

WILDLIFE CONSERVATION SOCIETY (WCS)

Final Report

Submitted By

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Introduction

The hawksbill turtle, *Eretmochelys imbricata*, is considered to be critically endangered with most populations in serious decline (Nietschmann, 1981; King, 1982; Groombridge and Luxmoore, 1989; Lagueux, 1998; Meylan, 1999; Meylan and Donnelly, 1999). On Nicaragua's Caribbean coast, hawksbill nesting occurs on the Pearl Cays, at El Cocal, and sporadically along the mainland; and all size classes forage in offshore coastal waters (Lagueux et al., 2003; Lagueux and Campbell, 2005; Lagueux and Campbell, unpubl. data). The Pearl Cays rookery is believed to be the largest remaining nesting population in the west-central Caribbean (Lagueux et al., 2003) and as such, has been identified as an important index site within the greater Caribbean for long-term population monitoring (see <http://www.cites.org/fra/prog/HBT/dialogue2/E-HT2-8.doc>). The Pearl Cays area also provides important foraging habitat for hawksbill turtles that nest both on the Pearl Cays and across the wider Caribbean, with up to five source populations identified in the Nicaragua foraging aggregation (Lagueux et al., 2001).

The Pearl Cays hawksbill population is severely threatened by decades of uncontrolled harvest of nesting females and their eggs, and by the opportunistic capture of foraging juveniles and adults (Nietschmann, 1981; Lagueux et al., 2003). In 1999, we conducted the first systematic surveys of the Pearl Cays rookery and discovered that nearly 100% of the clutches laid were taken by local fishers for personal consumption, and nesting females were often killed for their meat and scutes. In 2000, we implemented a local and government approved project to protect nesting females and their eggs. We also implemented a volunteer program that provides an incentive to local fishers and private guards to protect nesting females and donate live turtles (including juveniles) to the project to be tagged and released. This volunteer project provides an opportunity to educate locals and engage them in sea turtle conservation activities.

Both the volunteer and Pearl Cays nesting beach projects have been highly successful at reducing hawksbill mortality in the Pearl Cays area. For example, there has been a steady decrease in the number and percent of clutches poached and the number of clutches laid has increased since initiation of the nesting beach project (Lagueux et al., 2003; Campbell and Lagueux, 2004). In addition to protecting females and eggs, we have increased our efforts to collect data on their reproductive ecology to better understand nesting ecology and habitat needs of hawksbills in the Pearl Cays.

The Pearl Cays hawksbill population is currently facing destruction of its nesting habitat from the increase of human presence in the area. The construction of houses and the installation of lobster buying stations on several cays are directly affecting nesting behavior, as well as indirectly affecting their reproduction from the destruction and alteration of nesting habitat (e.g., sand mining and the clearing of upper beach vegetation), presence of exotic animals, and artificial lighting of nesting beaches. Because hawksbill turtles show a marked tendency to nest in the upper beach vegetation, we collected data on the vegetation present on the different cays to better understand its relationship to hawksbill reproductive success.

Objectives

To build on the accomplishments attained thus far, our objectives for the 2005 season were to:

1. quantify nesting activity on 12 of the Pearl Cays,
2. maintain or increase survival of egg clutches and nesting females,
3. determine hatching and emergence successes,
4. quantify alteration of nesting beach habitat and mitigate activities by alerting authorities of destructive activities,
5. collect reproductive and biometric data on nesting females,
6. promote conservation through the media and education,
7. build capacity at the local and regional levels,
8. improve local collaboration and increase government involvement in conservation activities, and
9. provide incentives to local fishers to donate live turtles for tag and release.

Methods and Results

Daily surveys

Daily nesting beach surveys were conducted on 12 of the Pearl Cays by local residents: William McCoy, Melvin Archbold, Ralph Cambalan, Jr., Roy Hodgson, Mitchell McCoy, Dorian McCoy, Mitchell Thomas, and Wesley McCoy; and two students from local universities, Michael Lewin (Bluefields Indian & Caribbean University, BICU), and Yenina Cooper (Universidad de las Regiones Autónomas de la Costa Caribe Nicaragüense, URACCAN), representing six coastal communities and towns (Corn Island, Bluefields, Haulover, Kahkabila, Pearl Lagoon, and Set Net Point). In addition to conducting daily nesting beach surveys, Ms Cooper and Mr. Lewin conducted research for their senior thesis. Periodic surveys were conducted in April, May, and early June to determine the onset of the nesting season and to protect clutches laid early in the season. Daily surveys were initiated on 8 June and continued until 25 October 2005. During each survey, data on the number of nesting emergences, and the status and location of each new nest was recorded. Nests were left *in situ* or relocated as deemed necessary by survey teams to protect them from would be poachers or environmental conditions inappropriate for incubation. Additional surveys were conducted post-25 October by the nest excavation team. From 20 April 2005 to 13 January 2006, a total of 1,680 surveys were conducted on 12 of the Pearl Cays.

A total of 205 egg clutches were laid on 11 of the 12 cays surveyed. The majority of clutches were deposited on Wild Cane (28.3%), followed by Crawl (12.7%), Grape (10.2%), and Columbilla (9.8%) (Table 1). No clutches were laid on Black Mangrove Cay this season. Poaching events were the lowest since 2000, with only 9.3% of clutches affected by poaching activities. Of the 19 clutches affected by poaching, 11 were completely poached and 8 partially poached (meaning some eggs were taken but part of the clutch was left to incubate).

Table 1. Distribution of hawksbill nesting and poaching activities in the Pearl Cays, Nicaragua, in 2005.

Cay	Total Clutches Laid		Clutches Poached or Partially Poached	
	Number	Percent	Number	Percent
Baboon	19	9.3	1	5.3
Black Mangrove	0	0	0	0
Bottom Tawira	16	7.8	5	26.3
Buttonwood	2	1.0	1	5.3
Columbilla	20	9.8	6	31.6
Crawl	26	12.7	0	0
Grape	21	10.2	0	0
Lime	11	5.4	2	10.5
Maroon	12	5.8	0	0
Vincent	13	6.3	3	15.8
Water	7	3.4	0	0
Wild Cane	58	28.3	1	5.3
Total	205	100	19	100.1

Of the 205 clutches laid, 103 clutches were left *in situ* and 94 clutches were relocated by the survey team, the remaining eight clutches were poached prior to encounter by the survey team. The average clutch size was 150.3 eggs, calculated based on the egg counts of relocated clutches (SD=41.9, range = 43-242 eggs, n=94). The average nest depth for *in situ* clutches was 39.0 cm (SD=4.4, range=30.0-58.5 cm, n=98) and for relocated clutches was 37.2 cm (SD=6.4, range=18.0-52.6, n=82).

As part of the additional data collected this season, a series of measurements were taken on each nest. Turtles crawled an average of 10.9 m on the beach to their nesting site (SD=8.78, range=1.4-42 m, n=140). The average straight line distance from the egg chamber to the most recent high tide line was 5.5 m (SD=3.9, range=1.0-27.2 m, n=173), which is similar to the 5.2 m average distance between abandoned digging attempts and the most recent high tide line (SD=2.8, range=1.6-15.4 m, n=50).

Nests excavations

Hatching and emergence successes for all clutches were 68.4% and 68.0% (n=164), respectively; regardless if any eggs hatched, and are similar to previous years. Hatching and emergence success for those clutches where at least one egg hatched (n=153) were 72.6% and 72.2%, respectively. Hatching success for relocated clutches and those left *in situ* were 67.2 % and 70.9%, respectively. We estimated that a minimum of 17,284 hatchlings emerged from nests in the Pearl Cays in 2005 (the exact number of emerged hatchlings cannot be determined since some nests could not be located to excavate and in other cases eggs shells were too fragmented to count). Of the 186 clutches that were not poached, 165 clutches (88.7%) successfully hatched, 10 clutches (5.4%) did not hatch for reasons unknown, 1 clutch (0.5%) did not hatch probably due to water inundation, 2 clutches (1.1%) were either completely or partially destroyed by other nesting females, 5 clutches (2.7%) were either completely or partially washed out by high tides,

2 clutches (1.1%) could not be located post hatching, and we could not locate 1 clutch (0.5%) that was relocated on Baboon Cay because cement was mixed and left to dry on top of the clutch prior to hatching.

Night Surveys

Night beach patrols to encounter nesting females were conducted frequently in June, July, August, and September by field staff and project supervisors. A total of 169 night surveys were conducted during these months. During night patrols, we encountered nesting females on 42 occasions, 25 of these encounters represented individual females, and the remaining 17 were resightings of the 25 individual females. Of the 25 females we encountered in 2005, 13 were not previously tagged and thus were tagged for the first time; and 12 were females that remigrated to the Pearl Cays from the 2003 nesting season. Two of these 12 remigrants were originally tagged prior to 2003: one in 2000 and one in 2001 (Table 2). A total of 34 females were observed nesting in 2003, thus, at least 35.3% of the females that nested in 2003 exhibited a two-year remigration interval (Table 2).

Table 2. Number of nesting hawksbills newly tagged and recaptured by year in the Pearl Cays, Nicaragua.

Year	# of Females Tagged	Number Recaptured by Year							Mean Remigration Interval
		1999	2000	2001	2002	2003	2004	2005	
1999	1 ^a					1			N/A
2000	4				1	2		1	2.5
2001	1					1		1	2
2002	17						9		2
2003	34							10	2
2004	14								-
2005	13								N/A

N/A Not applicable

^a Female was originally captured in-water and tagged, and was recaptured nesting four years later.

Habitat alteration

Human presence on the cays and its impact on nesting habitats were monitored throughout the nesting season. Eight of the 12 cays were permanently inhabited during part or all of the nesting season (from May to November). Four of these cays had residents at the onset of the nesting season (Baboon, Bottom Tawira, Buttonwood, and Wild Cane); while 2 other cays were inhabited later in the season (Black Mangrove and Lime). Water Cay was occupied only during October. The WCS survey team set up a temporary camp on Crawl Cay in early June and occupied the cay until late October. Out of the eight cays occupied, Bottom Tawira had the highest number of residents (with up to 32 inhabitants observed during the nesting season), followed by Black Mangrove with a maximum of 28 inhabitants, and Wild Cane with a maximum of 18 inhabitants. The inhabited cay with the lowest number of residents was Water (with a maximum of 6 people observed during the month the cay was occupied). Domestic animals were observed on 7 out of the 8 inhabited cays, including dogs, cats, and pigs. Bottom Tawira was the cay with the highest number and diversity of domestic animals, with up to 4 dogs, 3 cats, and 3 pigs simultaneously. Rats were observed on Lime, Water, and Grape Cays.

Nesting habitat alterations derived from human activities were observed on several of the Pearl Cays. New buildings were constructed on Buttonwood (1 house), Black Mangrove (3 houses and a lobster buying station), and Lime (where 2 houses were constructed on the upper beach platform) (Photo 1). Vegetation on some cays was also altered. Large areas of the upper beach platform were periodically raked throughout the season on Baboon and Wild Cane Cays, keeping them bare and preventing plants from growing. Also, cutting and clearing of dune vegetation were recorded on different occasions on Baboon, Black Mangrove, Bottom Tawira, Buttonwood, Lime, and Water Cays. It is important to note that on Water Cay, the upper beach platform on the south, west, and north sides of the cay was completely denuded, leaving large beach zones completely void of vegetation (Photos 2 and 3). Moreover, the extraction of sand from nesting beaches was observed on Vincent (once), Water (3 times), and Wild Cane Cays (4 times). The use of pesticides was observed 4 times on Wild Cane Cay.

Reproductive success and vegetation

The vegetation associated with each nest was analyzed to determine the relationship between nest site selection by nesting females and beach vegetation. Of 193 clutches, only 30.5% were laid in areas where vegetation cover per square meter was less than 40%, while 69.5% of the clutches were laid in areas where vegetation cover was greater than 40% (Table 3), indicating a preference for greater vegetation cover by females when selecting a nesting site.

Table 3. Number of clutches laid in relation to intervals of ground vegetation cover per square meter at nesting sites in the Pearl Cays, Nicaragua, in 2005.

Vegetation Cover (%)	# of Clutches	% of Clutches
0	17	8.8
1-20	24	12.4
21-40	18	9.3
41-60	30	15.5
61-80	28	14.5
81-100	76	39.4
Total	193	99.9

Turtles crawled an average of 18.3 m (SD=11.0, range=5.4-42.0 m, n=19) on the beach to their nesting site in areas void of vegetation, compared to an average of 9.4 m (SD=7.0, range=1.4-34.3 m, n=113) in areas with medium to high density ground vegetation cover. The distance crawled by turtles in areas void of vegetation was significantly greater than the distance crawled by turtles nesting in vegetation (T-test, $t= 3.39$, $df=21$, $p= 0.0014$), further evidence that hawksbills prefer to nest in areas with vegetation. Clutches laid in areas void of vegetation were also significantly farther from the most recent high tide with a mean distance of 8.6 m (SD=6.1, range=1.9-27.2 m, n=28) compared to a mean of 5.0 m (SD=3.0, range=1.0-21.1 m, n=135) for clutches laid in medium to high vegetation ground cover, (T-test, $t= 3.04$, $df=30$, $p= 0.0024$).

Hatching success was analyzed in relation to percent ground vegetation per square meter at the incubation site. No significant difference was found between hatching success of nests left *in-situ*

and relocated (T-test, $t = -1.55$, $df = 149$, $p = 0.1215$), thus all nests were pooled together for the remaining analyses in this section. No relationship was found between hatching success and total percent vegetation cover ($r = -0.17$). When hatching success was analyzed in relation to percent grass cover, no relationship was found between the variables for those nests incubated in areas with less than 40% grass ($r = -0.01$, $p = 0.8729$, $n = 129$), however, when grass cover was greater than 40% there was a negative correlation between hatching success and percent grass cover ($r = -0.58$, $p = 0.0355$, $n = 13$) (Fig. 1).

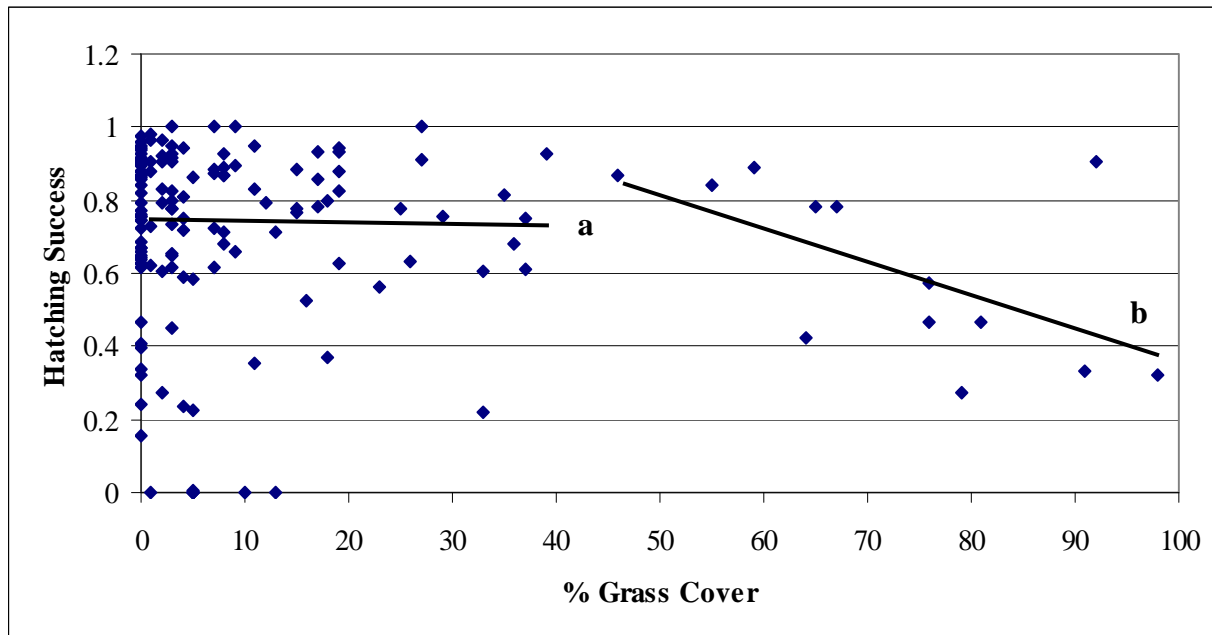


Figure 1. Scatter plot of hatching success and percent grass cover/m² for hawksbill nests on the Pearl Cays, Nicaragua. There was no relationship where percent grass cover was 40% or less (regression line a, $r = -0.014$, $p = 0.87$), however, there was a negative relationship where percent grass cover was greater than 40% (regression line b, $r = -0.585$, $p = 0.036$).

Beach vegetation where nesting occurs was also mapped on each cay. Ground vegetation of the upper beach platform was sampled every other meter along a 10 m transect from the maximum high tide line. However, due to the amount of data collected and the complexity of the analyses, it is still underway and the results will be provided at a later date.

Donation of live turtles

Between May and November, 63 live hawksbills (juveniles and adults) were donated to the project to be measured, tagged, and released. Of the 63 turtles, 12 were females, 4 were males, and the remaining 47 individuals were hatchlings, post-hatchlings, and juveniles. It is exciting to note that this was the first year post-hatchlings were observed in the waters of the Pearl Cays. Mean minimum straight line carapace length was 78.9 cm (SD=4.7, range=69.5-82.6 cm, $n = 7$) for females, 77.0 cm (SD=4.3, range=72.1-82.1 cm, $n = 4$) for males, and 41.4 cm (SD=15.4, range=3.9-66.6 cm, $n = 46$) for those of unknown sex.

Youth Group

The WCS Youth Group of Pearl Lagoon gave weekly radio spots throughout the 2005 season to update the communities on the status of the hawksbill project and problems that were encountered. These radio announcements were broadcasted by three radio stations in the region: Radio Caribbean Pearl (from Pearl Lagoon, broadcasted in English), Radio Rhyme and Radio Zinica (both from Bluefields, one broadcasted in English and the other one in Spanish). The Group also gave presentations about sea turtles to 5th and 6th grade students in the Pearl Lagoon and Haulover primary schools. A total of 176 students attended these presentations.

As part of the educational and awareness raising activities, the Youth Group made a trip to the Pearl Cays. During this trip, the students learned about different aspects of the biology of hawksbill turtles, the threats they are facing, and the conservation and research techniques used by the project scientists. They also had the chance to help measure and release several live turtles captured by project staff or donated to the project during their trip. The students were given the opportunity to appreciate and reflect on the natural richness and importance of the Pearl Cays. The Youth Group is currently working to raise funds to travel to Tortuguero, Costa Rica, to learn more about sea turtles and the potential for sustainable use of this valuable resource through ecotourism.

Discussion and Conclusions

An increase in nesting activity has been observed during the last three years (2003-2005) of the project with a mean of 187 ± 15.7 nests, compared to a mean of 156 ± 2.1 from 2000-2002. In 2005, a record 205 clutches were laid in the Pearl Cays since initiation of the project. We believe this is a result of increased survival of nesting females due to fewer females being killed during the reproductive season and thus allowing them to lay their complete complement of clutches for the season, rather than being killed after laying only one or two clutches. This apparent increase in the survival rate of reproductive females at the nesting site will aid in the recovery of this population more quickly. We are very encouraged by this gradual, but consistent increase in nesting activity.

Poaching activities have also consistently decreased since 2000, achieving the lowest poaching rate (9.3%) in 2005 since the onset of the project. We believe the low poaching rate in 2005 was due in part to the location of the WCS camp on Crawl Cay, locating the conservation team in the center of the group of cays where the majority of nesting occurs. At the same time, local fishers are becoming more cooperative with conservation efforts in the Pearl Cays. For example, they are taking fewer clutches, informing the survey crew of new clutches, and capturing females after they lay and donating them to the survey team to be tagged and released. Increased collaboration of the fishers on Bottom Tawira has been of particular importance this year due to the high number of clutches deposited on this cay in 2005 and the fact that most clutches were taken on this cay in previous years. Similarly, several nesting females and hawksbills captured in the water were donated to the project by fishers on Bottom Tawira. Our continued efforts to increase local involvement, raise awareness, educate local communities and fishers on the cays have played a critical role in improving local collaboration with conservation efforts, and we are confident that protection of hawksbills will continue to increase in the coming years.

Nesting habitat alteration and destruction is an increasing problem on the Pearl Cays, and is directly associated with human presence. Hawksbills are affected by habitat alteration and destruction directly and indirectly, for example, no nests were laid on Black Mangrove Cay this season, probably because the section of the cay typically used for nesting was turned into a camp for lobster fishers, where traps and materials regularly occupied the beach. Construction on the upper beach platform not only occupies the space turtles use to nest, but also destroys the surrounding beach vegetation (Photos 1-3). The presence of exotic animals that alter the beach (e.g., pigs) or deter turtles from nesting (e.g., dogs) also have a direct impact on nesting behavior. When hatchlings emerge from the nest and make their way to the sea, they are highly vulnerable to predators, both wild and domestic, and if domestic predators are not controlled they can increase hatchling mortality considerably. Moreover, the use of pesticides represents a threat not only to the hawksbill population, but also to the Pearl Cays' delicate ecosystem, potentially affecting the diversity of plant and animal species in both the marine and terrestrial environments. Because of the importance of this hawksbill turtle population, regulations and enforcement are needed to control destructive activities on or near the Pearl Cays. The declaration of the Pearl Cays as a marine protected area would be a first step in regulating destructive activities and protecting this valuable ecosystem.

Hawksbill turtles show a preference for nesting in the upper beach vegetation. Throughout recent years, this vegetation stratum has been repeatedly altered and destroyed on several of the Pearl Cays. Turtles crawl longer distances on the beach when there is no vegetation cover, spending more energy during the nesting process than they would if natural vegetation were present. A higher energy cost to lay eggs would likely result in lower production of eggs throughout the season, and a waste of their reproductive capacity. Moreover, early succession of ground vegetation after it has been cleared favors highly competitive species, which are commonly exotic grasses. Grasses often have long roots that grow into the nests and are the likely cause of decreased hatching success with increased grass cover. In addition, roots can trap hatchlings attempting to emerge from the nest, reducing their post-hatching survival (Photo 4). Thus, destruction or alteration of beach vegetation in the Pearl Cays can seriously compromise hawksbill reproduction and regulations are needed to prohibit these activities.

The 2005 season was highly successful with increased nesting and low poaching rates, and we are confident that as these efforts continue the Pearl Cays hawksbill rookery will gradually move towards recovery. Nevertheless, we need to keep working to reduce the poaching of nests and turtles, as well as to protect their critical feeding and nesting habitats. Efforts to protect hawksbill turtles in Nicaragua are currently focused on the Pearl Cays, where WCS is conducting a conservation program, however, because of the migratory nature of these animals, efforts to enforce existing regulations, increase awareness and educate local communities should be extended to protect hawksbills along the entire Caribbean coast of the country. This will ensure that they are protected no matter where they move within the territory of Nicaragua, and greatly improve their conservation outlook in the region.

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Photo 1. House built on the upper beach platform where hawksbills nest on Lime Cay, Pearl Cays, Nicaragua. (Photo: WCS)



Photo 2. Ground cover vegetation of the upper beach platform was removed where hawksbills nest on Water Cay, Pearl Cays, Nicaragua. (Photo: WCS)



Photo 3. Ground cover vegetation of the upper beach platform was removed where hawksbills nest on Water Cay, Pearl Cays, Nicaragua. (Photo: WCS)



Photo 4. Dead hatchlings trapped in grass roots at top of nest. (Photo: WCS)