

Figure 4. Number of nesting activities by beach sector documented during patrols on Pasture Bay Beach, Long Island, Antigua, from June 15 to November 16, 2005. Beach sector refers to the lowest number marker of a particular sector.

In 2005, females utilized areas on Pasture Bay Beach which were unused in 2004, specifically the beach from markers -5 to -3 (Fig. 5). Successful nesting attempts declined in 2005 along the northern portions of Pasture Bay Beach (e.g., sectors 27-28 and 30-31). Conversely, sector 4-5 contained a much higher concentration of nests in 2005.

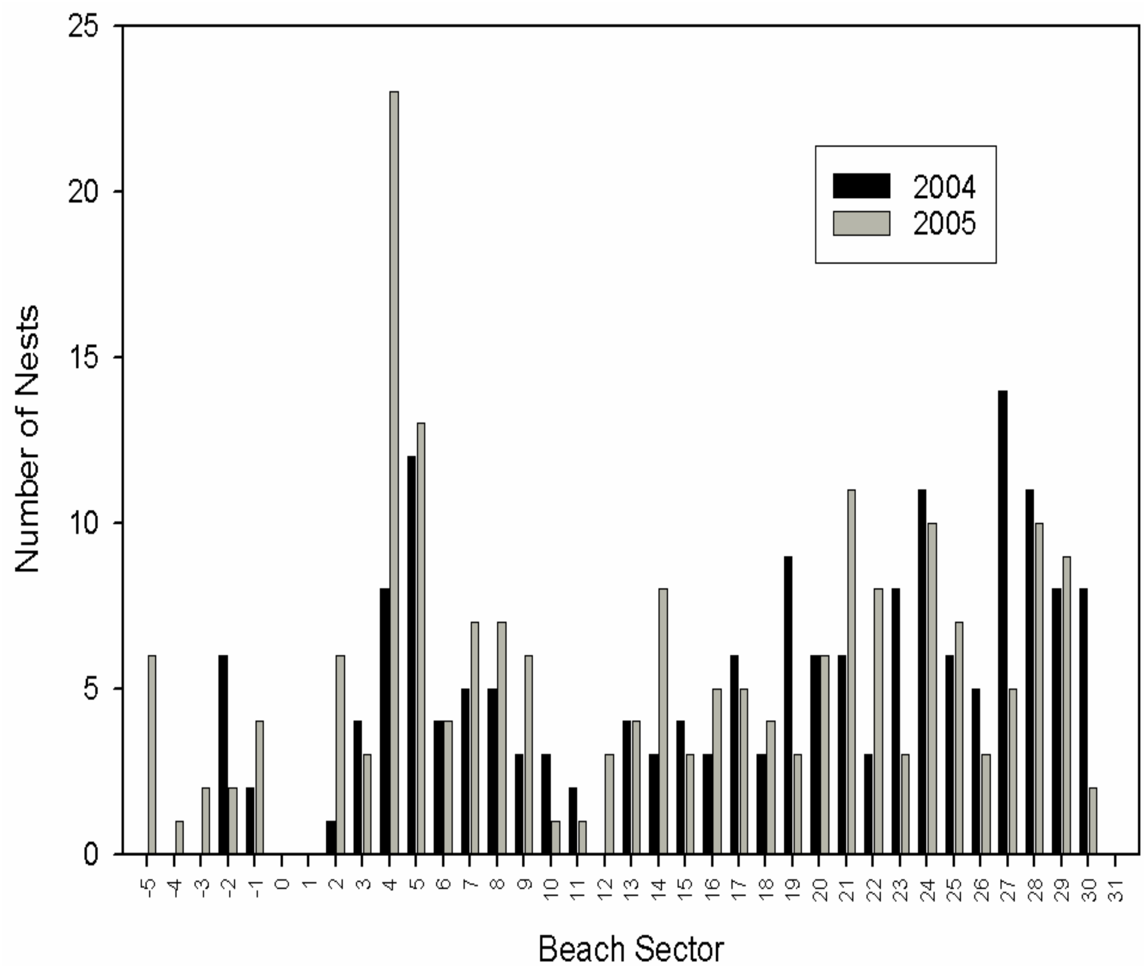

Figure 5. Number of nests deposited by beach sector documented during patrols on Pasture Bay Beach, Long Island, Antigua, from June 15 to November 16, 2004 and 2005. Beach sector refers to the lowest numbered marker of a particular sector.

Remigration
Remigration intervals (elapsed time since previous nesting season) ranged from 2 to 7 years (Fig. 6). Intervals of 2 or 3 years represented 77.5% of remigrants. The mean remigration interval for the 2005 remigrant cohort was 3.1 (SD: 1.24) years.

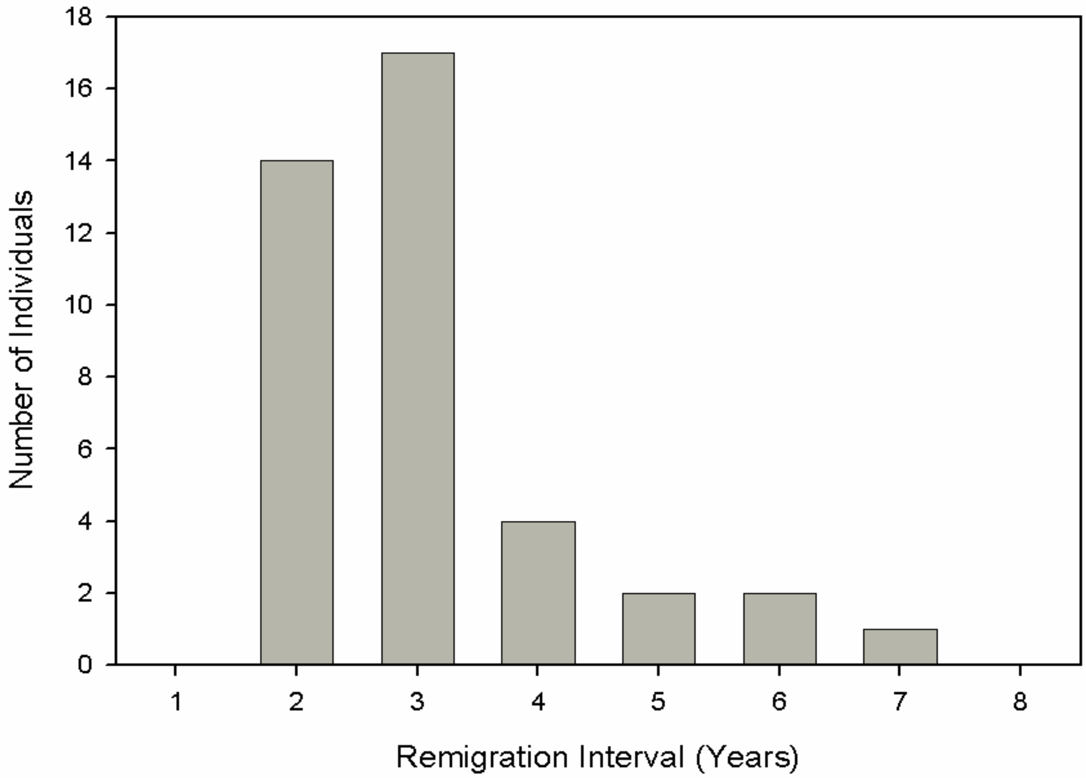

Figure 6. Remigration intervals of hawksbills documented on Long Island, Antigua, from June 15 to November 16, 2005.

Fecundity: Clutch Number
Between June 15th and November 16th, 221 nests were recorded on Long Island. Additionally, we recorded 26 nests laid prior to June 15th. As previously discussed, data from peripheral beaches are incomplete because of the irregularity of patrols on these properties.

Although hawksbills typically nest on a 2-week interval, we recorded several instances in which an individual would not be seen for 4 to 6 weeks between nesting attempts. We assumed that in such cases turtles nested elsewhere between observed nests and thus computed a predicted number of nests for each female. The number of predicted nests per female deposited between June 15th and November 16th 2005 on Long Island ranged from 1 - 6, with a mode of 4 and an average of 3.4 nests (SD: 1.5) per turtle. Neophytes deposited an average of 3.0 nests (SD: 1.5), and remigrants averaged 3.6 nests (SD: 1.5) (Fig. 7a).

To reduce error in assessing fecundity and maintain consistency with analyses from previous seasons, we also summarized the data for turtles with a documented first visit occurring between July 3 and September 15. Sample size decreased from 23 to 10 neophytes and from 43 to 29 remigrants (Figure 7b). Selected neophytes deposited an average of 3.5 nests (SD: 1.4), and selected remigrants an average of 3.6 nests (SD: 1.6).

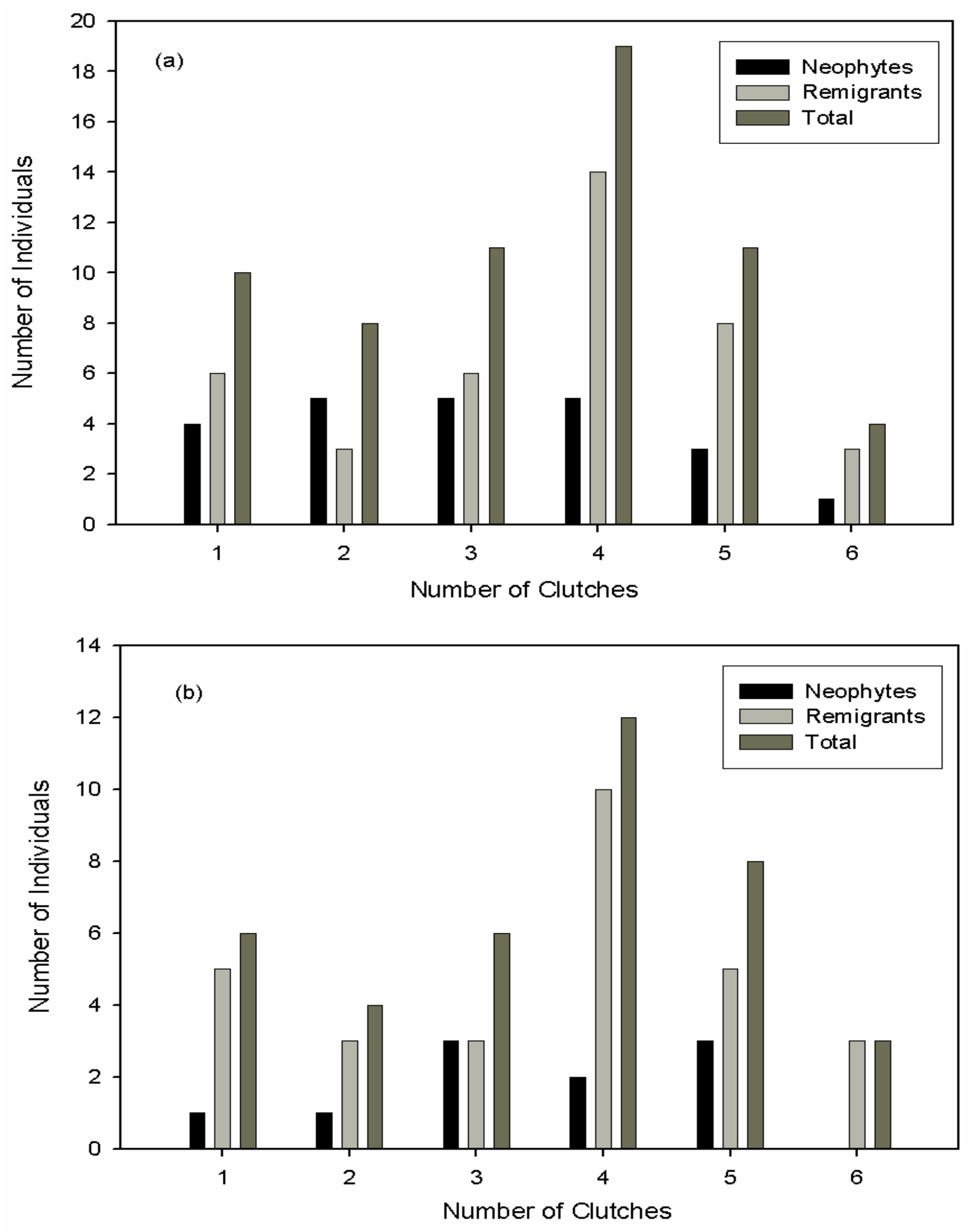

Figure 7. Number of predicted clutches for (a) all turtles recorded from June 15 to November 16, 2005, and (b) selected turtles which first nested between July 3 and September 15, 2005, on Long Island, Antigua.

Fecundity: Clutch Size and Release Success

As detailed above, the sheer volume of nesting activity and the high tides of October 15-17 prevented us from excavating all nests. Additionally, we recorded 11 instances in which an individual selected the same nesting site as a previous individual and either completely or partially destroyed the original nest. These circumstances compelled us to eliminate both the original and subsequent nests from clutch size and release success analyses, as we did not want to disturb incubating nests and were unable to differentiate between nests to obtain an accurate egg count. Finally, those nests in which clutches were completely or partially reburied were eliminated from release success analyses. Thus, we were able to include a total of 125 nests in clutch size analyses and 119 nests in hatchling release analyses.

Clutch size ranged from 39 to 205 eggs, with an average of 142 eggs (SD: 28.7) per nest (Fig. 8). Egg count values deviated ±3.3 (SD: 3.1) on average from excavation estimates when comparing clutch size values determined by egg counts at the time of laying or reburying with values determined by nest excavations post emergence (n=6). In other terms, egg counts deviated ±3.6% (SD: 3.2) from actual clutch size. We analyzed data from the aforementioned 119 nest excavations to estimate the number of hatchlings released from the nests (either naturally or with researcher assistance). Release success ranged from 0% to 100% with an average of 78.4% (SD: 18.3) released (Fig. 9). More than 30% of nests had a release success of 90% or greater.

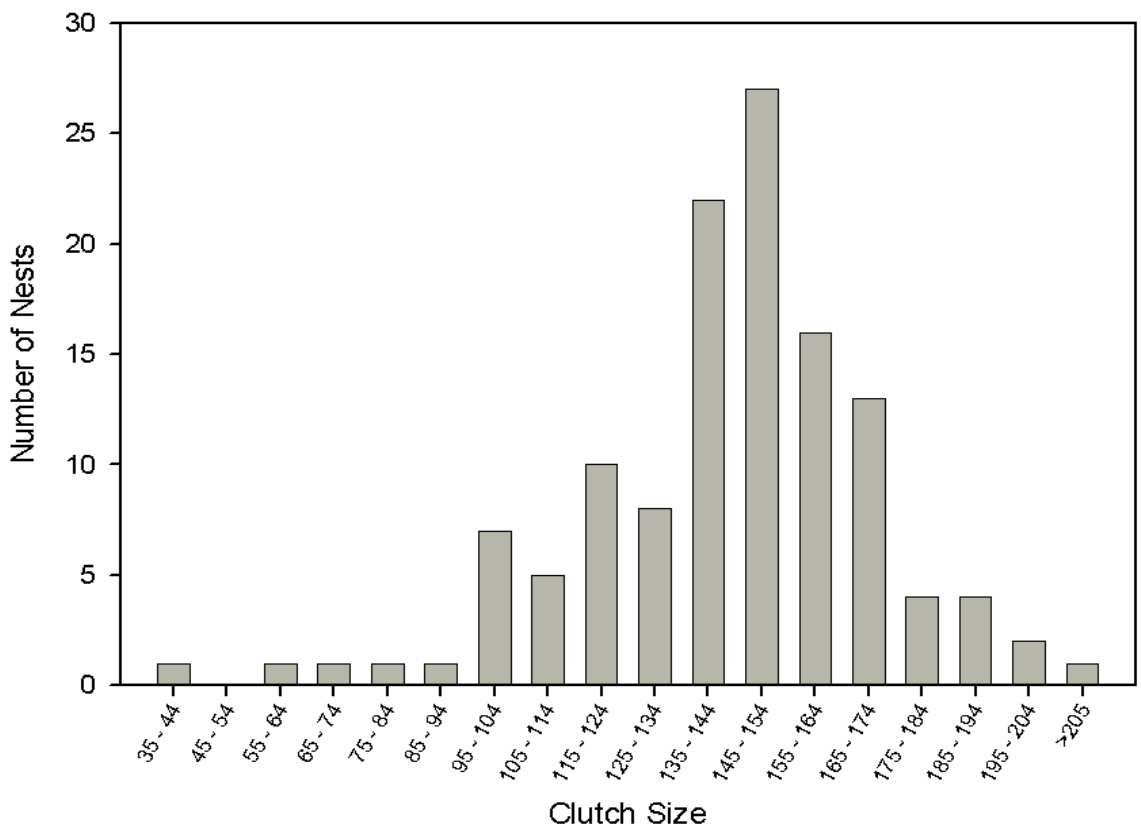

Figure 8. Estimated clutch size of nests recorded at Pasture Bay and Pond Bay Beaches, Long Island, Antigua, during 2005.

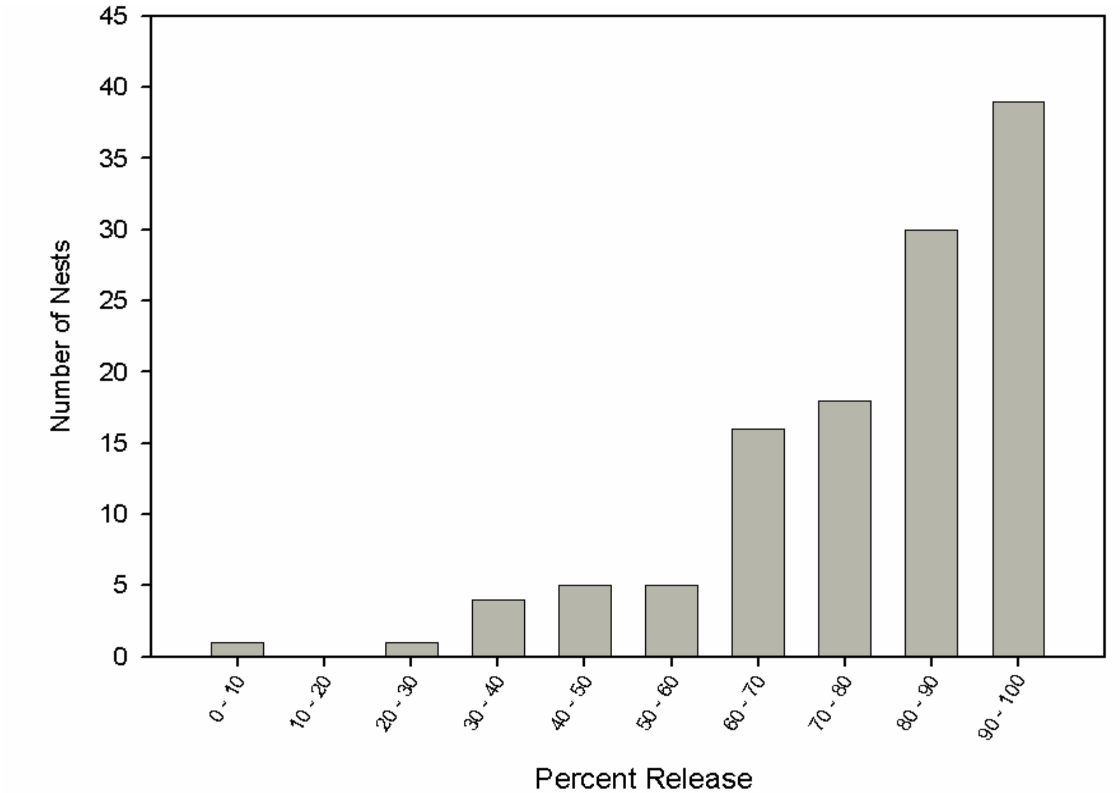

Figure 9. Estimate percentage of hatchlings released from nests recorded at Pasture Bay and Pond Bay Beaches, Long Island, Antigua, 2005.

Size of Nesting Female

We included 14 individuals from which we removed barnacles obstructing the trajectory of the CCL measurement. The sample size of individuals from which we removed barnacles obstructing the CCW measurement was inadequate for analysis. Measurements following barnacle removal were significantly lower than pre-removal measurements (t=4.32, 13 df, P=0.0004). However, the mean difference between pre- and post-removal measurements was only 0.47 cm (SD: 0.41). We thus averaged all size measurements of individuals (i.e., whether or not barnacles were removed) to examine sizes of neophyte and remigrant classes.

We included 20 neophytes and 35 remigrants in analyses. Mean size of neophytes was 87.7 cm (SD: 4.6) CCL and 77.7 cm (SD: 4.6) CCW; mean size of remigrants was 88.3 cm (SD: 3.7) CCL and 78.1 cm (SD: 3.8) CCW. Neophytes did not differ from remigrants in CCL (t=-0.58, 53 df, P=0.566) or CCW (t=-0.30, 53 df, P=0.769) (Fig. 10).

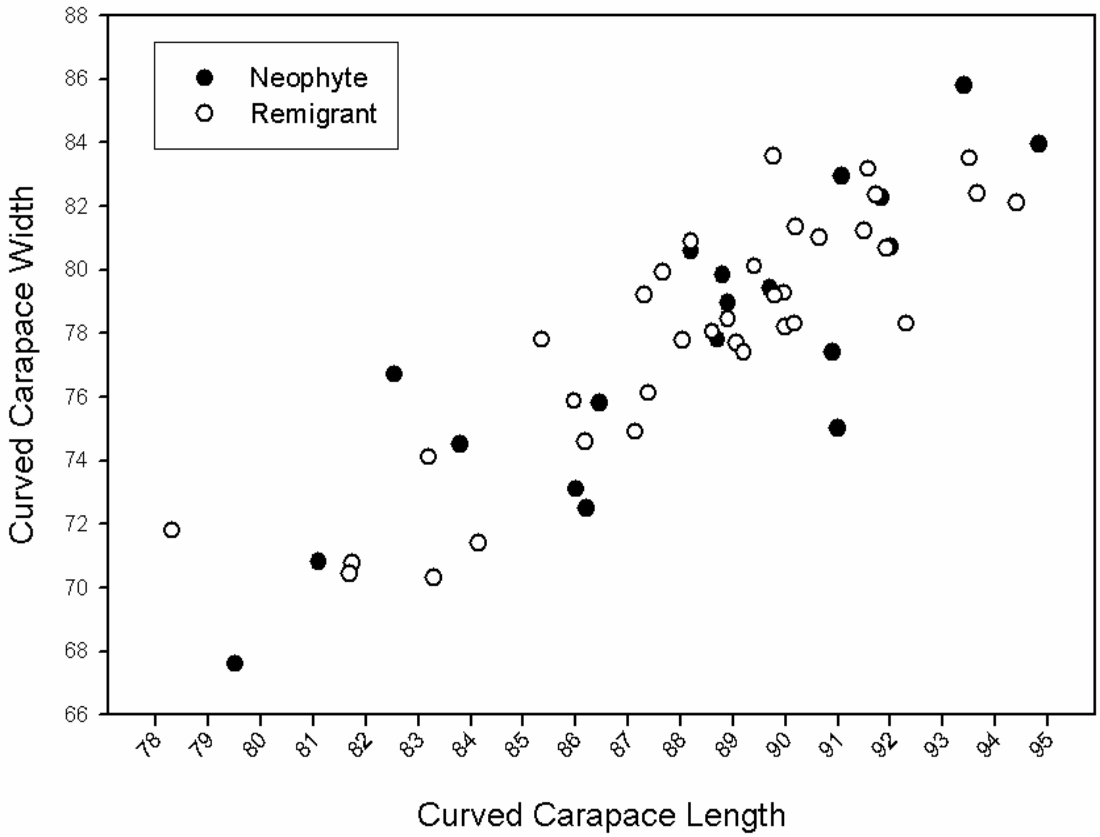

Figure 10. Curved carapace length versus curved carapace width for neophyte and remigrant hawksbills documented on Long Island, Antigua, from June 15 to November 16, 2005.

Genetic Sampling
We collected approximately 30 tissue samples for genetic analysis. All samples were collected from nesting adult females, and results from haplotype analysis are pending at this time. (Results from the 2004 haplotype analyses are available from the Jumby Bay Hawksbill Project)

Situations Requiring Researcher Assistance
In at least 2 instances, we redirected hatchlings that became disoriented by lights on the mainland and private residences. Approximately 5 adult females became disoriented on the northern sectors of Pasture Bay Beach by mainland lighting and were additionally redirected. We reburied nearly 600 eggs from 7 nests in which chambers were too small to hold all eggs or chambers were dug at or below the high water line. Four reburied clutches hatched and were excavated during the season. We estimated hatchling releases of 0%, 64%, 71%, and 89% for these clutches.

Several turtles had varying degrees of injury or deformity of their rear flippers and occasionally required some assistance digging. One neophyte, WE5093, was completely missing her right rear flipper and appeared to have great difficulty excavating nest chambers. Three clutches of WE5093 were reburied because of inadequate nest chamber volume.

We documented at least 2 successful poaching incidents and 1 attempted poaching incident on Pasture Bay Beach this season. Successfully poached nests were located between markers 4 and 6, in front of the bicycle rack and adjacent to the construction site of Trajan Blue. Following discovery of these incidents, we increased efforts to conceal crawls and nest locations to minimize the poaching threat and documented no additional poaching incidents.

V. DISCUSSION AND RECOMMENDATIONS

Season Results

Population Growth

The 2005 population marked the largest nesting cohort recorded in nearly two decades of intensive monitoring and provided further evidence of long-term population growth. Given that hawksbills may take 15 – 25 years to reach sexual maturity, the Long Island population may be reaping the benefits of conservation measures first implemented with the inception of the project in the mid 1980's. As such, the population may have the ability to function as a source for depleted mainland Antigua populations (Richardson *et al.* in review).

However, we caution that such conclusions may be premature and that alternative scenarios may be, at least in part, contributing to local population growth. As suggested in the 2004 Annual Report, Long Island may attract hawksbills that have become displaced due to the loss of suitable nesting habitat from factors such as beach erosion and development.

Development of mainland monitoring programs will be essential to address these hypotheses. The Environmental Awareness Group (EAG) of Antigua and Barbuda and the Antiguan Fisheries Department are currently coordinating efforts to obtain funding to commence a monitoring initiative on mainland Antigua in 2006. Regardless of the causes underlying local population increase, the importance of Long Island's beaches to hawksbills remains unquestionable and may strengthen as anecdotal evidence points to continued mainland population declines.

Seasonal Peak

Activity levels during the 2005 field season peaked approximately 2 to 4 weeks earlier than previous seasons and declined precipitously in the final 6 weeks of the season. We documented 26 nests deposited before June 15, further substantiating the earlier peak in nesting activity. (By comparison, we recorded only 7 nests deposited prior to June 15 in 2004.) Causes such as increased sea temperatures remain speculative at this point and certainly warrant further investigation. The coming years will tell if the early 2005 peak was an anomaly or will become the norm.

Shifts in Beach Use

In contrast to the 2004 nesting season, the 2005 cohort made use of nearly all sectors of Pasture Bay Beach. Additionally, this season's nesting females demonstrated a greater affinity for sector 4-5, a portion of Pasture Bay Beach lying just east of the bicycle rack, while nesting decreased along northern portions of Pasture Bay Beach (i.e., Pasture

Point). We hypothesize that changes in beach and vegetation composition may have played a role in the geographic shift of nests. For example, the northern stretches of Pasture Bay Beach have suffered heavy losses of sand and vegetation due to at least two instances of exceptionally high tides since the end of 2004. This erosion decreased the availability of suitable nesting sites, making nesting attempts less likely to be successful in this area. Additionally, the erosion may have caused this area to become less attractive to nesting females.

Unusually High Tides

Extremely high tides and rough surf inundated Long Island from October 15 to 17. Numerous sectors of the beach, particularly sectors -5 to -3, 3 to 7, and 13 to 18, were continuously washed over for the 2 to 3 day period. The surf deposited several inches of additional sand, covering or washing away some nest markers and thus making it difficult to locate some nests. Of those nests that we managed to find and excavate after the expected hatch date, mortality was generally very high as a result of seawater inundation and the additional surface sand which may have impeded emergence. We suspect that in excess of 10 additional nests were lost due to high tides. Thus, hatchling release estimates were probably lower than reported above. This unusual high tide event appeared to be a natural phenomenon.

Public Awareness and Education

Jumby Bay Resort Guest Turtle Watches

This season we hosted over 200 Jumby Bay Resort guests for a turtle watch on Pasture Bay Beach. We were told by multiple guests that the primary reason they decided to come to Jumby Bay Resort was for the chance to see a turtle! We believe the guest turtle watches were very successful, and we also enjoyed the company of many homeowners, their families, and guests on the beach.

We see the resort turtle watches as a very important part of the project's mandate and always strived to make sure the guests had an enjoyable experience on the beach. On the whole, guests were brought down to the beach in a timely manner and, from the feedback we received, the turtle watching experience was very positive for resort guests. We typed up a brief informational sheet on what to expect during a turtle watch that was supposed to be given out at the time guests signed up for the turtle watch. On this sheet, we highlighted that timing is crucial should they wish to see a turtle depositing her eggs and that guests should be prepared for possible rain, wind, and mosquitoes during the watch. We also included detailed information on the nesting process. We recommend that a similar handout be available each season.

The resort should consider assigning a staff member to be in charge of guest turtle watches during the nesting season peak between July 15th and September 30th. The bellmen, security officers, and night auditors did a great job with guests on turtle watches given the other duties they had to perform. However, a staff member specifically assigned to oversee turtle watches may alleviate some of the workload. At times, bellmen had to drop off guests at the beach and then quickly return to the resort to fulfill other duties or to leave the island at the end of a shift. It would have been beneficial to have a bellman or other staff member accompany the guests to the watch so that guests had a means to leave the beach promptly whenever they wanted. On a handful of occasions, we radioed the resort to arrange a pick-up at the beach but our calls went unanswered. As a result, a homeowner present at the watch gave the resort guests a ride back to their room, guests had to walk back, or we drove them in our cart (our cart is a two-seater and not equipped for passengers)! If the resort representative cannot remain on the beach with the guests, arrangements need to be secured for another resort staff member to return guests to their rooms.

Environmental Awareness Group Turtle Watches

Public outreach and education efforts are critical components of sea turtle research programs throughout the world. Because all sea turtle species are long-distance migrants, it is crucial to enhance both local and international cooperation in order to meet conservation objectives. Currently, the Jumby Bay Hawksbill Project is the only sea turtle research project in Antigua and Barbuda. Although Long Island serves as a sanctuary for nesting females, these individuals, as well as other segments of the population, may be susceptible to harvest and other threats throughout Antigua and the Caribbean. Therefore, the primary goal of our outreach programming is to inform local citizens, primarily children, of sea turtle ecology and conservation to ensure that future generations will be better equipped to deal with the challenges of sea turtle conservation.

We continued the tradition of hosting turtle watches for groups from the mainland through Antigua's Environmental Awareness Group (EAG) from 7:30 PM until 11 PM every Friday night beginning in July. An EAG volunteer accompanied each group of seven visitors, often local children and their parents or overseas visitors from hotels on Antigua. Since there are no opportunities for Antiguans to participate in organized turtle watches on the mainland, the Jumby Bay Turtle Watches are very popular and many families are repeat turtle watchers. The EAG watches are an extremely important part of our outreach efforts as it gives us an opportunity to spend time talking to Antiguans about turtle conservation. We conducted EAG turtle watches for over 80 people again this season.

Outreach through Radio

At the end of last season, we were concerned that school visits were becoming a bit dry and repetitive. The research teams tend to visit the same private schools each year and our education efforts reach the same children. In the 2004 Annual Report, we discussed our desire to begin a segment on turtle ecology on a kids' radio show. A radio show has enormous potential to reach a diverse audience, and in 2005 we turned this desire into a reality. We made five in-studio appearances on Observer Radio's show *Our House* over the course of two months for an hour each time. While on-air, we discussed sea turtle ecology and conservation, our research, and answered questions from callers. In addition to providing a new educational format, we feel that radio has the ability to reach many more citizens, thereby increasing the benefits accrued to effort exerted.

School Presentations

We conducted educational presentations at two schools in 2005. The first presentation was at St. Nicholas Primary School for 120 children between the ages of 5 and 13 years old. We met with individual classes after the presentation to answer questions and allow them to look at our natural history materials up close. The second presentation was at the Montesorri School where we talked about basic turtle information and showed pictures and turtle bones to 40 children between the ages of 2 and 4 years old.

Resort Staff Education

We had hoped to conduct educational presentations for resort staff members again this year, but unfortunately these presentations were not scheduled. Since resort staff members are very interested in the turtles and many receive questions about turtles and the JBHP from resort guests, we recommend that staff members have the opportunity to participate in a turtle watch and become educated about general hawksbill ecology. We hope the 2006 team has the opportunity to give a brief presentation on the project and sea turtles to any interested resort staff members and especially to those who interact with guests.

Visitors

In order to aid international turtle conservation efforts, the JBHP researchers have hosted multiple visiting turtle researchers from other countries in the last few years. Since the JBHP is a well-established project, we have much to offer fledgling projects in terms of field techniques. We hoped to host turtle researchers from Montserrat this year, continuing the annual researcher "exchange" through WIDECAST. Communication with our associate in Montserrat proved difficult though, and, unfortunately, we could not make the exchange possible this season.

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Gosh, where do we begin? We have so many wonderful people to thank for helping to make our time at Jumby Bay such a memorable and truly life-altering one! First and foremost, we are enormously grateful to the Jumby Bay homeowners for providing us with the opportunity to do our research and live on their beautiful island. Their continuing financial support for the project is unparalleled in sea turtle research and they should be rewarded for this fine commitment to the global conservation effort. We cannot possibly say enough to thank the homeowners for the warmth and hospitality bestowed on us during our two years at Jumby Bay. We will never forget your kindness. A special thank you to the following people who really made us feel part of the Jumby Bay family: Robin and Dennis McNeill, Dick and Judy Nelson, Roland and Nina Franklin, Karen and Don Tate, Peter and Pat Swann, Ron Budacz, and Ve and James McAllister.

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Finally, but most importantly, we want to thank our families for all their support, and for encouraging us to pursue our dreams. We dedicate this season's effort to you!

VIII. LITERATURE CITED

Eckert, K. L., Bjorndal, K. A., Abreu G., F. A. and Donnelly, M. (Editors). 1999. Research and Management Techniques for the Conservation of Sea Turtles. ICUN/SSC Marine Turtle Specialist Group Publ. No. 4 Washington, D.C. 235 pp.

IUCN 2004. *2004 IUCN Red List of Threatened Species*. <www.redlist.org>.

Mrosovsky, N, Bass, A., Corliss, L.A., Richardson, J.I., and Richardson, T.H. 1992. Pivotal and beach temperatures for hawksbill turtles nesting in Antigua. Canadian Journal of Zoology 70:1920-1925

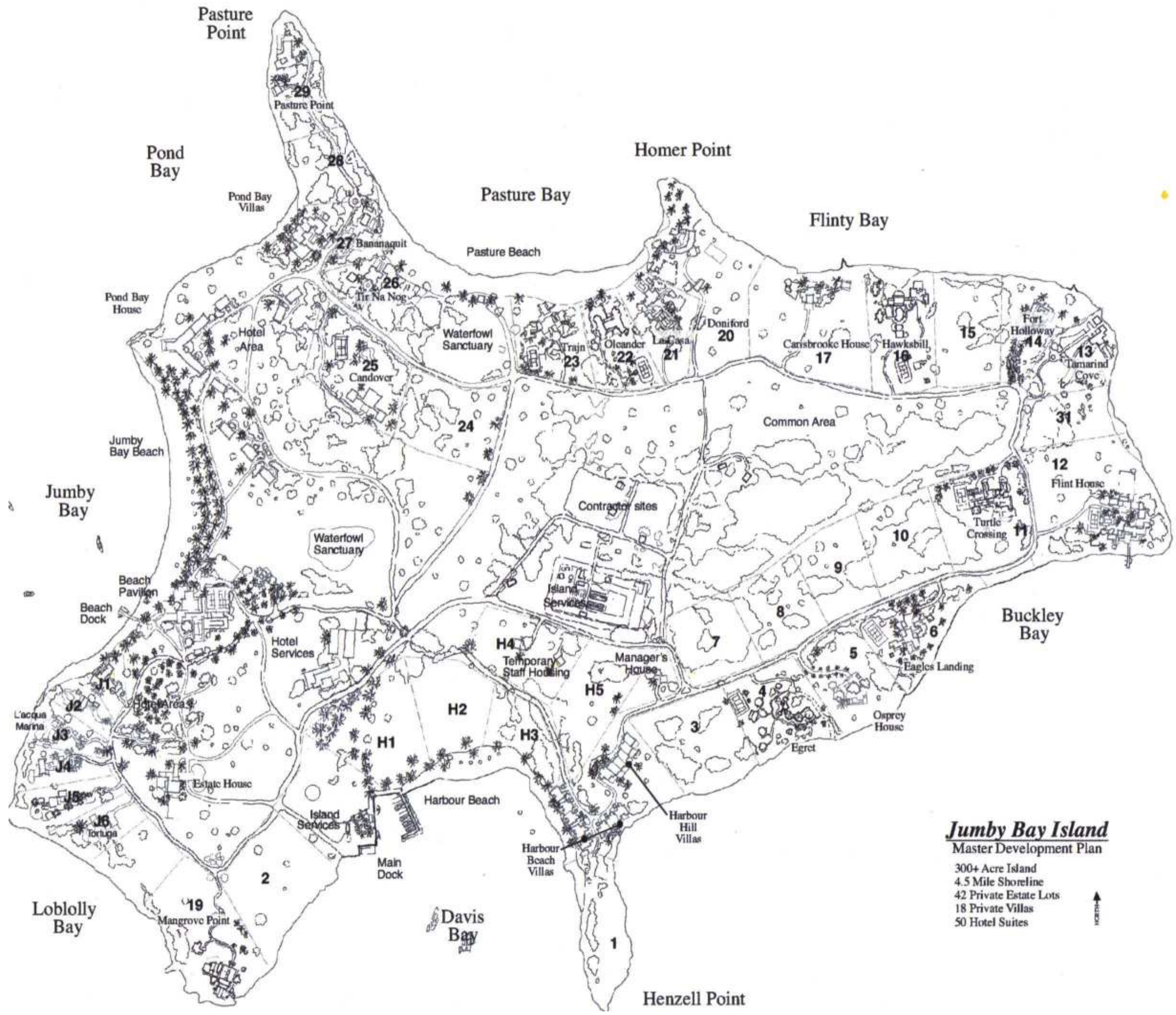
Richardson, J. I., Bell, R., Richardson , T. H. 1999. Population ecology and Demographic implications drawn from an 11-year study of nesting hawksbill turtles, *Eretmochelys imbricata*, at Jumby Bay, Long Island, Antigua, West Indies. *Chelonian Conservation and Biology*. 3(2): 244-250 pp.

Richardson, J.I., Hall, D.B., Bjorkland, R., Mason, P.A., Cai, Y., Andrews, K.M., and Bell, R. Eighteen years of saturation tagging data reveal a significant increase in nesting hawksbill sea turtles (*Eretmochelys imbricata*) on Long Island, Antigua. Animal Conservation. *In Review.*

Ryder, C., Richardson, J.I., Corliss, L.A., and Bell, R. 1989. Habitat preference and beach management for nesting hawksbills, Jumby Bay, Antigua, West Indies. In Proceedings of the 9th Annual Workshop on Sea Turtle Biology and Conservation. Compiled by S.A. Eckert, K.L. Eckert and T.H. Richardson. NOAA Tech. Mem. NMFS-SEFC-232 pp. 263-266

Witherington, B. E. and R. E. Martin. 2000. Understanding, Assessing, and Resolving Light-Pollution Problems on Sea Turtle Nesting Beaches (revised edition). Florida Fish and Wildlife Conservation Commission, FMRI Technical Report TR-2. 73 pp.

APPENDIX I



Map of Long Island, also known as Jumby Bay Island

APPENDIX II

WIDECAST
Wider Caribbean Sea Turtle Conservation Network

"Working together to build a future where all inhabitants of the Wider Caribbean Region, human and sea turtle alike, can live together in balance."

WIDECAST is a volunteer expert network and Partner Organization to the U.N. Environment Programme's Caribbean Environment Programme. WIDECAST was founded in 1981 in response to a recommendation by the IUCN/CCA *Meeting of Non-Governmental Caribbean Organizations on Living Resources Conservation for Sustainable Development in the Wider Caribbean* (Santo Domingo, Dominican Republic) that a "Wider Caribbean Sea Turtle Recovery Action Plan should be prepared ... consistent with the Action Plan for the Caribbean Environment Programme." Today WIDECAST embraces the largest network of sea turtle research and conservation projects in the world, including the Jumby Bay Hawksbill Project (JBHP) in Antigua, and is a unique model for multilateral marine resource management.

WIDECAST's vision for achieving a regional recovery action plan has focused on bringing the best available science to bear on sea turtle management and conservation, empowering stakeholders to make effective use of that science in the policy-making process, and providing a mechanism and a framework for cooperation within and among nations. By involving stakeholders at all levels and encouraging policy-oriented research, WIDECAST puts science to practical use in conserving biodiversity and advocates for grassroots involvement in decision-making and project implementation.

WIDECAST is all about partnerships - building bridges to the future that facilitate and strengthen conservation action, encourage inclusive management planning, and help to ensure that utilization practices, whether consumptive or non-consumptive, do not undermine sea turtle survival over the long term. Through information exchange and training, WIDECAST promotes strong linkages between science, policy, and public participation in the design and implementation of conservation actions. The network recommends standards for range state adoption, develops pilot projects, provides technical assistance, supports initiatives that build capacity within participating countries and institutions, and promotes coordination among Caribbean countries in the collection, sharing and use of biodiversity data.

With Country Coordinators in more than 40 Caribbean States and territories, the network has been instrumental in facilitating complementary conservation action across range states, strengthening and harmonizing legislation, encouraging community involvement, and raising public awareness of the endangered status of the region's six species of migratory sea turtles. At the center of WIDECAST's activities are its Country Coordinators. They are drawn from professional governmental and non-governmental sectors, must have sea turtle research and/or management experience and responsibility, and participate in the coalition as volunteers.

For more information on the larger context to which data collected by the JBHP contributes, or to contact WIDECAST Country Coordinators in Antigua or elsewhere in the region, please visit us at www.widecast.org.

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