Hawksbill Turtle *Eretmochelys imbricata* Nesting Environment and Population Study in Cuero y Salado Wildlife Refuge on the coast of Northern Honduras

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Date submitted _____________

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ABSTRACT

This report outlines my contributions to ProTECTOR’s Hawksbill turtle conservation project along the beachfront at Cuero y Salado Wildlife Refuge of Honduras. Observation-focused nightly beach patrols were conducted so as to census numbers of turtles nesting in this location presently and beach characteristic surveys were undertaken to create a map of environmental factors relevant to Hawksbill nesting along this beach.

Resulting environmental maps were correlated with known factors contributing to Hawksbill nest site choice in order to assess the suitability of this beach for hawksbill nesting, and thus determine its value for preservation efforts and ongoing funding.

Of the 10 km beachfront under observation, 267 m were selected for more intensive nesting environment data analysis. This analysis included mapping the elevation, multiple vegetation, and pollution factors as multiple overlying map layers so as to identify most viable sites for turtle nesting via ArcGIS technology.

It was found that the while the beach was under populated (our nightly observations yielded a count of 0 nesting turtles), significant portions of the beachfront displayed both overlap of environmental conditions favorable to function as a Hawksbill nesting site and an absence of environmental conditions which are known to inhibit Hawksbill nesting.

I found that certain portions of the beach displayed the most beneficial combination of environmental factors and are of highest value for preservation whereas other portions of the beach lacked positive environmental factors and thus are of a much lower conservation value.
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INTRODUCTION

The Hawksbill Turtle (*Eretmochelys imbricata*) is one of six species of sea turtles distributed in the waters of the Caribbean and tropical western Atlantic, including the Caribbean coast of Honduras (Kame and Delcroix, 2009). If able to survive the extraordinary odds—a mere 1 in 1,000 hatchlings live to maturity—sea turtles are among the oldest creatures in the sea (able to live more than fifty years) and are late maturing, first reproducing at ages ranging from 20 to 40 years (Stapleton and Eckert, 2008 and Chacon, 2004). The sexually mature female Hawksbill only returns to the beach where it was hatched to nest every 2-3 years by using an innate global positioning system (Chacon, 2004). For the seasons in which the female does nest, it may do so several times (1-8 nestings), laying as many as 200 eggs per nest (Chacon, 2004).

The Hawksbill species fills a unique ecological role in the Caribbean’s sea grass and coral reef ecosystems due, in part, to their atypical dietary preference for marine sponges (McClenachan, 2006). Their feeding habits help to maintain species diversity in the coral reefs they inhabit, which in turn stabilizes the coast (Stapleton and Eckert, 2008).

Due to the fact that Hawksbills only leave the water during the breeding season when females dig nests in the sand, not much is known of the Hawksbill turtle’s life cycle between its birth and reproductive periods. Substantial work has been done however to catalogue the specifics of the hawksbills’ nesting process and preferences in terms of sea access, slope of beach, elevation of nesting site above underlying water table, sand composition, moisture, and temperature (Eckert, 2004; Stapleton and Eckert, 2008; Delcroix, 2010). The entire process of nesting (choosing location, digging pit, laying
eggs, and refilling the pit) takes 1-3 hours and the hatchlings emerge about two months later at night, guided to the sea by light reflected off the water from the sky (Chacon, 2004).

Evidenced in longstanding records, Honduras’ coastline and bay islands once served as important foraging and nesting grounds for Hawksbills in the Caribbean region, a population estimated to have reached 11 million (McClenachan, 2006).

**CURRENT STATE OF HONDURAN HAWKBILL**

In sharp contrast to the once flourishing historic population reported from as early as 1666, 1774, and 1968, a 2001 study reported a maximum of 5,000 Hawksbills nesting annually in the Caribbean region at the time (Meylen, 2001). This number has continued to decrease dramatically over the course of the 20th century due to ongoing illegal exploitation of the population for tortoiseshell products (Kamel and Delcroix, 2009; Bräutigam and Eckert, 2006), harvesting of nesting females and clutches as nonessential food sources (Dunbar, 2010), degradation of reefs from extraction of coral, waste water and solid waste on reefs, destruction of mangroves, occupation of nesting beaches, and fishing fleet traffic (Bräutigam and Eckert, 2006). This population decline prompted the Hawksbill to be listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) in 1975, thus prohibiting international trade, and then in 1996 to be declared as Critically Endangered on the World Conservation Union’s (IUCN) Red List of Threatened Animals, which recognizes that Hawksbills have suffered adult population declines of at least 80% over their last three generations (Stapleton and Eckert, 2008). In the entire Caribbean 20% of historic
nesting sites have been lost entirely and 50% of the remaining nesting sites have been reduced to dangerously low populations; 44% of these beaches host fewer than 10 nesting female Hawksbills (Kamel and Delcroix, 2009; McClenachan, 2006).

While some Caribbean countries have allocated significant resources to manage and conserve marine turtles, Honduras has lacked a coherent turtle conservation strategy involving legislation, consistent enforcement, and a national or sub-national marine turtle management plan (Bräutigam and Eckert, 2006). However, Honduras’ 671 km of Caribbean coast and Bay Islands sport 12 marine protected areas, including Cuero y Salado Wildlife Refuge, which was established in 1987 by the Foundation for Cuero y Salado (FUCSA) (Burke and Maidens, 2004). As the mandated establishment of a research protocol for the park never occurred, FUCSA recently requested the aid of the Protective Turtle Ecology Center for Training, Outreach, and Research, Inc. (ProTECTOR) in doing so. It is at this particular refuge, located at the confluence of the Rio Cuero and the Rio Salado (Fig. 1), that I conducted my field research project under the guidance of Dr. Stephen Dunbar of ProTECTOR in the Department of Earth and Biological Sciences (EBS) at Loma Linda University (LLU).

Figure 1 A map indicating the locations of ProTECTOR bases. 1. Cuero y Salado. 2. El Venado. 3. Punta Raton. 4. Utila.

**PROJECT GOALS**

ProTECTOR, founded in 2007 by Stephen Dunbar for the purpose of establishing national sea turtle conservation efforts in Honduras, is working to provide information lacking in Honduras’ near nonexistent marine turtle database—there are no maps of
known nesting beaches, no estimates of Honduran Hawksbill population based on nesting females, no studies of hatching success, and no conservation programs along the majority of the Caribbean coast of Honduras (Dunbar, 2010). The data gathered from ProTECTOR’s research and observation will be used to report current Hawksbill status and trends in order to assist communities in the monitoring and recovery of this species toward historical numbers in the Honduran waters of the Hawksbills’ range (Dunbar brief, 2009).

On the north coast of the mainland of Honduras, the 24km beachfront of the marine protected area of Cuero y Salado Wildlife Refuge is considered a historic nesting beach for Hawksbill turtles and has reports of Hawksbills nesting as recently as July of 2010. It has become (along with the island of Utila) one of the two most recent focal sites of ProTECTOR’s Hawksbill Conservation and Population Recovery in the Caribbean Honduras project through FUCSA (Dunbar, 2010). This project is directed towards addressing the local community’s need for technical assistance in the development of conservation measures to protect and promote nesting beaches and populations of nesting Hawksbills. Within Cuero y Salado Refuge (and along the majority of the Caribbean coast of Honduras), there exists no previous conservation programs for Hawksbill nesting, foraging, or migratory habits nor have any estimates been made of nesting Hawksbills, nests, hatching success or assessments of critical habitats (Dunbar, 2013). In light of this deficiency, establishing a long-term index site for population monitoring for nesting Hawksbills is of high importance.
PROJECT SPECIFICS

Within the outlines of accomplishing the establishment of a population monitoring site, the specifics aspects of my role in ProTECTOR’s project at Cuero y Salado Wildlife Refuge included careful monitoring of the beachfront and thoroughly characterizing the environment of the beachfront relative to attributes known to be favorable to turtle nesting.

Beach profiling involves collecting data on factors that will encourage or discourage turtles to nest: width of beach, slope, altitude above sea level, density of vegetation, vegetation type, shadows cast, and pollution by both refuse and light. This information can be used to estimate the likelihood of a turtle to nest and a hatchling to successfully reach the water, from varying locations along a single beach, and the corresponding likelihood of this occurring along the beach at large. Matching these maps of beach slope, percent vegetation coverage, and beach characteristics with the recorded location of turtle nests, correlations may be drawn to determine the most favorable combination of beach profile features. The resulting conclusions may be used, in light of limited resources, for determining which sites are of highest conservative priority.

Regular beach patrolling by foot is a well-established research technique providing information on the number and species of sea turtles using the beach in question, and which additionally, by the presence of beach patrollers, results in reduced poaching activity (Stapleton and Eckert, 2008). Marking individual sea turtles for long-term identification, referred to as tagging, and measuring the carapace (shell), allows for more detailed information to be gathered in regards to the turtle’s size, growth, number of nesting episodes per season, and migratory pathways. As none of this has been done
previously at the beachfront of Cuero y Salado Wildlife Refuge, these efforts, at present, will result in a baseline for the population, and will provide data for further analysis during following summers.

Anticipating the need to build local community capacity for long-term conservation and thus increase the longevity of implemented changes, the project recognizes the significance of going beyond data collection. For this reason ProTECTOR also engages the community in these efforts so as to develop stewardship through outreach, mentoring community members, educational events, and positive publicity.

MATERIALS AND METHODS

STUDY SITE

Our study was conducted along the 26 km beachfront of Cuero y Salado Wildlife Refuge on the northern Caribbean coast of Honduras. We actively monitored approximately 10 km of beachfront, a stretch of beach divided from the entrance into eastward (6 km) and westward (4 km) portions and bordered by the outlets of Rio Zacate and Rio Salado, respectively. Beach width varied between 3m and 30 m. Both stretches of beach were backed by a coastal woodland forest and progressively thickening vegetation, which included Hicaco (Chrysobalanus icaco), various grasses, sea grape (Coccoloba uvifera), and a number of unidentified vegetation types. The only exception was a portion of beach open in the west that lacked adjacent forest, where the river bar convenes with the beachfront. The area between east and west beach sectors is the site of a palapa (wooden structure comprised of sticks and overhung with palm fronds) used by
local fisherman under which they store canoes. Light pollution was not a factor along the beachfront, eliminating one deterrent for female turtles exiting the water in this location, as the closest homes of Salado Barro village are set back from the beach entrance by approximately 90m. By our observations tidal variations along the beach could not be avoided and thus all measurements of transect profiling were taken assuming the 0 m to be the visible high water mark.

Surveys were taken during July and August 2012. I participated from July 2nd to August 16th. The Hawksbill nesting season in the Caribbean Sea stretches from April to November, and peak nesting activity is thought to occur from June to September in Honduras (Chacon, 2004).

**BEACH SECTOR PATROLS**

Initially the beachfront, limited for the sake of patrolling to a 10 km stretch, was divided into sectors by natural landmarks from the entrance and named West 1, West 2, East 1, and East 2. This delineation facilitated scheduling of patrols and reporting of location between patrol groups.

A monitoring program via patrols, for the purpose of tracking the use of nesting sites on the beach has been established (Dunbar, 2010). Patrols were conducted 5 nights out of the week, within an hour of sunset (19:00) until sunrise (5:00), with varied longevity of 3, 4, 6 and 7 hours depending on weather conditions. During the nightly patrol period, each segment of the beach was patrolled each hour. This maximized our chances of observing nesting turtles, since the marine turtle nesting process typically lasts 40 to 90 minutes (Stapleton and Eckert, 2008). When weather did not permit an evening
patrol, a morning patrol was done to count tracks and identify any nests laid the night before.

The two standard patrolling groups that covered the westward and eastward beaches were typically composed of at least one researcher, one guard, a volunteer from El Centro Universitario Regional del Litoral Atlantico (CURLA) if possible, and one community member. When guards were unavailable, the group composition increased in community members. When no personnel were available, besides the two researchers, a single patrol group covered the entirety of the beach with reduced rest time than designated in standard protocol. Direction of patrols alternated in the eastward or westward direction. The patrol groups walk their respective beachfronts continuously for the duration of each patrolling session with 10 - 20 min breaks at each end of the beach sector.

Factors known to discourage female turtles from nesting are light, noise, and movement. While walking the beachfront the patrol groups held flashlights (dimmed if possible) at a low level and parallel to the ground, and scanned the sand as infrequently as possible (regularity being dependent upon visibility). They also took efforts to minimize noise and motion (Stapleton and Eckert, field procedures manual, 2008).

If crawls were encountered, they were first identified by species type (the Hawksbill crawl pattern is asymmetrical and of a maximum width of 70 - 85 cm) and then as either a false crawl or a nesting situation, in accordance to the graphics provided in Stapleton and Eckert 2008 and Gulko and Eckert 2004. If a nesting incident was encountered, a standardized protocol for “Patrol Information Collection” and “Tagging” were followed so as to ensure data collected could be used by the wider Caribbean regional database.
BIPOLAR LINE TRANSECT BEACH PROFILING

We used the bipolar line level to document topographic profiles along the beach, with GPS locations at the beginning and end of each transect. The beach (Fig. 2A) was principally divided in the same manner as outlined previously (BEACH SECTOR PATROLS), with each sector further divided into 5 m increments (Figs. 2B-C). The beach entrance was set as the central reference point (aka the 0 m mark in terms of east-west direction). For data recording purposes we assigned the graphical planes X,Y,Z as indicative of the east-west tangent (X), north-south tangent (Y), and up-down (Z) directionalities respectively. The 0 m and central point for X,Y,Z planes was set at the high water mark in line with the beach entrance (Fig. 2D). In demarcating the transect lines with respect to Y (from high water mark to vegetation line), a constant compass bearing of 21 degrees south was maintained to ensure that from the beginning point the transects lines remain parallel and thus the 5 m distances between X0, X1, X2…etc. hold true for each Y point along the given tangents (Fig. 2E). At a given X point the width of the beach, from high water mark to vegetation line was measured and divided into 5 m segments along the Y axis, with 0 m being the high water mark (Fig. 2F).

In order to topographically survey the beachfront using the bipolar line level method, the following materials were needed: 3 pieces of PVC piping at least 150 cm in length each with a leveler attached (to be considered as pipe F, G, H for referral purposes), a string of at least 10 m length (markings made at 5 m intervals), one soft measuring tape of 1 m length to be affixed to PVC pipe H, a larger measuring tape of at least 20 m length, a detachable line-level able to be hung on a string, a GPS device with compass feature, notebook, pen, and reflective or bright tape for marking sectors.
At the beginning of each transect, the starting point of Y = 0 at the high water mark, was marked both visually (for the placement of PVC pipes held by researchers) and on the GPS device (labeled as Wbeach0, Wbeach1, Wbeach2…etc., or Ebeach0, Ebeach1, Ebeach3…etc.).

Beginning at the high water mark (considered 0 m along the Y axis) of a given tangent, a researcher held the PVC pipe F. The 12 m string was then, at one end, tied to...
pipe F and at the other, tied to pipe G. Another researcher held pipe G and walked in the southward direction (away from water) until the string was taut. When this was achieved, holding the PVC pipes F and G upright (checked with the affixed levelers), the two researchers adjusted so that the string’s mark for 0 m was directly over the transect mark at the high tide line. A third researcher took a compass reading while walking along the string length, from high water to vegetation, to ensure it was lying in the 21 degree south direction, adjusting the position of the second researcher (holding pipe F) if necessary. This was repeated until proper orientation was achieved. The detachable leveler was then used at the string’s 5 m mark, to ensure that the string was level, adjusting at which height the string was tied to pipes F and G if necessary. This was repeated until the string was level.

The pipe H, with soft measuring tape affixed along its length, was used to measure the height of the string at the 0, 5, and 10 m mark. The affixed leveler on pipe H was used to ensure that it’s orientation was directly vertical as measurements were taken. The measured heights (Z) of the string were recorded in a field notebook as heights (Z) at points A, B, C, D…etc. in accordance to the various Y points of 0, 5, 10, 15 m and entered into the computer database at a later time (Fig. 3).

As the width of the beach Y (north/south—from high tide to vegetation) was variable along the X (east/west) axis, it was sometimes necessary to shift the contraption up beach.
(south) so as to take measurements at Y = 15, 20, 25…etc. (As the length of the string is 10 m, this must be done in 10 m increments). To do so, the first researcher must move pipe F to pipe G’s previous position and the second researcher walked with pipe G 10 m 21 degree south until the string was taut. The procedures outlined previously for ensuring that the string is both lying in the southern 21 degree orientation and level, were followed, with one important difference. Before leveling the string, the height of the string on pipe F was adjusted to the previous height measured at the point Y = 10 m, previously on pipe G (this was done to calibrate the measured height at pipe G). Then, when leveling the string, adjustments were made only to the height of the string tied to pipe G (now located at Y = 20 m). By doing this the string will theoretically remain at a constant level over any Y distance over 10 m.

The relative heights of the strings (Z) for a given tangent (Y) along the beachfront (X) were entered into the computer database, in which the mathematical difference of the adjacent heights (Figs. 4A-B) were found and, by reversing the sign of the difference, used to determine the relative slope of each segment (Fig. 5).
By setting the first height measurement at the waterline at an elevation of 0, relative height differences could be calculated for the subsequent elevations 5m up from the waterline.

![Figure 5](image.png)

Figure 5 The mathematical difference of the adjacent heights, once calculated, can determine the relative slope (by reversing the sign) between X,Y coordinates.

**VEGETATION PERCENTAGE BEACH PROFILING**

Both my research partner and I received training from Dr. Stephen Dunbar on proper vegetative percentage cover profiling procedure. We determined the type and distribution of various vegetation categories along the beachfront. Equipment needed included a soft measuring tape of at least 20 m length, a field notebook, GPS, and three researchers. Pairing vegetation transect section data collection with GPS readings, at the transect section’s beginning and end enabled for the data to later be put into an all inclusive beach map constructed by the use of ArcGIS.

Beginning at the X=0 and Y=15 point (this line was chosen for the following reasons; studies note a 10 m above water line minimum for nesting site and as a
procedural note, characterizing the entire beach area by vegetation percentage would be impractical), a GPS location was taken and the measuring tape stretched (with 0 m of the measuring tape corresponding to the X=0) to the X=20 and Y=15 point, where a second GPS location was marked. With one researcher holding each end of the measuring tape taut, a third noted the distance covered (in m) by each vegetation type in the field notebook. Vegetation classifications were: sand, grass, sea grape, Hicaco, or unknown. In the latter case, the vegetation was sampled and photographed to allow subsequent identification.

This procedure was sequentially repeated along the beachfront in both the eastward and westward directions. For example the next vegetative transect was from X=20, Y=15 to X=40, Y=15, once again noting the GPS coordinates at the beginning and ending of each transect.

**POLLUTION DETERMINATION**

We observed a wide range of refuse pollution. Thus, we created a protocol for Rapid Beach Pollution Assessment in which we used descriptive methods to divide the beach into sections of more-or-less homogeneity.

Starting at the coordinate X=0, Y=0 (as used in the Bipolar Line Level methodology), a GPS coordinate was marked, serving as the beginning of the profiling segment #1 (P01). We then walked along the high tide line, recording observations of pollution features in descriptive terms and qualitatively dividing the beach into homogenous segments.
At the end point of a determined homogeneous segment a GPS coordinate was marked, serving as the end of profiling segment #1 and as the beginning of the profiling segment #2, denoted as P02.

Pollution severity was determined and observations recorded in a qualitative manner because attempts to display differences quantitatively by weighing pollution samples proved unreliable.

**MAPPING**

ArcGIS 10.0 (http://www.esri.com/software/arcgis/arcgis10) was used to generate a multilayered display of environmental features relevant to turtle nesting.

The following attributes known to favor nesting were mapped: beach elevations ranging from .75-1.25 m (Gulko, 2004; Horrocks, 1991; Zare, 2012), sand coverage ranging from 22.5-67% (Zare, 2012), and grass coverage ranging from 35-82% (Horrocks, 1991; Zare, 2012). Also mapped were two features expected to interfere with turtle nesting—combined sea grape and Hicaco vegetative coverage above 60% (Horrocks, 1991; Zare, 2012), and areas of severe pollution (Bräutigam, 2006; Chacon, 2004).

The physiognomies of sand, grass, sea grape/Hicaco, and pollution were mapped for the entire 10 km stretch of beach, whereas beach elevation data were mapped only for the central 267 m of beach front due to time constraints.

The focus of plotting these favorable and unfavorable features, by overlaying the resultant maps, was to identify areas of the beach constituting viable potential nesting
sites—indicated by overlapping of the favorable attributes and an absence of unfavorable characteristics.

COMMUNITY INVOLVEMENT PROJECTS

Although research was the predominant focus of our project, as ProTECTOR is a conservation program that encourages community involvement events to increase public preservation efforts.

To help fulfill the mission of ProTECTOR, we enlisted the help of community members for our nightly patrol groups. Small food and monetary compensation were offered to children who accompanied us on nightly patrolling. We also sponsored both weekly English classes and multiple children’s activities focused around a message of conservation techniques and general information about the Hawksbill turtle species. My research partner, Angela Randazzo, and I acted as teachers for weekly English lessons. Lesson plans for each week were created using Power Point and generally included repetition of key points from the previous week, useful introductory phrases, and English names for animals found in the reservation. Community events, primarily intended for the children of the Cuero y Salado village, included craft projects, outdoor games, instructional demonstrations, celebrations, and animal movie screenings.
RESULTS

BIPOLAR LINE TRANSECT BEACH PROFILING, VEGETATION PERCENTAGE BEACH PROFILING & DESCRIPTIVE BEACH PROFILING

The 10 km study area of beachfront, (Fig. 6A), was mapped for vegetative categories and pollution (Fig. 6B), but only the central 267 m was intensely investigated and mapped with elevation data as well (Fig. 6C).

Beach elevations matching known preferences of nesting Hawksbills were observed (listed as coordinates in degrees minutes seconds in APPENDIX A) at intervals throughout the study area (Fig. 7), with favorable elevation occurring more commonly in the West beach sections.

Favorable percentages of sand-coverage (APPENDIX B; Fig. 8A) and grass coverage (APPENDIX C; Fig. 8B) were found at intervals throughout the study area along the line 15m above high water mark.

Unfavorable percentages of sea grape and Hicaco coverage (APPENDIX D; Fig. 9A) along the 15m line and an area of pollution (APPENDIX E; Fig. 9B) were only observed in the west beach portion.

By layering maps displaying favorable and unfavorable environmental features, the most viable locations on the beach for turtle nesting, which displayed an overlap of three positive nesting environment characteristics and a lack of negative nesting environmental characteristics, were found in a large region in the west beach portion and a small region in the east beach portion (APPENDIX F; Fig. 10). Also, we considered potentially feasible nesting ranges as areas displaying an overlap of two positive nesting
environment characteristics and a lack of negative nesting environmental characteristics these secondary sites (APPENDIX G) were found in both the east and west beach segments (Figs. 10A and B).

Fig. 6 (A) Map displaying the Cuero y Salado beachfront, highlighted by the blue rectangular box is the 10km of beach front under study. (B) Map of the 10km of beach front under study, highlighted by the green rectangular box is the 267 m considered by intensive data analysis. (C) Displaying the 267 m multilayered data map, including elevation.
Fig. 7 Areas of favorable elevation between .75 and 1.25m located 10m above sea level indicated by green dots and those points greater than 10m from waterline incorporated in polygons.

Fig. 8 (A) Displaying areas of favorable sand-coverage percentages between 22.5% and 67% in the green crosshatched boxes. (B) Displaying areas of favorable grass percentage cover between 35% and 82% in the green crosshatched boxes.
Fig. 9 (A) Displaying areas of unfavorable Hicaco and Sea Grape vegetation cover above 60% in the red crosshatched boxes. (B) Displaying areas of severe pollution in the red cross-hatched circles.
Figs. 10 (A) Areas most suitable for nesting are highlighted in dark green, with overlap of three positive environmental attributes and devoid of negative environmental attributes, other areas suitable for nesting with overlap of preferred elevation and at least one other positive environmental element and devoid of negative environmental attributes are highlighted in bright green. (B) Displaying viable nesting sites with all other layers removed for visual clarity.
DISCUSSION

No turtles or nesting incidences were observed, suggesting a very low nesting population along the 10 km beachfront of Cuero y Salado Wildlife Refuge for the months of July and August. Dunbar et al (2013) have reported numerous anecdotes from local fishermen of both Hawksbill turtles and nesting sites from previous nesting seasons. However, none were reported to us for the 2012 nesting season (see Dunbar et al, 2013 A & B). We have further confidence in our conclusion as nightly patrolling procedures were executed in such a way to note all turtle nesting incidences (BEACH SECTOR PATROLS), and the nights when patrols were shortened or cancelled due to extreme weather conditions represent time periods of very low nesting likelihood, and are thus not suspected to have influenced results.

While our observations are disturbing, they are not entirely unexpected. The resultant 0 baseline observation for the historic Cuero y Salado nesting beach confirms worldwide and regional trends reported elsewhere (Bräutigam, 2006; Chacón, 2004; McClenachan, 2006) as it applies to Honduras.

Caribbean Hawksbills were abundant in the past, as confirmed by historical records, with an estimated population of 11 million Hawksbills (McClenachan, 2006) and high-density nesting areas. At present, however, the Hawksbill population is very diminished over the entire western Atlantic Caribbean region (Chacón, 2004), now listed as critically endangered on the IUCN’s Red List for having suffered adult population declines of at least 80% over the last three generations (Stapleton and Eckert, 2008). The present vacancy of nests along the beachfront at Cuero y Salado agrees well with the estimated
20% loss of historic nesting sites and, 50% reduction to dangerously low levels reported for remaining nesting sites (McClenachan, 2006).

There have been no previously detailed marine turtle population counts, nesting habitat studies, and only maps of nesting beaches based on anecdotal reports (ref) in Honduras. Thus our results contribute much-needed information to Caribbean Hawksbill conservation efforts (Dunbar, 2010; Bräutigam, 2006).

The other significant portion of our study are the maps of environmental factors relevant for turtle nesting success. These maps are vital in making the case for habitat preservation of Cuero y Salado’s beachfront, because we have demonstrated that it is a suitable nesting area.

Results from previous Hawksbill studies in other countries note that turtles tend to cluster their nests at specific elevations, near 1 m above sea level, and that elevation is the most important cue for nest-site selection (Horrocks, 1991; Zare, 2012) with a necessary minimal distance of nest site from high tide line (average distance of 10 m) of which this beach generally displays beach width of over 15 m (Horrocks, 1991; Zare, 2012).

Distribution of vegetation cover has been documented in other studies as another vital characteristic in determining a beach’s suitability (Eckert, 2008; Gulko, 2004; Horrocks, 1991; Kamel, 2009; Zare, 2012). Hawksbills, in contrast to leatherback and green turtle, are known to prefer beaches with mature vegetation (Stapleton and Eckart, 2008), such as that which borders nearly the entire 10km of the Cuero y Salado Wildlife Refuge beachfront.

Of the 10 km beachfront under observation, 267 m were considered for more intensive nesting environment data analysis. This analysis correlated elevation, beach
width, multiple vegetation percentages, and pollution severity—displayed as multiple overlapping map layers, using ArcGIS to identify most viable sites for turtle nesting. We have demonstrated that the beachfront at Cuero y Salado contains features associated elsewhere with viable nesting habitat; we documented substantial regions displaying low pollution, and interspersed vegetation with adequate sand coverage within the central 1 km area of beach. Along with this, we measured significant areas of adequate elevation and beach width within the 267 m central area of the beach that was intensively surveyed. It is important to note that while these results may suggest the state of the entire beach at CYSWR, the limited beach area where data analysis took place (only 1/10 of the entire 10 km beach front was characterized by vegetation and pollution, and of that only the central 670 m was analyzed in terms of elevation) may not actually represent the remaining beach accurately.

COMMUNITY INVOLVEMENT PROJECTS

Offering minor monetary compensation to the children who accompanied us, and providing small snacks during patrol breaks, did garnering larger nightly patrol groups. Similarly, relationships forged in the English lessons and hosted community activities with village children facilitated opportunities for enlargement of our patrol and profiling volunteer groups.

Our single-season presence at Cuero y Salado Wildlife Refuge (preempted by interviews of various community members and local fishermen the season before) does not allow for a conclusive statement on improvement of community opinion regarding, and priority given to, Hawksbill conservation. However similar programs in the
communities of Punta Raton and El Vanado have—by comparison of the 2009 and 2010 annual reports—resulted in improvement of community attitude towards preservation efforts. Regarding community involvement projects, though the actual activities varied on their face value (i.e., crafts, celebrations, instructional demonstrations, English classes, and movie showings) the undergirding purpose of the community involvement events and undertakings was to change the municipal mindset regarding turtles, individuals’ impact on and responsibility for the turtle population, and to involve the community in ongoing preservation efforts in Honduras at large, and more specifically within their village (Figs. 11).

The activities facilitated opportunities to discuss the significance of sea turtles in both their ecological niche and for their necessity to the community of Cuero y Saladao. Through such discussions more volunteers were garnered for patrolling and surveying—

Figs. 11 (A-B) Researchers Ariana Cunningham and Angela Randazzo helping during a Hawksbill awareness children’s craft activity. (C-D) Local school children who partook in our community and turtle awareness activities. Included are volunteers for night patrols.
in such an easy-to-understand context I believe a precedence and framework was set on which to build a long-term national nesting beach conservation program and establish a long-term index site for population monitoring should ProTECTOR decide to continue investing in this area.

CONCLUSION

In summary we have demonstrated that the historically noted Hawksbill nesting beach of Cuero Y Salado (currently under study and observation by the ProTECTOR program) may have a very low nesting population density. However, various beach characterizations of principal environmental factors (elevation, vegetation, beach width, and pollution) suggest, however, that the beach is still suitable for Hawksbill nesting although it may not be currently used as such due to substantial population declines in the area. Despite this, the beach is of significant preservation value.

As a result of this study, a useful framework has been established on which to build a long-term national nesting beach conservation program and established a potential long-term index site for population

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APPENDIX

APPENDIX A

Favorable elevations (from .75 m to 1.25 m) are found in the following ranges, expressed as coordinates in degrees minutes seconds: 

APPENDIX B

APPENDIX C

APPENDIX D

Sea grape and Hicaco coverage (above 35% and below 82%: 86°59'58.952"W 15°46'14.197"N and 86°59'58.147"W 15°46'13.896"N.)
APPENDIX E

Pollution incidence was noted at the following point: 86°59'59.459"W
15°46'14.895"N
APPENDIX F

86°59'57.654"W 15°46'13.898"N, 86°59'57.124"W 15°46'13.701"N, 
15°46'13.464"N, and 86°59'57.817"W 15°46'13.625"N; 86°59'52.284"W 
15°46'11.676"N, 86°59'52.128"W 15°46'11.618"N, 86°59'52.18"W 15°46'11.443"N, 
and 86°59'52.336"W 15°46'11.508"N.
APPENDIX G

86°59'59.009"W  15°46'14.121"N, and 86°59'58.844"W  15°46'14.41"N;
86°59'57.986"W  15°46'14.096"N, 86°59'57.697"W  15°46'13.928"N, 86°59'57.911"W
15°46'13.484"N, and 86°59'58.235"W  15°46'13.674"N; 86°59'55.007"W
15°46'13.019"N, 86°59'54.727"W  15°46'12.834"N, 86°59'54.78"W  15°46'12.701"N,
86°59'54.54"W  15°46'12.589"N, 86°59'54.487"W  15°46'12.739"N, 86°59'54.331"W
15°46'12.662"N, 86°59'54.447"W  15°46'12.347"N, 86°59'54.318"W  15°46'12.304"N,
86°59'54.22"W  15°46'12.61"N, 86°59'54.042"W  15°46'12.537"N, 86°59'54.105"W
15°46'12.352"N, 86°59'53.971"W  15°46'12.296"N, 86°59'54.078"W  15°46'12.158"N,
86°59'54.358"W  15°46'12.167"N, 86°59'54.354"W  15°46'12.175"N, 86°59'55.047"W
15°46'12.537"N, 86°59'54.949"W  15°46'12.778"N, and 86°59'55.101"W
15°46'12.864"N; 86°59'53.736"W  15°46'12.399"N, 86°59'53.58"W  15°46'12.347"N,
86°59'53.744"W  15°46'11.891"N, and 86°59'53.896"W  15°46'11.947"N;
86°59'53.051"W  15°46'11.986"N, 86°59'52.744"W  15°46'11.891"N, 86°59'52.811"W
15°46'11.719"N, and 86°59'53.109"W  15°46'11.848"N; 86°59'52.126"W
15°46'11.615"N, 86°59'51.984"W  15°46'11.568"N, 86°59'52.046"W  15°46'11.392"N,
86°59'52.17"W  15°46'11.448"N; 86°59'51.73"W  15°46'11.284"N, 86°59'51.57"W
15°46'11.215"N, 86°59'51.637"W  15°46'11.077"N, and 86°59'51.779"W
15°46'11.116"N.