Wildlife Conservation Society

NICARAGUA HAWKSBILL CONSERVATION PROJECT REPORT 2018

PEARL CAYS WILDLIFE REFUGE (PCWR)

By Karen Joseph, 2018

Wildlife Conservation Society

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Contenido

LIST OF ACRONYMS

CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora

DNC Did Not Check the cay

ES Emerging Success

FBD Found By Depression

GPS Global Positioning System

HCP Hawksbill Conservation Project

HS Hatching Success

IMP Intensive Monitoring Period

IUCN International Union for the Conservation of Nature

MARENA Ministerio del Ambiente y los Recursos Naturales

MVL Nests moved from Vincent cay to Lime cay

PCWR Pearl Cays Wildlife Refuge

REC Newly tagged turtles without previous tags/evidence of tags

REM Re-Migrant turtles with existing tags

REN Re-Nesting turtles with tags checked or implanted in the same nesting season

RACCS Region Autonoma Costa caribe Sur

SERENA Secretaría de los Recursos Naturales

SD Standard Deviation

TG Territorial Government

WCS Wildlife Conservation Society

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EXECUTIVE SUMMARY

The Wildlife Conservation Society (WCS) conducted monitoring surveys of hawksbill sea turtles (Eretmochelys imbricata) in the Pearl Cays Wildlife Refuge (PCWR), Nicaragua since 1999. For this 2018 nesting season we have found a total of 918, all clutches were recorded during this 2018 season; the greatest number of clutches in the 19-year history of the project in Pearl lagoon basin, Pearl Cay Wildlife Refuge.

During the intensive monitoring period (IMP), from May 4th to December 07th 2018, and additional opportunistic surveys, include ending of December 2018 to April 2019, at least one time per month in the year 2018. WCS teams worked in total 235 day, an approximate of 1,292.5 hours with a mean of 5.5 hours per day; and completed 1,869 cay surveys (this is defined as number of times each cay was surveyed by teams during the period May-December 2018) which represent an 79 cay visit per trip, on an average of 8 cays visits per day as a short run survey and 11 cays on a long run survey including opportunistic surveys.

The number of clutches lay in this 2018 represents 27.67% increase from 2017, and almost 500% increase from the first year of the project, exactly 496.10% increased since the year 2000. As previous years, it shows a continuous increasing pattern, the greatest number of clutches in the WCS history report on the Pearl Cay Wildlife Refuge. Most nest were located on tree cays, a continued pattern since 2016, leading Wild Cane Cay with 259 nest, followed by Water cay with 218 nest, and this year for first time highest third position is Crawl cay with 127 nest. Our saddest results was the report from Vincent Cay, one (1) nest were recorded, because it's already under water during the season period of 2018. Similarly will be the result for Maroon cay on a close future.

But also we have positive results in poaching, it have been a year of the lowest poaching rate in project history. Of the 918 nests only 36 nests were poached or sacked, resulting in 3.92% in poach for the 2018 season, a reduction of 0.8% less than the previous year, with a higher number of clutches.

Based on the range of survival rates, of the 918 nests, 792 nests had at least one turtle hatched out its egg; one hundred and twenty six (126) clutches had 0% survival rate. This caused by fallow: nest with 0% hatched 45, wash away nests 11, nests dig up by dogs 4, nest destroyed by roots 14, nests destroyed by turtles 3, nest eaten by rats 1, nest destroyed because of high tide 12 and 36 nets were poached.

Based on the number of empty egg shells >50% found during excavations, an estimated of seventy two thousand two hundred and fifty five (72,255) live hatchlings were hatched in the 2018 season on the Pearl cays, a number of nineteen thousand five hundred and forty nine (19,549) young babies turtles more than the previous year, equivalent to 27.09% increase of previous year. As a global summary this 2018 season for Hawksbill was grate we had a reduction of unhatched eggs form 63,779 eggs to 36,030 eggs which didn't hatchet out because a number of reason, this represent a decrease of unhatched eggs of 43.5% in comparison of the previous year.

During the intensive monitoring period (IMP), the pattern continue to be same, six of the 11 cays monitored were permanently inhabited (Baboon, Crawl, Grape, Lime (Calala), Water, and Bottom Tawira), three of the cays were frequently inhabited by residents or fishermen (Buttonwood, Columbilla, and Wild Cane) and two cays were not observed to be inhabited (Maroon and Vincent-both cays are practically disappeared) these last two are completely eroded with no presence of vegetation. Practically, Vincent cay was under water most of the time. As similar with previous year, Bottom Tawira recorded the highest mean number of observations for people per cay-survey (by fishers), with Lime now Calala Resort and Crawl second and third highest because an increase of tourism, this phenomenon also occurred on Wild Cane Cay. Also a fish collection center was established on Wild Cane Cay, but territorial board asks the fishers to move away because of turtle nest in the area.

Based on our daily check recorded in our human activities books, a total of 26 burning events went on in turtle nesting areas or beaches, they reduced a 50% of burning activity on Maria Crowcam cay by workers of Lime Cay (Calala Resort), constantly vegetation removal in and out water, digging and removing sand also digging and destroying coral reef was done by workers of Calala resort also

around Lime Cay and Wild Cane cay. Vegetation clearing events, mangroves cutting inclusively, and path way were constructed on the southeast side of the island. Also they are constructing into the water a platform out concrete, this is set on the Northeast side of the island.

WCS teams continue to observe human activities harmful to hawksbill nesting habitat and conservation on a regular basis in the PCWR (i.e. harvesting of juvenile marine species, including different species of turtle, sharks, and lobsters). The presence of Exotic animals such as Monkeys and Parrots was also observe on cays, including dog that barking at she turtle when to put eggs and digging and eating turtle eggs, especially on Grape Cay and Crawl cay. Include the animals mention before it also observed the presence of chicken destroying nest on Crawl and Grape cays. In resume, we have observed on all inhabited cays vegetation burning and getting clean out and sand removal.

A total of four (4) turtles were tagged clean off and measured this year (pin was put on fins) by the team, those were donated by fishers in this 2018 season, this year same as last year, this time a young juvenile green turtle were donated to the project on main land in Pearl lagoon office by two fisher

men, this was tagged then it was taken out on cays out to sea to be release hour after by our Hawksbill turtle team members, T-shirts was given to all those people who give support on turtle conservation activities, in and out the pearl Cay Refuge.

In 2018, WCS staff continued to support Kabu Tours (www.kabutours.com), the alternative livelihoods project that promotes the transition from green sea turtle harvesting to ecotourism activities. Efforts were made to inform local communities, authorities, and tourists about the hawksbill conservation project and state of turtle conservation in the PCWR before, during, and following the 2018 season. This season was not as prosperous like previous years, because of the reduction of tourist in the region. Kabu Tour is considered bankrupt, which will need major attention to restore their activities in the future.

At an educational level, more than one thousand (1000) children and youth were trained and educated about seas turtle and WCS Hawksbill project in Pearl lagoon and the Pearl Cays Refuge.

WCS marine coordinator in company of the office secretary visited all primary and secondary schools in the communities of Pearl lagoon, Hallover, Awas and Raitipura, (local communities of the Pearl Lagoon basin), presentations were made for children's and youth about marine sea turtles and the Hawksbill turtle project in Pearl lagoon and Pearl cay Wildlife Refuge. Also students competition, ***"WHO KNOWS AND LEARNS MORE",*** we also made a coordination with MARENA regional office and had the visit of CARLITOS the official MASCOT of the Municipal council of Bluefields. Student University field trips, was done monitoring and patrolling activities include managing the bock for data collection was given for student training, nest check and nest excavation process included. All students that had the opportunity to go out on the Pearl Cays Refuge had experience in see turtles hatching and nesting. These activities were communicated through a variety of mediums (radio, signage, presentations, informal talks, classrooms (primary, secondary and University) visits, Earth and Environmental Day activities, etc.) in two different languages (English-Creole and Spanish).

The project was also featured in several WCS social media posts celebrating the record-breaking year and long-term achievements in the Pearl Cays.

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This 2018, WCS continue giving technical and economic support to the process to create the Pearl Cay Wildlife Refuge Management Plan, the objective was to have a draft by the end of the year. We also initiate the process of communication with Corn Island authorities to see if we can get Corn Island and Litle Corn Island to be declared as a Marine Protected Area.

There were many achievements to celebrate during the record-breaking 2018 hawksbill nesting season, these last three years has been very prosperous, and has shown great progress jumps resulting in almost 200 nest more than 2017 season and more than 300 nest since 2016 season when I first begins; but still facing significant threats to this important rookery. The state of sea turtle conservation in the Pearl Cays is extremely fragile, sensitive to a number of different human activities, human necessity and poverty; include market demands, Social and Political issues and never less, climate change. WCS presence on the cays during nesting season are crucial as to reduce poaching, and volunteer compliance of regulations from resource users. We consider that our long term goals are being fulfilled and visible in the eyes of the owners and resource users for Nicaragua and for WCS, it is well seen in our results and our presence in the region, well accepted by most of fishers and authorities at the communal and regional level.

Continued conservation success hinges on the consistency and expansion of current scientific and education activities, as well as dedicated efforts towards achieving progress on recommendations for the PCWR. WCS recommends continued work on these focal conservation areas for a greater positive impact on the recovery of local hawksbill nesting population and the habitats, essential for sea turtles and local livelihoods, the theme of Climate change is need to be addressed. Which might not sound as interested by some but very important for the Hawksbill population worldwide. We need to take into consideration that Seas turtle are migrant, not a static species, and they swim to to and in the Nicaraguan waters not just for a short visit but some to feed and others to nest as is the case of the Hawksbill turtles. The continuation of our project, this project is very important for the hawksbill population size recovery of the world, not just for the Caribbean Coast of Nicaragua. We will like to extend this project activity to other areas such as Corn Island and Litle Corn Island, include the Coastal zone of the Bluff Beach nearby Bluefields area.

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INTRODUCTION

The hawksbill sea turtle (Eretmochelys imbricate) is classified as critically endangered on the International Union for the Conservation of Nature (IUCN) Red List (Mortimer & Donnelly, 2015) and also listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix I (CITES, 2014). Hawksbills have been categorized as critically endangered since 1996, after being listed as endangered as early as 1986 (Mortimer & Donnelly, 2015).

The **hawksbill sea turtle** sea turtle belonging to the family Cheloniidae; it is the only extant species in the genus ***Eretmochelys***. The species has a worldwide distribution, with Atlantic and Indo-Pacific subspecies—*E. i. imbricata* and *E. i. bissa*, respectively. The hawksbill's appearance is similar to that of other marine turtles. In general, it has a flattened body shape, a protective carapace, and flipper-like limbs, adapted for swimming in the open ocean. *E. imbricata* is easily distinguished from other sea turtles by its sharp, curving beak with prominent tomium (sharp cutting edge of the beak), and the saw-like appearance of its shell margins. Hawksbill shells slightly change colors, depending on water temperature. While this turtle lives part of its life in the open ocean, it spends more time in shallow lagoons and coral reefs. The World Conservation Union, primarily as a result of Human fishing practices, classifies *E. imbricata* as critically endangered. Hawksbill shells were the primary source of tortoiseshell material used for decorative purposes. The Convention on International Trade in Endangered Species outlaws the capture and trade of hawksbill sea turtles and products derived from them. www.google.com/wikipedia/hawksbillseaturtle.

It is good to mention that Hawksbill reduction is the result of over-exploitation of adult females and eggs at nesting beaches, degradation of nesting habitats, taking of juveniles and adults in foraging areas, incidental mortality relating to marine fisheries, and degradation of marine habitats (Meylan and Donnelly 1999). On the Nicaragua's Caribbean coast, there is an increase in the number of nests despite of the list of reduction causes mentioned before. Hawksbill turtle nests have been recorded in the Pearl Cays Wildlife Refuge (PCWR), El Cocal, and periodically along the mainland, and all size

classes have been recorded foraging in offshore coastal waters (Lagueux et al, 2003; Lagueux & Campbell, 2005; Lagueux et al, 2012).

The Pearl Cays rookery is believed to be the largest remaining nesting population in the west-central Caribbean (Lagueux et al, 2003; Campbell et al, 2012) and as such, this area has been identified as an important index site within the greater Caribbean region for long-term population monitoring (CITES, 2002). Estimates from 2010-2012 showed an increasing trend in the Pearl Cays nesting population, with an estimated 60-104 females nesting per season (NOAA & FWS, 2013). And for recent years 2016-2018 evidently show increase trends in nesting population base on our total nest count and hatchelling with an estimation of 194 female nesting per season (analysis made from assumption that each turtle nest between 3 to 5 nets per season). According to LeRoux et al, 2012, more than 20 genetic haplotypes of turtles that are using the PCWR, have been identified. Annual report of WCS of Hawksbill project in Pearl Lagoon have shown an increase in population from 154 nests in 1999 to 719 nets in 2017 and for 2018, a total of 918 nests were recorded, with high expectation for an increase of nets for the 2019 season. (Hawksbill annual report 2000 and 2017).

Hawksbill turtles on Nicaragua's Caribbean coast are severely threatened by decades of unregulated harvesting of nesting females and taking of their eggs (poached nest), and by the opportunistic capture of foraging juveniles and adults (Nietschmann, 1981; Lagueux, 1998; Lagueux et al, 2003; Lagueux & Campbell, 2005; Campbell et al, 2012; Lagueux et al, 2013) not for consumption as in the case of green turtles, but for the carapaces for jewelry. In 1999, the Wildlife Conservation Society (WCS) conducted the first systematic surveys of the Pearl Cays that led to two important discoveries:

1. Nearly 100% of the clutches laid were taken by local fishers for personal consumption;
2. Nesting females were often killed for their meat and scutes (Lagueux et al, 2003).

In 2000, the community and government approved project to protect nesting females and their eggs on the Pearl Cays, this initiative was implemented by WCS ('Hawksbill Conservation Project'). In addition, WCS established a 'Donate A Live Turtle Program' that provides incentives to local fishers and inhabitants on the cays to voluntarily donate live turtles to the project for tag and release (including males and juveniles, as well as green (Chelonia mydas) and loggerhead (Caretta caretta)

turtles). This volunteer program is conducted throughout the years, and helps save turtles while also engaging a wider audience in sea turtle conservation that might be overlooked during typical community outreach activities (i.e. fishers, cay watchmen, etc.).

Both the Donate a Live Turtle Program and the Hawksbill Conservation Project have been successful at reducing hawksbill mortality in the Pearl Cays Wildlife Refuge (PCWR). For example, fishers see excited donating a turtle after participate with the team in measuring, cleaning, releasing, etc. then as recompense we deliver a sport short with messages related to turtle conservation, WCS and the Pearl Cays Wildlife refuge, this action avoid fishers to reduce the number of poached nest on cays, these in place of poach now they are doing conservation activities such as donate a sea turtle and protect turtle nest. In addition to protecting females and eggs, WCS in previous years has also increased efforts to collect data on the reproductive biology of females, in order to better understand nesting ecology and habitat needs of hawksbills in the Pearl Cays. This includes the collection of genetic samples which was done until 2012, studies on nesting habitats, and more detailed data collection on nest parameters such as thermal profiles.

The Pearl Cays hawksbill population continues to face the destruction of its nesting and feeding habitats from increasing human presence in the area. The construction of permanent houses, hotels and/or the installation of temporary structures on cays with nesting habitat negatively affects nesting behavior, as well as indirectly affecting reproduction from the destruction and alteration of habitats (i.e. sand mining, clearing of upper beach vegetation, and construction in nesting areas) (Lagueux et al, 2013). In addition, fishing activities in the Pearl Cays such as the lobster, shark, and sea cucumber fisheries contribute additional threats to sea turtles (Lagueux et al, 2013). The lack of a Management Plan and an effective administrative and rules application system for the PCWR has led to an increase in human impacts and pressure on sea turtles and other marine resources on the cays. A severe reduction in these populations in the PCWR could have detrimental effects on other resources and overall habitat quality, as seen in other selected marine ecosystems around the world (Jackson, 2008; Worm et al, 2009). Other factors negatively affecting hawksbill reproductive biology and survival in the Pearl Cays include the presence of domestic animals (Lagueux et al, 2013) and artificial lighting (Witherington & Martin, 2000) on nesting beaches, these threats have recently been

increasing because of high demand of tourism in the area and constructions of new building and more visitors in the area..

The conservation of hawksbill turtles in the PCWR is important for both the regional and global recovery of hawksbills. In these 18th years of monitoring, conservation, and research efforts, and despite the ongoing aforementioned challenges, the WCS program has made significant strides towards the recovery of this important hawksbill nesting and feeding ground. This has been achieved through stakeholder management and communications and a push towards better natural resource use and management practices by WCS and local communities themselves. In this report, results from WCS conservation and research efforts during the 2018 nesting season are provided, as well as results from the 18-years effort.

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PROJECT OBJECTIVES

Project objectives have maintained since the project begging, for the 2017 nesting season were to:

1. Quantify nesting activity spatially and temporally on 11 cays in the PCWR
2. Document survey effort and human activities on the cays during the nesting season
3. Monitor nest condition for entire incubation period
4. Maintain or increase survival of egg clutches and nesting females
5. Excavate nests after incubation period to determine hatchling success
6. Promote conservation through the media, presentations, and education
7. Build local and regional technical capacity for ecological monitoring and resource management
8. Improve local collaboration and increase government involvement in conservation activities
9. Assist local communities to continue and expand conservation of marine turtles through sustainable turtle watching and eco-friendly tourism in the Pearl Cays
10. Raise awareness of the plight of sea turtles, targeting fishermen to discourage the harvesting of marine turtles, particularly hawksbills and juveniles of all species
11. Provide incentives to local fishers and residents to donate live marine turtles of any species and age class for tag and release

STUDY SITE: the Pearl Cays Wildlife Refuge

The Pearl Cays are located from 3-22 km east of the mainland, off the central Caribbean coast of Nicaragua, and encompass an area of approximately 700 km2. The study area is comprised of 11 of the 22 Pearl Cays: Baboon, Bottom Tawira, Buttonwood, Columbilla, Crawl, Grape, Lime, Maroon, Vincent, Water, and Wild Cane. Cays range in size from 0.04 ha to 18.4 ha; however, the size of the cay is not necessarily related to the amount of available nesting habitat see **Table 1,** Area and cumulative nesting beach length for each of the cays regularly monitored in the study in 2009. Although I do believe that this table needs to be adjusting to actual situation, mapping areas is

needed to quantify or measure the lasted habitats and in some cases such as Maroon and Vincent cays were cays has disappeared or eroded completely.

Data is based on a mapping survey conducted in October 2009 (Lagueux et al, 2011). Although, we will like to update this information, because cays condition and dimension have change during these lost year. Total nesting area also changes throughout the season with changing tidal and wind activity, and over time due to increasing levels of erosion, result from cutting and burning vegetation and other human related activities. Although rare, hawksbill nesting has been reported on Crow Cam, Seal, Askill, and Little Savanna. These latter cays were not included in regular surveys because of either distance from our primary study area and/or the infrequency of nesting on each cay. No nesting activity has been reported on these cays since 2007, based on qualitative data collection acquired each year.

Table 1 Area and cumulative nesting beach length for each cays

Cay	Area nesting /beach length	Cay	Area nesting /beach length
Baboon	4.61/310	Crawl	1.80/590
Bottom tawira	18.4/310	Vincent	0.04/169
Button wood	0.22/226	Water	4.69/460
Columbilla	3.02/113	Grape	0.46/120
Lime	3.5/393	Wild cane	7.47/517
Maroon	0.2/132		

Note: Data need to be updated, because of erosion, cutting down of mangroves and coconuts trees, constructions and new infrastructures on cays, in some case 0% vegetation on cays, especially on Vincent and Maroon (both cays have already under water, 0% of vegetation), Lime, Baboon, Crawl, grape and Wild Cane Cay (principal nesting grown for Hawksbill, but also on Bottom Tawira and Water Cay).

In this 2018 season, we had observed big changes in some of the Cays, mainly on Vincent cay and Maroon, where are completely wash away and now under water, there is no presence of any type of

vegetation. Coconuts trees are complete cut down and shown that the size of the cays are reduced tremendously. This cutting down of trees are also been experimented on Wild Cane Cay, include Lime cay, known as Calala Cay, also on Water cay with the restorations of the heliport. Not everything is negative on cays, we also we observe positive changes on Lime Cay (Calala cay), this include the number of nest in comparison of the previous season.

With the management plan, some expected outcomes are the actualization of update ecological and topographic maps in the area, which will permit us to know exactly the level of degradation since the first study was done.

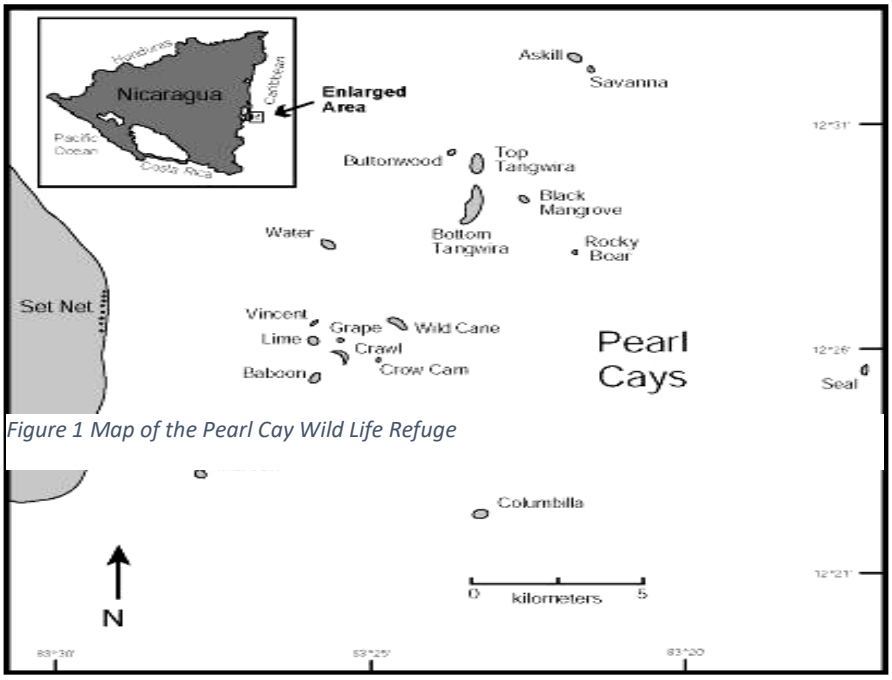

Figure 1 Map of the Pearl Cay Wild Life Refuge

Nesting has yet to be recorded on Top Tawira, Esperanza, Savanna, Walter, and the two unnamed Cays, due to the lack of appropriate nesting habitat, i.e. only large rocks or dense mangroves lining the coast).

Black mangrove was also added to this list in 2014 for the same reason. No nesting activity was reported on Black Mangrove in 2013 or 2014, 2015 up to 2018 confirmed by opportunistic surveys and qualitative data collection from temporary residents on the Cay. Beside the cay do not have any condition to consider as nesting beach, because it surrounded completely by gravels.

The study site is located within the Pearl Cays Wildlife Refuge (PCWR), established in 2010; **Figure 1 (Map of the Pearl Cays Wildlife Refuge).** The PCWR currently has no management plan, but

with high expectative and optimism to have count on the first draft by the ending of this 2018 and a final version by the ending of 2019. This may be fulfilling because of the effort and support of WCS international funds in coordination with the Bluefields Indian and Caribbean University (BICU), through Horizont 3000, National, Regional, Territorial, and Communal government and under the guidance of MARENA.

METHODS

TRAINING AND TEAM COMPOSITION

Advertisements for the job of seasonal staff are normally over radio station and local vocal media in March or beginning of April every year, with an application deadline in mid-May. For this 2018, include previous year we circulate application in March, deadline mid-April, training and team selection by the end of April and begging the project fully in the first week of May 2018, precisely 04th of May. As the 2017 season and this 2018 season we started a one month early than how the project have been set up since 1999, this due because of the number of new nest identify by that date, which we can says the change of patter of Hawksbill nesting season; on the other hand it was because fishers and community members were reporting seen turtles nesting since January, and they asking for us to get out because some unconscious fishers were seeking on poaching the nests were turtles nested early, this year. This year we close on December 09th then we had opportunistic survey after Christmas day, because we had a lot of nest that was hatching out in the month of December, include January and February 2019 for final excavation.

To complete application process, applicants were asked to fill out a two (2) pages' application form and to submit two letters of reference and a copy of the Nicaraguan identification (cedula). Those who had work before on previous years are not required to submit the cedula or letter of recommendations, but required to submit an application form, which will tell us the interest of him or her to keep on working with us. We give priority to our old workers, those who have given us a great job during previous seasons.

Seasonal staff first received classroom and practical training in sea turtle biology, nesting ecology, and field data collection methods by experienced WCS personnel during a one-day training workshop, it include a practical training. This training activity was done on May 03, 2018. The marine coordinator are responsible to facilitate one whole day training, to teach about biology and characteristic of sea turtles, history and background of the WCS program and its projects, rules and regulation of compliance include functional system of the project itself, team responsibilities, salaries, swap day, holidays, data collection and importance of real data, etc. Old workers, who have already had experience in field work, are those who teach the applicants-candidates about the turtle monitoring on field activities, example how to identify turtle track, nest or attempt nesting (test), the uses and objective of each materials and instruments include how to manage the write in rain book and what is it used for in the field, include the practical activity and finally an evaluation/exam.

Candidates were assessed by both a practical and written exam, covering the use of field materials and methods provided during the training workshop. Selection was based on performance and attitude, which is very important, verbal, written and practical. After that, the eight team members are selected, this selection included a multidisciplinary team which means a mixture of people with different culture and background from as many local communities from the basin as possible (twelve community plus Bluefields). The group of eight is split into two teams of four based on skill sets and experience, in each team we need a leader, a boat driver and two technics, and each team would alternate for 10-day rotations from May to November or extraordinary December. Teams were then intensely trained in the field for the first five days, then we do a ballot to determine which group of four will be team one. Fallow this, during their first 10-day rotation, depending if we have new team recruit in the team then these are trained by the project coordinator and field team leader, as well as receiving continued mentoring by the aforementioned experienced staff members throughout the season. Every member should have the capacity to manage the books, to seek for new nest and to make excavations.

NESTING BEACH SURVEYS

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During the 2018 nesting season, monitoring surveys were conducted regularly on 11 of the Pearl Cays where hawksbill nesting occurs. A comprehensive survey protocol document produced in 2015 by Laura Irvin, was updated and used again in 2018 to ensure consistency in scientific methods (Karen Joseph 2017-2018). The aforementioned document was developed from a number of different sources, including: descriptions of methods used by project over 18 years from the project team leaders, past databases and field books, and existing literature for new experience is learn each and every year. All methods described below are summarized from the aforementioned document.

Surveys were carried out in 10-day rotations by two different teams, each consisting of four WCS seasonal staff (team leader, boat captain, and two team members), sometimes with the marine coordinator (Karen Joseph). Opportunistic surveys were conducted before and after the intensive monitoring period (IMP) to record newly laid nests or any nests found by signs of hatching, and also to conduct excavations, normally in the months of December to April every year.

The team obtained permits to live on Crawl cay during the IMP, and left the cay by boat/panga each day to conduct nesting beach surveys on as many of the 11 cays as possible, if weather permitting. Teams carried survey equipment in the Kit Bucket, which included: 50 mt measuring tape, field books and excavation datasheets, two hand-held compasses, one Garmin GPS units, a ACR Personal Locator Beacon, one ACR C-Strobe, one Gun flayer, cell phone for communication, rain coats, three sets of AAA and AA alkaline and rechargeable batteries and charger, one survival blanker, one signal device survivor combo, one handheld signal pack, a small panel for charge cellphone on cays, pencils, sharpeners, ruler, permanent markers (sharpie), orange flagging tape/cinta, white garden sticks to mark nests, excavation gloves, first aid kit, and dry bags for each GPS units and a phone with a list of emergency contacts. **Figure # 2. field materials and equipment**.

Figure 2 Fieldtrip equipment 2018

Teams recorded the start time of the nesting beach survey into the Survey Summary Book as soon as they exited the boat onto the cay. Then teams walked around the cay in a clockwise direction, looking for signs of nesting activity or turtle track. Teams examined the beach and inland areas within 30 mt of the high tide line. One or two team members checked existing nests for their condition and recorded the data in the Nest Check Book. Other team members recorded nesting activity from the previous night in the Nest, Test and Track Book (latter two terms explained in 'Test and track data' chapter below). The team simultaneously observed and recorded any human activities throughout the survey in the Human Activities Book.

Before leaving the cay, the team double-checked all the data books, recorded the human activities as a group, calculated the summary of nesting activities, and recorded additional comments and survey end time. Quality control of data was completed each evening.

SURVEY EFFORT

Survey effort indicated team presence on the cay and was calculated to determine hours worked both directly on recording data and working with live turtles. Survey effort was a new addition to the data collection regime in 2014 (Irvin 2015), and continue to do so in this 2018 season; the process entailed the recording of a start time when the team arrived on the cay to conduct a cay-survey (defined as each time a cay was surveyed) and an end time right before the team got back into the panga (skiff) to leave. This data helped estimate the times females were laying depending how recent the nest observed to be and considering the last time a survey was done on the cay (i.e. survey conducted the morning before and track looks very fresh so we can safely conclude that the nest was laid that night). This data also allowed a record of more recent human activities on the cays relative to our survey hours (i.e. nest laid the night before was poached when particular fishermen were observed spending the night on the cay). Finally, the data gave estimated times required for particular survey activities which helps inform survey logistics (i.e. longer surveys during peak season, estimates for how many excavations can be done during a particular time period, etc.).

NEW NEST DATA

New nests, reported as clutches, were used to quantify spatial and temporal nesting behavior on each surveyed cay. Teams were trained to identify the characteristics of new nests efficiently and carefully, looking for flipper dig marks, up and down tracks, and sand mounds. On cays where poachers were more likely to be present, such as (Bottom Tawira, Buttonwood, Columbilla, Maroon, and Wild Cane), teams tried to conceal the presence of a nest – as this can tip off poachers to the nest location, no mark is left on sight. Teams did not use flagging tape to mark nests on these cays, but

instead used more discrete markers for each nest; include GPS and compass position and specific record position in books; this to guarantee that nest can be finding after hatch.

Once the clutch was found, the nest was given a number in sequence (1, 2, 3 …). Clutches were left in situ unless there was a significant mortality threat from poachers or environmental factors (i.e. high tides inundating the nest during the incubation period, predators in nest, etc.).

Translocation of clutches is a common practice in sea turtle conservation projects all over the world, and can serve to mitigate a variety of threats that negatively affect nest success (Wyneken et al, 1988; Bolton, 1999; Kornaraki et al, 2006; Tuttle, 2007; Pfaller et al, 2008; Pike, 2008). This practice is often done by our team members. Teams dug an artificial nest chamber with the same nest depth and shape as the natural nest. The relocated nest site had similar vegetation coverage and vertical zone to the original nest site, where possible. The relocation process involved careful removal of each egg into a deep pan with sand, transport of the eggs to the new site, placement of the eggs into the artificial nest cavity, and covering the original nest of eggs with lite material (camouflage). **See Figure # 3**. WCS staff teaching student Relocating eggs to artificial nest.

We consider an artificial nest, those nest which turtle dint naturally excavated and put eggs, the nest was dig by the team members to protect the clutch from erosion, poaching etc. When moving the clutch, teams always maintained the eggs in their original vertical orientation so as not to cause movement-induce mortality of the embryos (Limpus et al, 1979; Bolton, 1999; Mortimer, 1999). The

moved site was minimally disturbed and then camouflaged to hide the clutch from poachers. In the vast majority of cases and wherever possible, eggs were relocated less than 10 hours after being laid (or greater than 15 days), as threat of mortality is lower during these periods, (Limpus et al, 1979, Miller & Limpus, 1983; Morisso & Krausse, 2004). Delayed relocations are not necessarily cause for reduced nest success (Abella et al, 2007), but they were avoided wherever possible as a best practice.

When teams found a nest, they first decided whether it needed to be relocated or left in situ. This involved assessing the level of significant mortality threat by tides, predators, or poachers. Then, several parameters were measured for each new nest, including: distance to high tide line, length of crawl, vegetation type, vertical beach zone, distance and degree from tree marker, and GPS location.

These data were recorded in the Nest, Test and Track Book for both in situ and moved locations when a nest was relocated. Distance (in meters) and compass heading (in degrees) from tree marker were taken only for the place where the nest was left to incubate (in situ location for those nests not relocated and artificial nest cavity location for those nests relocated), so that teams could find the nest again for monitoring and excavations. Crawl length was measured along the center of the turtle's track from the most recent high tide to the center of the nest cavity/egg chamber. Distance from nest to high tide was measured in a straight-line, perpendicular to the shore, from the most recent high tide line to the center of the nest cavity. Also recorded was the vertical beach zone classification (related to amount of shade received per daytime hours (Beach: 0-50% shade, Upper Beach: 51-89% shade, or Inside: 90-100% shade), GPS coordinates directly above nest cavity, navigational side of cay (north, west, etc.), and the vegetation coverage type (Vegetation: fully covered, Border: mix of vegetation and natural lack of vegetation coverage, Cleared: vegetation removed by people, or No Vegetation: natural lack of vegetation coverage).

Eggs in each relocated clutch were counted when removing the eggs from the in situ nest and then a second time when placing the eggs into the artificial cavity. Mean clutch size was based on egg counts of relocated clutches because this number is more accurate than eggshell counts during excavations (Miller, 1999). Nest depth was measured in the original nest cavity, from the bottom of the nest to the beach surface level (using a stick across the cavity mouth at surface level). Nest depths were not measured for clutches left in situ until they were excavated. Finally, any notable comments

about the nest were added to the field book (i.e. lay date, burst eggs found during relocation, suspicious footprints or dig marks around nest, etc.). Where relevant, nest success data from 2018 were used to influence translocations and moved site selection is conditions of the habitats remained the same (i.e. avoid moving to areas which had 0% or low success, move from areas with 0% or low success, etc.). Or the moving of eggs from one cay to another cay to increase the probability for eggs to hatch well, example, from Maroon to Baboon and from Vincent to Lime.

TEST AND TRACK DATA

Tests (false crawl with attempted egg chambers) and tracks (false crawl without an attempted egg chamber) data were used to calculate the total amount of effort and site preferences of nesting turtles in the study area. These false crawls can also indicate potential disturbances to the nesting female (in the case of artificial light or human presence) or help predict the return of a nesting female to a similar area that night or over the next few days (Richardson et al, 1999). During each cay-survey, teams recorded the cay, type of activity (test or track), series number for tests (first, second, etc. attempt in the series), vertical beach zone, vegetation coverage type, straight distance to high tide from middle of the test event or highest point of track, crawl length from high tide to middle of test attempt or total crawl for tracks, GPS coordinates, and any other comments for each test or track. Crawl lengths for first test attempts were measured along the center of the crawl with a flexible measuring tape or cinta as called in the field, from most recent high tide line to the center of the attempted cavity. Subsequent test attempts were measured from the center of the first attempted nest cavity to the center of the second attempted nest cavity, from the center of the second attempt to the third, and so on. In the case of tracks, the measurement began at the most recent high tide line when the turtle visibly re-entered the sea. If a test was connected to an eventual nest, then that nest number was indicated in the comments. All tracks and tests were camouflaged after data was collected, so not to be confused as unrecorded activity in following days. This was especially important on swap out days to avoid double counting of activities by the next team. Beside each nest after been recorded, and market to locate, there is a white garden stick buried just on top of eggs I nest, this got written

with marker date and nest number, to ensure that when the nest is excavated is the right nets recorded.

NEST CONDITION MONITORING

Nest checks were used to assess final nest success, accounting for any predated eggs, natural events, and human impacts that might have directly affected specific clutches (including the number of eggs predated and timing of human/natural events). Methods and variable definitions are based on best practices from the Sea Turtle Conservancy in Tortuguero, Costa Rica, and the Caño Palma Biological Station in Playa Grande, Costa Rica (Christen & Garcia, 2013a; Christen & Garcia, 2013b; Christen & Garcia, 2013c; Garcia, pers.com, 2013).

Each nest was assessed for its anthropogenic and environmental condition on each cay-survey, starting from the day after they were first recorded in the Nest, Test and Track book. Teams assessed all nests on each cay-survey for any signs of predation, poaching, flooding, erosion, and any other unknown disturbances, then recorded them in the Nest Check Book. Location data in the Nest Check Book helped the teams find the exact nest location to ensure that they were checking the right location for condition. Each nest was monitored daily, weather permitting. When days were missed, we put 'DNC' or 'did not check' was recorded. If any abnormalities or uncertainties with conditions of nests occurred, they were discussed immediately with the field supervisor and/or project coordinator.

On the 60th day of the incubation period, teams checked nests for signs of hatching (depression/hatchling cave, live hatchlings exiting or around the nest, etc.) and recorded this information to determine the excavation schedule. If live hatchlings were seen exiting the nest, teams watched them go to sea without intervention. If suspected predation or if hatchlings were stuck in the nest during the final days of incubation, an impromptu excavation was performed with the consultation of the project coordinator. This can be appreciated in the fallowing figure. ***Fig. 4. Turtle hatching.***

Figure 4Turtle Hatching

Nest conditions and definitions used in daily nest monitoring.

Example Condition (code)=NAT its definition is: "Nest was in a natural state, undisturbed by the environment, predators or people. Flooded (FLO) Nest was inundated (water in nest). Eroded (ERO) Nest was eroded (saw eggs that have been washed out of the nest or clutch was fully exposed). Taken (TAK) Partially Taken (P.TAK), Nest was fully (TAK) or partially taken by poachers (P.TAK), as indicated by an empty egg chamber with digging marks, footprints, stick holes, sometimes a few egg shells, difference in depth of nest since the nights before, etc. Predated (PRE) Partially Predated (P.PRE) Nest was fully (PRE) or partially predated (P.PRE), known by evidence such as hole dug up near the nest, animal prints, egg shells scattered around the nest, sand spray, lack of footprints or stick holes, crab holes leading to nest, presence of predator itself, etc. Unknown (UNK) Nest was in

an unknown condition Hatchlings (HAT) Signs of hatching were observed at nest (hatchling tracks or hatchling cave). Definitions guided primarily by Christen & Garcia, 2013c.

HUMAN ACTIVITY SURVEY

Human activities were recorded on each cay to identify any negative anthropogenic impacts on nesting beach habitats that might affect turtle nesting or nesting habitat quality/availability. Teams made daily observations of any human activities that were new since the last survey on that cay. Data collected included: number and type of people (watchmen, tourists, fishermen, workers, guides) and location, the number and type of any animals and location, the number of incidents of burning, cutting or clearing – along with location, the number of incidences of taking sand and construction, and the location of each, and any comments on those activities or others which did not fit into the predesigned form (i.e. turtle fishermen from Haulover or elsewhere, ongoing house construction, tourists with Kabu Tours or others tour company, etc.). despite our effort, we still find fishers on cays catching green turtle, note and report to authorities about the anomalies occurs on cays in relation of green turtle fishing activities.

These reports are crucial for WCS and communities authority, when anomalies are observe, the information is giving to the local authorities evidencing the abuse of the catch of green turtles or other marine species on the cays.

NEST EXCAVATIONS

Nest excavations determined the hatching success (% of neonates to exit their eggshells) and emerging success each year (% of neonates exit the nest) for each clutch (Miller, 1999). Nest contents were used to determine causes of mortality, as well as potential number of neonates newly added into the local population. **Figure 5. Nest excavation process 2018**.

Figure 5 Nest excavation process 2018

The mean incubation period for hawksbill turtles is estimated at 60 days (US Fish and Wildlife Service, 2014; IUCN MTSG, 2014). The mean incubation period for nests in 2018 was 68 days, this number of days had a slight changes in two days maybe because the season was not as hot as previous years. Nests were checked for signs of hatching at 60 days then after 65 and excavated after 72-76 days or sooner if evidence of hatching was observed during monitoring surveys. Using location data, teams measured nest locations and carefully dug into the nest. If live hatchlings were present, the team checked a few hatchlings for physical development and activity levels. Unhatched and live (or suspected live) unhatched eggs were covered with sand and recorded in the Nest Check Book. If no live hatchlings or live unhatched eggs were in the nest, the nest contents were dug up,

separated into categories, and counted. Nest depth was then measured from the bottom of the nest to the surface level (using a flat stick across the cavity mouth at surface level), then the nest is covered back with sand. Also hatched nest were identify by depression, this can happen alter turtles hatch out and crawl out nest then the cavity sink forming a depression of nest.

Once all eggs were categorized, the individual conducting the excavation put on disposable gloves and counted the total unhatched yolk eggs to record on the Excavation Data Form. Each unhatched egg was examined externally (searching egg for holes or pips) and internally (opening eggs with no punctures and searching all content for development stage, predation, and deformities).

Seventeen excavation variables were used; those are on the excavation sheets. **Figure 6. Excavation variables.** (Excavation Variables was adapted from Wyneken et al, 1988; Eckert et al 1999; Miller 1999; Christen & Garcia, 2013c., Garcia, pers.com., 2013). And used for WCS annual excavation. A laminated excavation guide was used as a reference to identify development stages, predation signs, deformities, and other important information. This information was recorded in a data base posterior analysis for project result of surveys. Developmental stages were not based on biological stages but used as guides to help investigate timing of any disturbances to the clutch that might have significantly affected hatching or emerging success. All excavations were either performed or supervised by the team leaders, occasionally by the project coordinator when she are out doing surveys with the team. After the data collection was completed and the excavation data was double-checked, all contents were put back into the nest and buried.

To guarantee all nest is excavated, the team leader on the shift day, deliver the list of excavation sheet to the office secretary who double check the excavations sheets with the nest check book then check the nest check book, also open another list with nest already excavated and nets to be excavated during the 10 days survey. After this double check, the secretary introduce this information in the data base developed on the computer and deliver a list of nest to the fallowing team to guarantee the coming nests are needed to get excavated.

Excavation Variables

Empty eggshells: empty egg shells found in nest, over 50% of complete empty eggshell found Live hatchlings: hatchlings found alive in nest Dead-in-nest hatchlings: hatchlings that are out of egg and found dead in nest.

Unhatched egg categories: No embryo: no evidence of any sign of embryo or blood Pipped eggs: triangle shaped hole right near face of dead hatchling in stage 4, inside undisturbed egg Yolkless: unfertilized egg, usually much smaller than yolked eggs with no yolk inside.

Embryo development stages: Stage 1: 0-25% of egg content is embryo, remaining content is yolk Stage 2: 26-50% of egg content is embryo, remaining content is yolk Stage 3: 52-75% of egg content is embryo, remaining content is yolk Stage 4: 76%-100 of egg content is embryo, remaining content is yolk

Predated* egg categories: Microbe: evidence of suspected fungi or bacteria (use visual and olfactory cues to assess) in the case that eggshell is not penetrated by other predators (i.e. crab hole) Crab: small circular holes found, not many contents or no contents in egg Ants: smaller multiple holes (size of ant head) with ants present Other: evidence of predation by multiple predators without clear first cause or unable to determine type of predation * when an egg is labeled as predated, it is not also recorded in the development stage category

Deformities: Albino: hatching is devoid of color pigment, usually with blue eyes. No eyes: hatchling has skin covering eye socket or no eyes at all Twins: hatchling has two embryo s(including two conjoined embryos) Other: any other 'natural' deformity or injury to hatchling not caused by external factors

Figure 6. Excavation variable definition in 2017.

TAG AND RELEASE PROGRAM

The tag and release program began in 1999 to collect reproductive and morphometric data on individual turtles. For this 2018, one method were used to obtain subjects; the "Donate A Turtle" incentive program. In efforts to increase capacity building in 2015, both Team Leaders were trained for that season, unfortunate one of the team leader leave the project, for the 2016 until now we count with one of the team leader with tagging capacity to tag with Inconel and PIT tags and collect tissue samples. According to Laura Irvin all members of the two teams in 2015 were also trained to both measure turtles and fill in the datasheet which is easier so all team member have the knowledge to do so, this process continue to be the same all member are obligated to do as the team leader, who was trained in 2015. The 2018 turtle season, we continued tagging turtle, the team tagged 4 turtles all donated by fishers, three on cays and one at the office in Pearl lagoon. **Figure #7 and #8, show team**

member teaching students to do turtle tagging and measure. We are hoping to continue tag (turtle pin on flippers) and do pit tagging this coming 2019 season. Training should take place.

Figure 7Turtle tagging and measured

SATELLITE TAGGING

In 2014 Wildlife Computers SPLASH10 309A, SPLASH10-BF 297B and SPOT5 model satellite tags were used to track the spatial movements of individual turtles (i.e. depth, temperature, distance, location, etc.). Tags were deployed in 2014 and continued to transmit spatial data well into 2015. Extensive satellite tagging of green sea turtles has been conducted by the Sea Turtle Conservancy and other organizations in the Tortuguero region of Costa Rica, just south of the Nicaraguan border (STC, 2015). These tagging efforts have revealed a great deal about the movements of the region's population. SPLASH10 309A tags generate low-resolution location data through the ARGOS satellite system and collect data on temperature and depth. SPLASH10-BF 297B tags can collect higher resolution location data using their Fetlock system that uses GPS technology for determining location. They are also able to collect data on temperature but not depth. SPOT5 tags collect low-resolution location data and no depth data but tend to have longer battery lives than SPLASH tags (Holmes, unpublished data, 2015).

The satellite tags were attached using Devcon© 5-minute Epoxy with fiberglass and Loctite Fixmaster Metal Magic Steel ™, following a protocol developed by the New England Aquarium Rescue Department and the Northeast Region Stranding Network for Rehabilitated Hard-shelled Turtles (Wildlife Computers, 2012). First, satellite tags were programmed using software from Wildlife Computers. The Project Coordinator also received technical aid and guidance from Katherine Holmes (WCS, New York) when setting up and learning how to deploy the tags. An instructional guide was developed for future tagging efforts by the Project Coordinator, that contribute to a more comprehensive satellite tag process document developed by WCS (Holmes, unpublished data, 2015). Data was downloaded and stored weekly until the last tag stopped transmitting in August 2015. Satellite Tagging did not take place during the last three years. WCS marine coordinator hope they can do satellite tagging in the close future.

INCENTIVE PROGRAM - DONATION OF LIVE TURTLES

The "Donate A Turtle" incentive program began in 2009 and was used to encourages fishers and residents to donate live marine turtles to the project for tag and release. A WCS t-shirt was given for each turtle donated to the project and a life jacket for every 15th live turtle donated by an individual. Each lifejacket is painted on the back with a turtle silhouette and the slogan, "Donating Turtles Saves Lives, Protect Our Resources, Nicaragua Sea Turtle Conservation Program, Wildlife Conservation Society". The program was also promoted in monthly radio announcements and through regular interpersonal communications with fishers and residents.

We are still trying to run the program, a WCS t-shirt is giving to each fishermen or person who donate a live turtle to us in this 2018 season.

QUALITY CONTROL OF DATA

Data in 2016, 2017 as well 2018 went through several quality control checks to ensure accuracy; when in the field, by the team leader every day after survey. On fields trips one person is engage to wright down data usually by the team leader, but also data is recorded by one of the team member assigned by the team leader. Then, the team leader, with the help of another team member, checked the data again after every daily survey and transfer nest data to the Nest Check Book. After every team shift, all information of all activity take place is deliver formally to the office secretary, who is in charge to review that all data is correctly in all books specially nest check book to verify the number of nest recorded, this information is photocopy by the office secretary then posterior introduced in the computer data base for the season. The books and information shared is deliver to the team that is ready to get out for they ten days survey and so on. The Marine coordinator checked data opportunistically while team is out, to verify and to guarantee that all data are collected appropriately on field and all data is introduced in the computer data base. When we have dough over something in copy sheets from books, we call the team leader to the office and we double check existing information. When all data is in the computer we do another confirmation check reviewed

all physical and electronic information and databases, cross-referencing them with field books, excavation sheets as a final proofing measure at the end of the season. Data for the report was analyzed using the Microsoft Office Excel Program (Microsoft, 2010).

RESULTS

NESTING BEACH SURVEYS

SURVEY EFFORT

Eight candidates (seven men and two women) were selected to work for the project in 2018 season, from the 18 candidates who attended the training workshop on May 03, 2018.

The teams included: Keffrey McCoy-team leader 1, Arton Lam team leader 2, Sheiby Thinkam"Passy"-boat driver 1, Anthony Sambola-boat driver 2, Ciomara Blandon-team member 1, Doris Terry-team member 2, Narton Stamp- team member 3, and Berney Collins – team member 4. We also had voluntaries students of Biologist and Ecologist from the Bluefields Indian and Caribbean University (BICU) for several survey during the season. Seasonal staff represented four communities in the Pearl Lagoon basin: Haulover, La Fé, Brown Bank and Pearl Lagoon.

Surveys conducted in the 2018 season were classified as either daily surveys during the Intensive Monitoring Period (IMP) (May 04 – December 09, 2018) or opportunistic surveys outside the IMP (in December 2018 two trips and January to April 2018). The IMP was 235 days long, during this time teams worked a total of 1,292.5 hours (mean = 5.5 hours per day.

A total of one thousand six hundred and eighty (1,869) cay-surveys (defined as each time a cay was surveyed) were conducted in the IMP. Eleven (11) cays were visited during the IMO, with a daily visit of eight most important nesting cays per day and every day from May to December 05 2018. Additional, surveys were conducted opportunistically before and after the IMP. Most surveys on opportunistic activity in relation of time consumption was done on Wild Cane Cay and Water Cay and Crawl Cay for final excavation. Mean survey efforts during IMP were 5.5, but during high season and excavation period team worked up to 10 hours per day. On some days survey activity was null, the primary reason for not visiting cays and doing surveys was because of adverse weather conditions causing unsafe travels. In case of opportunistic survey activities are conducted because of new turtle nesting outside nesting season (get late for nesting) and mainly because of nest need to get

excavated, we also find new nest in November and December 2018, the formal close up of the turtle fulltime monitoring was December 2018, which mean that we continue with opportunistic survey for the rest of months until season begin again in 2019.

As previous years, it shows a continuous increasing pattern, the greatest number of clutches in the WCS history report on the Pearl Cay Wildlife Refuge in the Caribbean Coast of Nicaragua. Most nest were located on tree cays, a continued pattern since 2016, leading Wild Cane Cay with 259 nest, followed by Water cay with 218 nest, and this year for first time highest third position is Crawl cay with 127 nest. Our saddest results was the report from Vincent Cay, one (1) nest were recorded, because it's already under water during the season period of 2018.

But also we have positive results in poaching, it have been a year of the lowest poaching rate in project history. Of the 918 nests only 33 nests were poached or sacked, resulting in 3.59% in poach for the 2018 season, a reduction of 1.3% less than the previous year.

Base and survival rates, out 918 nest found in this season, 792 nests had at least one turtle hatched out its egg; one hundred and twenty six (126) clutches had 0% survival rate. This caused by fallow: nest with 0% hatched 45, wash away nests 11, nests dig up by dogs 4, nest destroyed by roots 14, nests destroyed by turtles 3, nest eaten by rats 1, nest destroyed because of high tide 12 and 36 nets were poached or taken by human..

Based on the number of empty egg shells (more than 50% shell found in nest - >50%) found during excavations, an estimated of seventy two thousand two hundred and fifty five (72,255) live hatchlings were hatched (new born) in the 2018 season on the Pearl cays, a number of nineteen thousand five hundred and forty nine (19,549) young babies turtles hatched out, more than the previous year, equivalent to 27.09% increase of previous year. As a global summary this 2018 season for Hawksbill was grate we had a reduction of unhatched eggs form 63,779 eggs to 36,030 eggs which didn't hatchet out because a number of reason, this represent a decrease of unhatched eggs of 43.5% in comparison of the previous year.

During the intensive monitoring period (IMP), the pattern continue to be same, six of the 11 cays monitored were permanently inhabited (Baboon, Crawl, Grape, Lime (Calala), Water, and Bottom

Tawira), three of the cays were frequently inhabited by residents or fishermen (Buttonwood, Columbilla, and Wild Cane) and two cays were not observed to be inhabited (Maroon and Vincent-both cays are practically disappeared) these last two are completely eroded with 0% presence of vegetation. Practically, Vincent cay was under water most of the time during the season. As similar with previous year, Bottom Tawira recorded the highest mean number of observations for people per cay-survey (by fishers), with Lime now Calala Resort and Crawl second and third highest because an increase of tourism, this phenomenon also occurred on Wild Cane Cay. Also a fish collection center was established on Wild Cane Cay, but territorial board asks the fishers to move away because of turtle nest in the area. For the ending of the season we had a dramatic decrease of people on cays, which was good for turtle nesting and hatching.

Based on our daily check recorded in our human activities books, a total of 26 burn events went on in turtle nesting areas or beaches, they reduced a 50% of burning activity on Maria Crowcam cay by workers of Lime Cay (Calala Resort), constantly vegetation removal in and out water, digging and removing sand also digging and destroying coral reef was done by workers of Calala resort also around Lime Cay and Wild Cane cay. Vegetation clearing events, mangroves cutting inclusively, and path way were constructed on the southeast side of the island. Also they are constructing into the water a platform out concrete, this is set on the Northeast side of the island. Win resume we have observe on all inhabited cays vegetation and sand removal include burning.

WCS teams continue to observe human activities harmful to hawksbill nesting habitat and conservation on a regular basis in the PCWR (i.e. harvesting of juvenile marine species, including different species of turtle, sharks, and lobsters). The presence of Exotic animals such as Monkeys and Parrots was also observe on cays, including dog that barking at she turtle when to put eggs and digging and eating turtle eggs, especially on Grape Cay and Crawl cay. Include the animals mention before it also observed the presence of chicken destroying nest on Crawl and Grape cays.

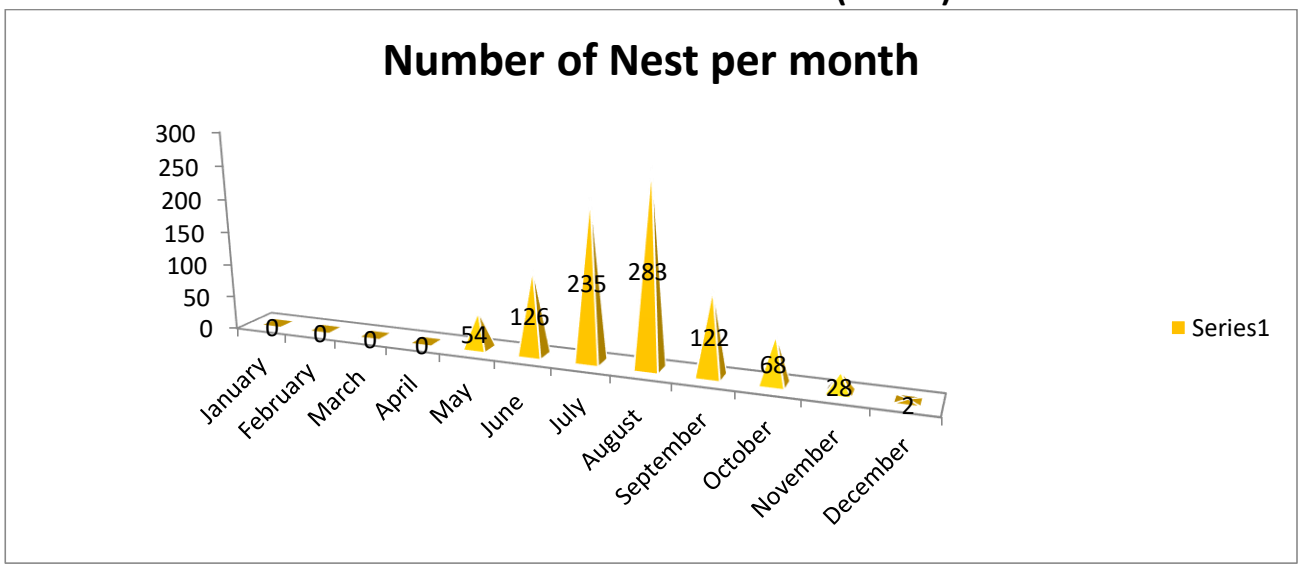
A total of three (3) turtles were tagged clean off and measured this year (pin was put on fins) by the team, those were donated by fishers in this 2018 season, this year same as lost yea, this time a young juvenile green turtle were donated to the project on main land in Pearl lagoon office by two fisher

men, this was tagged then it was taken out on cays out to sea to be release hour after by our Hawksbill turtle team members, T-shirts was given to them.

NESTING ACTIVITY

In 2018, the greatest number of clutches in project history was recorded with nine hundred and eighteen (918) clutches. A twenty seven point sixty seven percent (27.67%) increase in nesting in comparison with 2017 nesting season and four hundred and ninety six point ten percent (496.10%) increase since project started in 1999 and first recorded in 2000. The temporal distribution of clutches conformed to past project seasons, with peaks from June with one hundred and twenty six (126), July with two hundred and thirty five (235), August with two hundred and eighty three (283) and September with one hundred and twenty two (122), information are based on estimated and confirmed lay months. We also find turtle nesting in month of May, October, November and December 2018. We recognize with an **"Hurray"** for team No. 2, composed ***by Keffrey McCoy, Doris Terry, Sheiby Thinkam and Narton Stamp*** because of the effort to record the highest number of nest in the ten (10) days field trip, from July 29 to August 07 2018, ninety four nest (94) nest was found by the team, first time in history of the project this was done. This show the enthusiastic and effort each member of the Hawksbill project, which is reflect in their actions and hard team work putting to reach to this result and fulfill our goal. **Graph # 1 show the behavior of number of nesting find per month during the 2018 season and figure # 8, shows report on broken record by team No.2 in 2018 season.**

We can clearly appreciate the graphs #1 and figure # 8 that shows how was the number of nest per month during the 2018 hawksbill season, plus the record control by WCS office staff Hurrey for team number 2. As a team we are hoping that this can be grater for the 2019 season. this confirm the change in starting to do monitoring from the month of May is effective, showing we got 54 nest in May and with the highest peak in August with 283 nest, and then reduced back down in September and goes on.



Graph 1 Number of Nest per month 2018

We formally carry out a control of number of nest find each trip per team per month in the main office, this information is posted up on a white sheet, this also permit us to know exactly how many nest is find and recorded by team and per month, so it was also use to congratulate team number 2 who presented and evidented the highest number of nest found in ten day intensive monitoring perior in the month of August, see figure # 8.

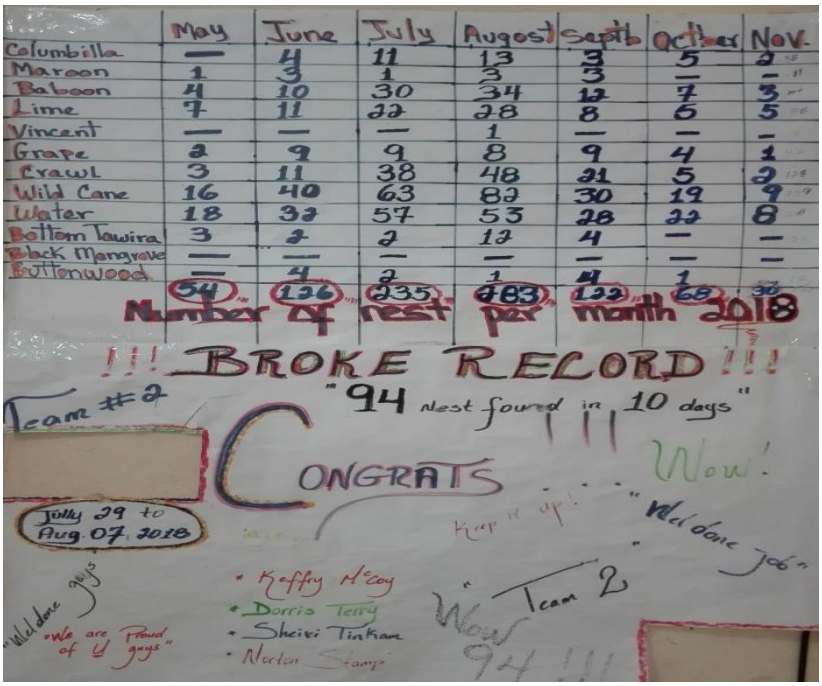


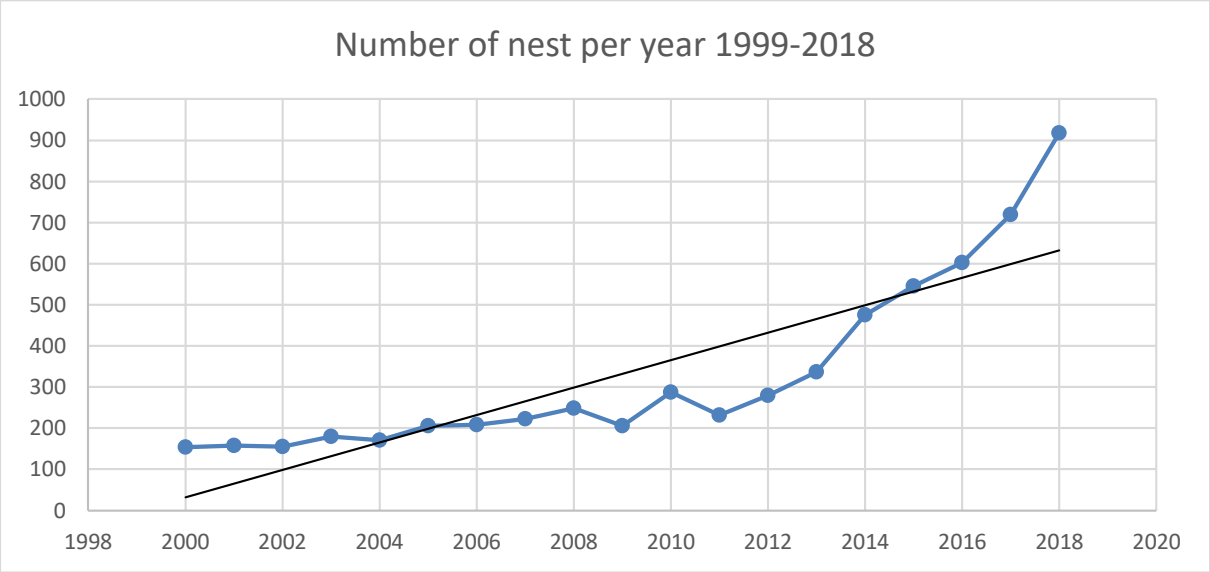
Figure 8 Broke record in ten days

Both, graph and figures represent the effort per month of the Hawksbill turtle team, the number of nest found by team per moth each time they go doing daily surveys, include figure #8, shows the total of nest found and the total of nest excavated by each team and the final clean up done by both teams.

Teams confirmed exact lay dates for clutches (96.51% of all nests) to be accurately to calculate incubation periods and excavation dates.

The number of thirty two (32) nests was found by depression which represents 3.49%. There continued to be a significant positive relationship between the number of clutches recorded and the number of years since initiation, which represent a gradual increase in nesting. Turtle high season begging this year in the month of May, we found 54 nest and reaches to the Highest peak in August.

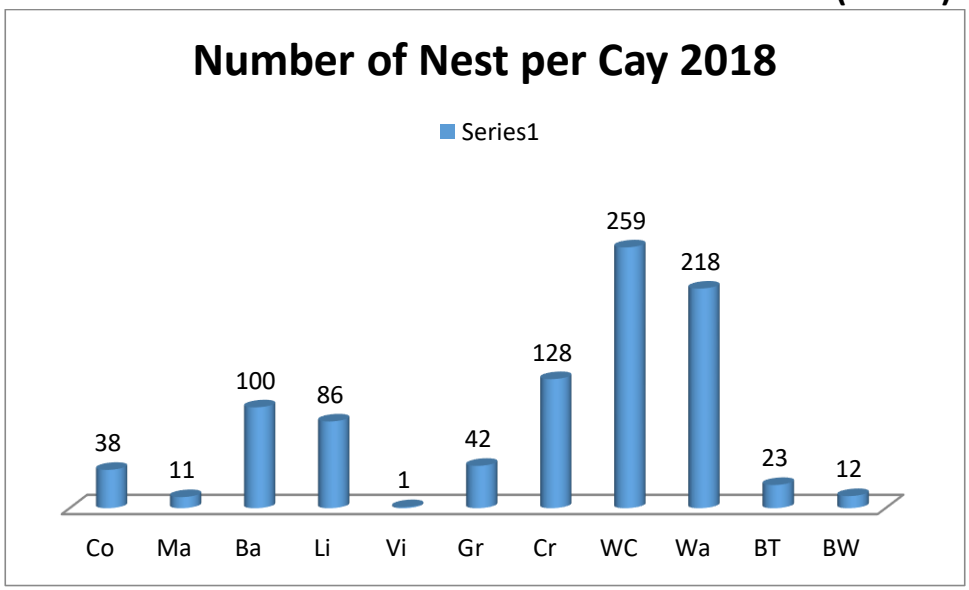
The number of clutches laid in 2018 represented a 27.67%% increase from 2017, a number of 199 new clutches more than previous year, and 496.10 % increase from the first year of the project (1999, reported in 2000). **See Graph # 2**. Trend of clutches (Number of clutches per year 1999-2017.



Graph 2 increase of Number of Clutches per year since 1999 to 2018

We continued finding turtle nets on eleven (11) cays in this 2018 season, Lime, Baboon, Crawl, Grape, Water, Wild Cane, Maroon and Columbila Cays, Vincent, Bottom wood and Bottom Tawira Cays. With a high reduction of nest on Vincent Cays, only one nest was found. This was removed and transfer to Lime Cay. Eleven nest was found on maroon, it is mentioned because maroon is also another Cay that soon it will be no more in existence. Bottom Wood and Bottom Tawira cays continue to be the cays where human activities are relatively high, survival rates are low for the turtle nests, poaching are the main theme on both cays most of poached nest was found on those cays.

Most nest were located of find on three cays, Wilds Cane Cay leading with two hundred and fifty nine (n=259 nest) fallowed by Water Cay with two hundred and eighteen (n=218) nest, and finally for first time, Crawl cay with one hundred and twenty eight (128) new nests. This data can be appreciated in Graph # 3. That Show the number of nest/clutches per cay for 2018 season.



Graph 3 Number of nest/clutches per cay 2018

Co=Columbilla, Ma=Maroon, Ba=Baboon, Li=Lime, Gr=Grape, Cr=Crawl, WC=Wild Cane, Wa=Water, BT=Bottom Tawira, BW=Bottom Wood

Out the 918 clutches, 74.29% equivalents to 682 nests were left in situ, and 25.71% equivalents to 236 nests, were relocated. This 236 nest represents 35,770 eggs that were relocated from one spot to another to artificial nest. This relocation was done because of various reasons, some are associated with high tide, added to this are human poaching and others because of predators visibility. Clutches were relocated primarily when significant mortality threats were posed; we also relocated clutches because of inundation or because of predation by animal.

For the particular cases of Vincent Cay, one (1) nest was found and relocated on Lime cay, for Maroon Cay, three (3) nests out 11 nests, equivalent to 27.2% of nest were removed and relocated on Baboon. Relocation of nest was done on the eleven cays.

The lowest percentage poaching rate in project history was recorded in 2018, based on the number of nest found and poached. Out 918 clutches 3.93% (36 clutches) were poached, a difference of 2 poached clutch more than the 2017 seasonal, a reduction of the 0.80% in comparison of previous year. Poaching was observed on four (4) of the 11 Cays where clutches were found: leading this time on Columbila with 12 clutches poached, fallow by Bottom tawira and Bottom Wood with 9 and 8 clutches poached respectively and finally Wild Cane Cay with a significantly reduction of 64.7% of

nest not poached (from 17 in 2017 to 6 for this 2018). These Cays are continuously used by fisher for refuge at night or area use for gathering seafood where it is inhabited by them.

We had two nest that was partially poached, for those nests we found 3 and 4 eggs remained, one all was hatched the other unknown reason of not hatched. We also observed nest where eggs were destroyed by female's turtles while nesting in this case three nests, where turtle used the same chamber to lay her eggs. Another phenomenon strange but not impossible to find several turtle nesting in the same nest, this time 10 nest, out those, 3 of the chamber has 3 nest in one (turtle lay at thre different times); four (4) nests were dig up and destroyed completely by dogs (on Grape, Crawl and Bottom Tawira).

Despite of effort removing nest because of high tide, a total of eleven (11) nests was wash away completely, where sand had tremendous shift from one side to another, also tide went up very high and wash away the sandy bank where turtle usually do nesting on. Out those 11 wash away nest, most was from Wild Cane cay with 4 nest, fallow by Crawl with 3, then Columbila with 2 and finally Grape and Water with 1 and 1 wash away nest.

Calculating Clutch size

Clutch sizes were determined by using data from relocated clutch counts for those not suspected or observed to have evidence of poaching or predation before teams arrived to relocate the nest, the mean clutch size for this year was 152 eggs per nest, in a range of nest with clutch of 80 eggs to clutches with 214 eggs; this information also included data on burst eggs found in chamber during relocation, as mentioned before, a total of 35,770 (thirty five thousand seven hundred and seventy) eggs were relocated, equivalent to 236 nest, with a success hatch rate base on > than 50% egg shell gave us 29,649.00 (twenty nine thousand six hundred and forty nine) young turtle born or hatchet out removed nest for this 2018 season, the information is based on egg count more than 50% egg shell remained in chamber during excavation period. And the survival rate mean size for this year was 126 individual per nest survive. Relocated clutches had a mean in situ nest depth of 34.74 cm, which was measured and recorded for each nest or chamber.

Again, we observed that many females laid their eggs in the upper beach vertical zone. What call us attention is that turtles nesting in 2017 and 2018 were find nested in locations with no vegetative cover, this was observe on Vincent and Maroon Cays also turtle deposit their eggs in the water, no cover, no nest dogged by turtle, this was observed on Grape Cay. These nests were relocated. We also found nest under houses. The nests found in water hatchelling success was 0%, all eggs were spoiled. In the case of the nest found under the house, it was leaved insitus.

The cays with highest number of nest in a consecutive manner were Wild Cane Cay 259 nets, then fallow by Water Cay with 218, and this time in third place for the first time Crawl with 128, Baboon is also one of the most important nesting sites with 100 nests. This year we had an increase of 32.6 % of nests on Lime cay, from 58 nests in 2017 to 86 nests for this 2018. This situation is mentioned because some years Lime cay was one of the cays with highest nesting rate. Also this year the responsible of the Resort located on Lime cay had put some more interest on turtle conservation activities, because, of the demand of tourist that have been visiting the cays and have had the opportunities to watch turtle nesting and hatching, a unique experience in life. Also the experience to meet with the team and learn more about the biology and turtle behavior, include the history of the hawksbill project in the Pearl Lagoon basin and the Pearl cays Refuge.

NEST CONDITION MONITORING

Nest condition (environmental and anthropogenic) was checked for each nest during each cay-survey. Clutches incubating on Baboon, Crawl, Grape, Lime, Vincent, and Wild Cane cays checked daily during the IMP, while clutches on Water cay were checked day in between, because owner and workers (guards) are volunteer to do daily check, when team arrive they report how many turtle went up on beach, if turtle nest or do crawling etc. Clutches on Bottom Tawira/Sand fly, Buttonwood, Columbilla, and Maroon cays, were checked two to three times during the ten days survey, this situation is due because of bad weather and the difficult access to the cays (rocky area lots of waves). So, consistency in monitoring was based on access to cays, with the latter four cays being more difficult to access in windy/rough weather conditions. Another concern is that on the three first

mentioned cays, there is fishermen living and visiting constantly, which increase the level of poaching, the most poaches occurs on these cays mentioned before.

During daily monitoring of environmental and anthropogenic condition, the vast majority of nests equivalent to 646 (six hundred and forty six) nests were visibly undisturbed by any environmental or human impacts during the entire incubation period, 236 (two hundred and thirty six was removed or relocated by the team and 36 was poached by human.

NEST SUCCESS

A total a number of 866 (eight hundred and sixty six) excavations were conducted for the 2018 season. Fifty two nests were not included in the nest success analysis, this represents nests affected by poaching thirty six (36), nest eroded or wash away by high tides or storms equivalent to eleven (11), and nest destroyed or dig up by dogs were five (5). We also had nest eaten by rats, crabs, destroyed by roots or other unknown predator, but these was also excavated. We also had Clutches disturbed by other turtles (more than one clutch mixed in the same nest cavity). Nest were relocated most because of high tide, where all Relocated clutches was analyzed, we had a survival rate of 29,649 individuals out 35,770 relocated eggs.

Based on the number total egg count an estimated of 108,285.00 (one hundred and eight thousand two hundred and eighty five) eggs were laid by hawksbill turtles in this 2018 season on the Pearl cay Wildlife Refuge, and 72,255.00 (seventy two thousand two hundred and fifty five) live hatchelling were produced in 2018 season, this information is based on the count of empty egg shells >50% found during excavations. Out of the total egg count, 36,030.00 (thirty six thousand and thirty) did not hatched.

Unhatched eggs are mainly related mostly with biological issues, specially because of the absence of embryo with 12,979.00, yolkless 35, embryo reaches to different stages and dint hatched out the egg are: Stage #1= 2,862, Stage #2= 516, Stage # 3= 317, Stage # 4= 205, eggs affected by microbes 5,356.00, eaten by crab, ants, rats, and other unknown predators with 13,725.00 eggs. We recorded forty three (43) individual's albino, some deformities such as twin baby turtles, only one. **See Table 2 .** Unhatched eggs (classification) 2018. This year we had an increase of live hatchelling in comparison of 2017 season.

Table 2 -Unhatched eggs 2018

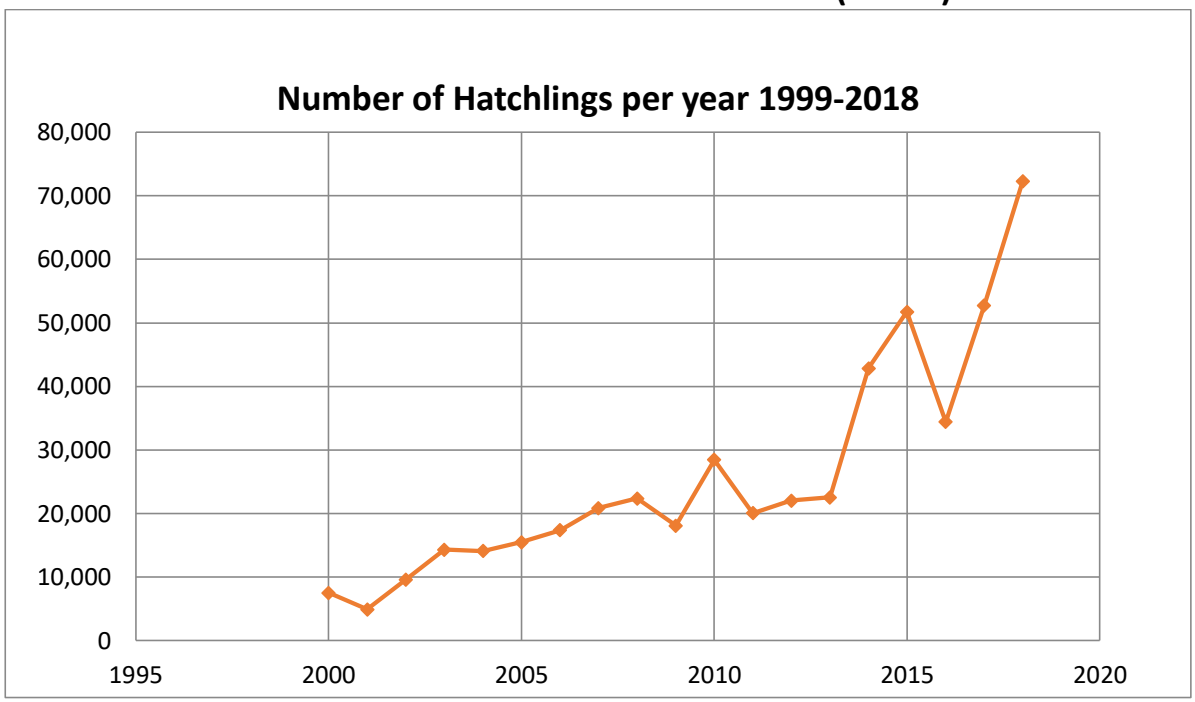
Reason of	Number of	% of unhatched

unhatched egg	unhatched eggs	eggs
Yolkless	35.00	0.09%
no embryo	12,979.00	36.0%
stage 1	2862.00	7.9%
stage 2	516.00	1.4%
stage 3	317.00	0.8%
stage 4	205.00	0.5%
Microbe	5,356.00	14.8%
eaten by crabs	1,008.00	2.7%
eaten by ants	966.00	2.6%
other unknown	11,754.00	32.6%
dead in nest	223.00	0.6%
		100%

Table 2:Unhatched eggs (classification) 2018

This year, fallowing logic, by having more nest, for shore we will have an increase of more eggs with biological issues, example eggs with no embryo with an increase of 24%, this situation, it is also shown in the number of different stages (1,2,3 and 4) we had an increase of 34.53% not hatched turtles, but also we had a reduction in nest eaten by ants and crab with 18.34% and 10.32% respectively in comparison of 2017 season. In despite of the number reflected above, this year has been another successful year for turtle hatching, an increase of more than 25% of hatched turtles.

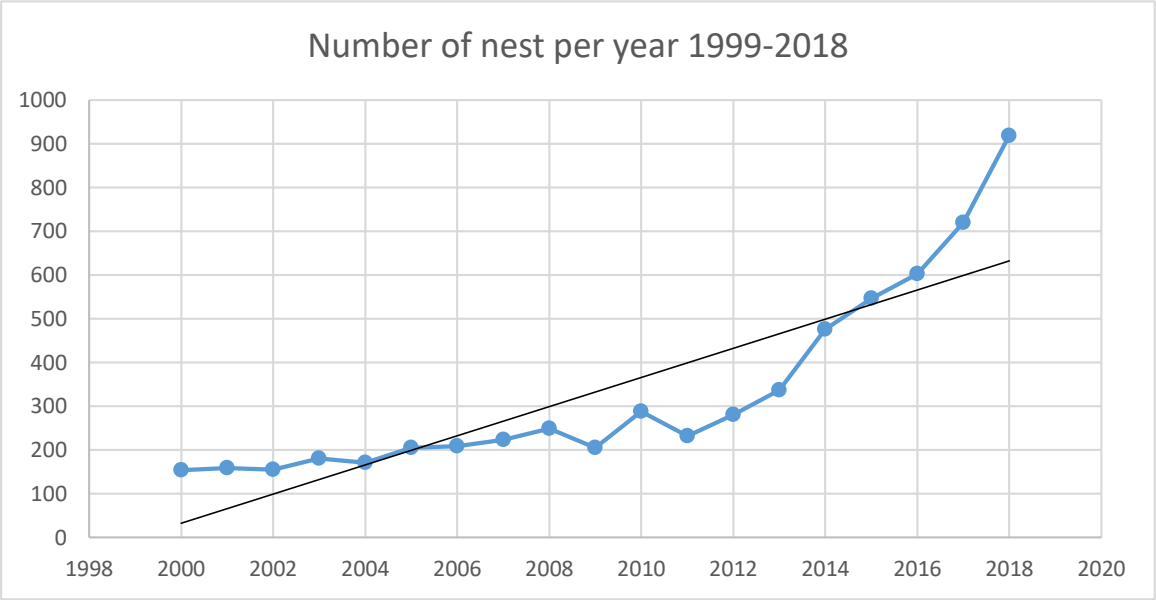
With gathered information from 2000 hawksbill report until 2018, we were able to create a trend chart that shows the fluctuation or the pattern that the Hawksbill sea turtle project on the Pearl cays each season. In the fallowing graph we can appreciate the increase and decrease of hatchelling versus years (2000/2018). This 2018 as previous years have been experimenting the yearly highest live hatchling rate through the history of the project.



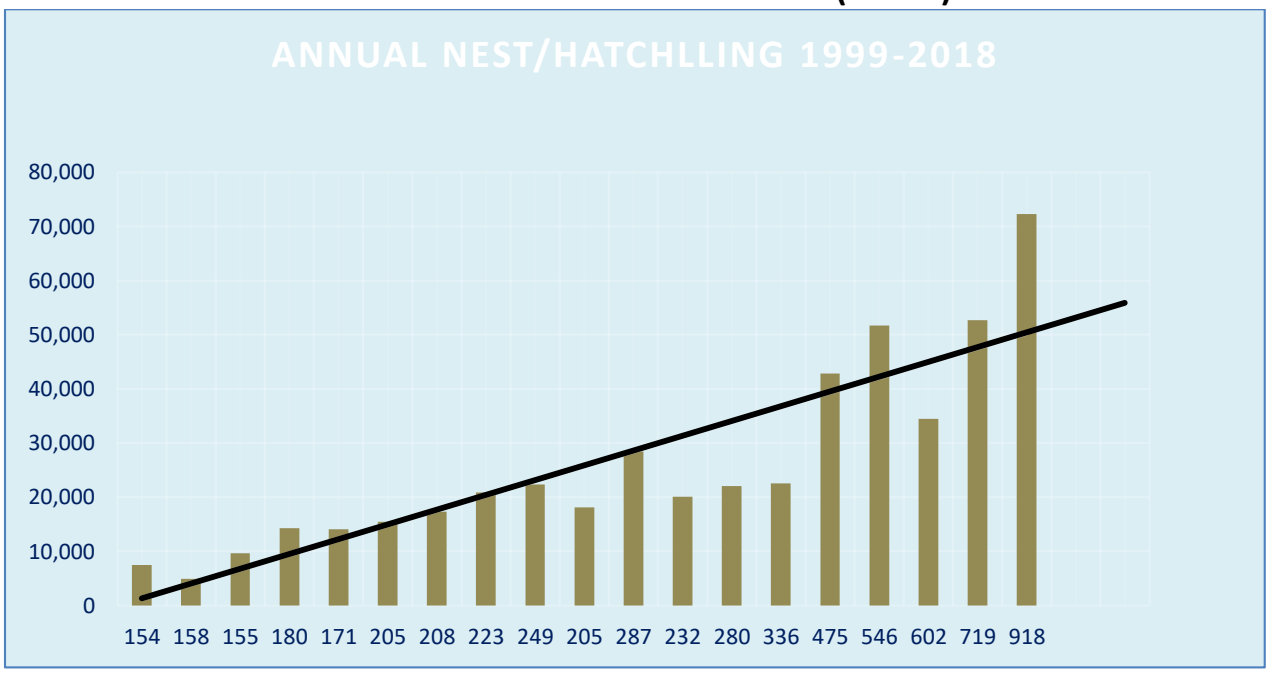
Graph 4 Trend, number of hatchelling 1999-2017

Also you can appreciate an estimated trend of number of nest per year with the fallowing graph. **(graph # 5 / Number of Nest per year)** Beginning with one hundred and forty four (144) nests in 1999, and for 2018 we recorded nine hundred and eighteen (918) nests. Seven hundred and seventy four (774) nests more since the project begging, this number represent an increase of clutches exactly 637.5%. Which is showing the effectiveness of the project its self, thanks to our donors, national, regional and community leaders include team member's effort with the program in pearl lagoon and the pearl Cays. Despite of difficulties dealing with fishers, we can say that the program have been success in the communities of the Pearl Lagoon basin. We do have more work to do, because we need to focus not just on the Hawksbill turtle but also the green sea turtle in the region, they are vulnerability to be catch and eaten by the people. Some alternative livelihood activity can be propose and implement by us to reduce the level of consumption of it. It is good to mention that WCS is part of the Green Turtle commission, we have provided support to conduct meetings in community during the Green turtle close season to talk to leaders, fishers, butchers and sellers about the importance to conserve and protect sea turtles. Also the effort that the Navy, Police and other institutions that

enforce the law toward protection of sea turtles, all good actions that they have been don. For this 2018 police had arrested fishers whose were confirming of trafficking green and hawksbill turtles. But at the same time communities people expose that sea turtles are the only economical source of income for them during the lobster and sea cucumber close season. Because of this situation it has result again in a formal permission extended to communities to catch turtles for "subsistence".



Graph 5 Trend of number of nest per year 1999-2018



Graph 6 Annual nest/hatchling 1999-2018

This graph (**graph #6/ Annual nest versus hatchling 1999-2018)** represent the fluctuation observed how is the fluctuation between the increase and decrease of number of nest versus number of hatchling according how time goes by a trend from 1999 to 2018. The 2018 results, have a big and significant jump, it reports the highest number of nest but also the highest number of hatchling since the history of the program. The number of 918.00 new nests was found, with a success of 72,255.00 new hatchelling, resulting from 108,285.00 that represent the number of total eggs laid by hawksbill turtles on the Pearl Cays.

HUMAN ACTIVITIES SURVEYS

Data on human activities were collected on every cay-survey. Six of the 11 cays monitored were permanently inhabited (Baboon, Crawl, Grape, Lime, Water, and Bottom Tawira), three of the cays were frequently inhabited by residents or fishermen (Botton wood, Columbilla, and Wild Cane) and two cays were not observed to be inhabited (Maroon and Vincent) during the IMP this can be

because of all coconut trees were cut down. Leading to uniform observations of each cay-survey for Baboon, Crawl, Grape, Lime, and Water cays, Lime cay were leased in 2016 to foreigners to construct a Resort now named Calalla Cay Resort. On cays were permanently and frequently inhabited (Lime cay, Wild cane, Bottom Tawira and Bottom wood) a few nests on the nesting beach were cover with construction material for lobster traps also seasonal house for fish stockpiles. In this 2018, we had increase of tourist on all cays at the beginning of the year, but then we observe a reduction of tourist and tour guides on cays, probably because of the Nicaraguan conflict. Dispite of this, we had an increase in the number of nest recorded on Lime (Calalla). In addition, the WCS surveys teams, (four to eight people) were permitted to inhabit Crawl Cay from June to December 2018. WCS staff was excluded from the number of people observed per cay-survey.

This year we had founded twenty three (23) nests on Bottom tawira cay, nine (9) of those were poached by fishers who inhabit the cay. Same experience we have with Bottom wood, we found twelve (12) nests out those 8 nets were poached. This information tells us that out the 36 poached nests, 17 nests were poached on these inhabited cays. Most tourist visit and stay on Lime cay, Fallowed by Wild Cane Cay, them Crawl that is used for local tours guide and finally Baboon and Grape, these cays mentioned are related mainly with tourism activities, (sandy beaches), best site to swim and to do snorkeling. We also observe the presence of dogs destroying nests, chicken mainly on Crawl, bottom Tawira and Grape cays. Include pigs on Bottom Tawira. Parrot on Grape cay. On Vincent and Maroon cay had no observations of any human activity during the IMP. This year we have observed less burning events on cays, and the once we saw burning were people from Calalla continued burning garbage on Maria Crowcam cay. Also we observed almost everyday vegetation clearing events, cutting and taking sand events and construction activities Calalla Cay, include extraction of rock from rocky bore and Maria Crowcam cay during the IMP. On Crawl cays where vegetation was burned in 2018, it shows a recovery from damage cause from burning in 2016, which is very important for sea turtles nesting resulting. All these burning and cays destruction were reported to Regional, Territorial and communal boards, who been working in coordination with other authorities, especially with BICU-WCS in the process of the construction of the Management plan of the Pearl Cay Wildlife Refuge.

Figure 9 constructions and materials over nesting area in 2017, same situation 2018

On some of the Cays, such as Baboon, Crawl, Grape, Lime and Water people continually been raked ('cleared') regularly, sometimes two or three times per day, this action impede the new growth and regeneration of native vegetation that could help secure/stabilize the substrate and avoid erosion in nesting areas. Despite this situation we continue with an increase of new nests in nesting areas, Wild cane represents and constant and significant increase annually in numbers of nest for hawksbill turtles for these lost three years. Wild Cane, the site with highest turtle nests in 2016, 2017 and now 2018 with 259 new nests an increase of 28.21% which equivalent to 57 nets. This cay are continuously been visited by fishers and been use for refuge and temporary home for them, we continued observed all types of vegetation's destructions and trees cut down with no control or conservation issues. Fishers argued that they cut and burn vegetation because of insects, mainly sand flies and mosquitos that bites them, also they says that cutting trees, create space so breeze can passes true.

On Bottom Tawira and Bottom Wood cays, nesting area were covered with materials for fishing gears; (lobster traps mainly) and other material for construction. **See figure # 9,** construction materials over nesting areas. On those cays we evidently found turtle nest dig up and turtle egg shell throw all around the cay (poached nest).

The number of lost nets were reduce in comparison of the 2016 and 2017 seasons, we had less severe storms this year; and because of experience with pass years, teams improve their skills to guarantee that all nest were located, relocated and daily monitored in the upper area, where we consider that they can be out of reach of high tides and poaching. All nest found near the sea side and swamp were removed and relocated on high land, away from washing away or to stay under water because of high tides. Evidently there was an increase of sea level we considered it as salt water entering to higher area or upper land, areas was once considered secure for turtle nesting; now these areas are not suitable for turtle nesting. On the other hand Wild Cane Cay was also used by high number of tour guides for tourist stay over at night, include a high number fishers were camping others for lobster and sea cucumber collection center. Sea cucumber become another issue around the cays, especially at night when fishers do diving using compressor.

Meetings with the watchmen of cays, shared information among fishers, bosses and other workers was done during the season, this sharing and teaching information related to the Hawksbill project and conservation activities was done by both team and occasionally by the marine coordinator every time she are out on the fields. We explain about our role in conservation activities and how resource users can also help us and be part of this process, all together with everyone help can reduce all harmful activities on the cays. For this 2018, the responsible of Calalla Cay become more flexible with the monitoring activity, understanding about the program and the benefit he obtained by supporting us and doing turtles monitoring and conservation activities. As respond to our work on Calalla cay this year we had an increase of 36 new nest equivalents to 41% for this 2018 in comparison of the 2017 nesting season on this particular cay.

On the other side of the story, it is good to mention the visit of our new country coordinator in June, the team was formally presented and work was done on cay with the coordinator Edgard Herrera Scott.

TAG AND RELEASE PROGRAM

FLIPPER TAGGING and SATELLITE TAGGING

Only four (4) turtles were tagged with control pins. These turtles were donated by fishers on cays and one donation was done at the office, after tagging turtle was release out to sea. T-shirts was deliver to all those who donated a turtle, but also we had some volunteers on cays that also had a T-shirt as recompense.

No new satellite tracking or attached was done in 2018 by WCS Nicaraguan Marine program.

INCENTIVES PROGRAM

DONATION OF LIVE TURTLES

The WCS team continued to encourage fishers, watchmen, and divers to donate live turtles in exchange for a WCS t-shirt, or a lifejacket for every 15th donation by the same individual. Donated turtles were then tagged and released. To date, there have been over 1074 T-shirts and 18 life jackets rewarded for turtle donations throughout the project's 19 years. In the 2018 season, we had received four turtle donated by fishers on cays and one young green turtle donated by a commercial boat driver with a community member. According to them, they were trying to raise it in their house, but turtle was not happy been there and they dint had time to take care of it as how it should be, they decided to donate it to WCS.

People are still trying to sell us tags (turtle pin), almost every day fishers and house wife visit the office in Pearl Lagoon to find out if WCS are still buying those tags or do the exchange for five dollars. This buying of tags was abolishing since 2014 because we dint want to continue promoting

negative incentive to fishers who catch turtles just for an additional five dollars tag. **See graph # 9,** young **Green turtle** donated boat drive and community member at WCS office.


ALTERNATIVE LIVELIHOODS PROGRAM

In 2018, WCS staff continued to support Kabu Tours project see (www.kabutours.com), the alternative livelihoods project that promotes the transition from turtle harvesting to ecotourism.

In an effort to reduce pressure on sea turtles and other marine biodiversity, WCS, the Conservation Enterprise Development Program (CEDP), and other partners continue collaborating with turtle fisherman from the community of Kahkabila to develop ecotourism in the Pearl Cays Wildlife Refuge. Through Kabu Tours (KT), a start-up, community-based ecotourism operator, turtle fishermen are attempting to transition from turtle fishing into sustainable tourism. This is a model for transitioning from different types of resource extraction to sustainable tourism. The marine coordinator and WCS secretary and occasionally the staff gave talks to visiting tourists, demonstrated field activities with ecotourism staff and tourists and answered numerous questions about sea turtle biology, project work, and local conservation efforts. The story of the transition call attention to most people knowing that these tours leaders was once turtle hunters and now trying to survive in the world economically competing and challenging. In addition, the

marine coordinator provided regular feedback on accompany promotional materials, budget strategy, grants, and offered logistical support throughout the year, also provide them with space for office lodging, light, water and internet for they daily work. The 2018 season was not good for them, Kabu Tour practically is out of work because of the social economic situation that has Nicaragua and other central American country under pressure, less tourist was traveling to Nicaragua, and Kabu Tour member was once more shift again to turtle fishing and other activity except tourism. Hopefully for this coming 2019 season things can change for them and for all tourist centers in Pearl lagoon and Nicaragua.

AWARENESS AND OUTREACH

WCS staff regularly shared information with local and regional communities, authorities, students and tourists. These activities were completed through a variety of mediums and in three different languages (English, Spanish and Creole) in order to reach a large and diverse audience. Also we have been doing educational activities at different schools and level of education (primary and secondary schools) in Peal lagoon and Bluefields. A selected team from different secondary school of pearl lagoon had the opportunity to go on one day trip to the Pearl Cays Wild Life Refuge. Teaching activities directed to children and youth about the work of WCS, biology of sea turtles and the importance that Hawksbill represent for the community of Pearl lagoon, the Nicaraguan Coast and the world. For youth, WCS marine coordinator prepare different educational activities in pearl lagoon and also on cay, also the turtle team show them how to do turtle walk and watch to identify track, turtle nest check and turtle excavation during they one day stay on cay. Formal presentation about the history of WCS in Pearl Lagoon and biology of marine turtles the marine was given by WCS marine coordinator, followed by an evaluation to the students. This was consisting by doing competition activities “Who knows more, win a WCS T-shirt or a cap”. Students were very excited about learning and all the different activity we done with them on the cays.

Also WCS in coordination with the Environment and Natural Resources Ministry (MARENA/ Ministerio de Ambiente y Recursos Naturales-in Spanish) we make some presentation at schools and

parade in the community of Pearl Lagoon, where all students from all schools came out and march on street in name of turtle conservation activities, using posters and pamphlets with announcement saying, stop eat turtles, this is our resources etc. additionally we had the participation of the Municipal government of Bluefields and pearl lagoon with the presence of CARLITOS. Carlitos is the mascot of the municipal office of Bluefields from the environmental affairs for resource conservation. Children was excited with the presence of Carlitos in the community and at the different schools in Pearl lagoon and Hallover. **See figure # 10, students on Pearl cays**.


Figure 10 and 11 students on Pearl cays

Presentations was also done again in the city of Bluefields at the Moravian primary school, where children were interested to learn about sea turtles, the marine coordinator also made presentations about turtle life cycle, the pearl lagoon and the pearl cays and WCS in Nicaragua. Children were really enthusiastic to know more about marine life and sea turtles but also land turtles. The same thing occure with student from the University of BICU, mainly with students from Marine Biology and Ecology; those students had the opportunity to go out to the refuge and learn about sea turtle activity done by WCS team. This is a joint venture between WCS and the University of BICU. **See figure 12 and 13, children activity in class room.**


Figure12 and 13 children activity in class room

WCS NICARAGUA WEBSITE AND COMMUNICATION ATIVITIES

In 2015 a dedicated website for WCS Nicaragua was created (http://nicaragua.wcs.org)! Previously, there was a one-page information sheet on the main WCS website and one page about hawksbill sea turtles. Efforts to create the design and function of the website first started in early 2015, with the collaborative efforts of WCS Nicaragua staff and IT support from WCS Bolivia (Mr. Roger Paz). Over time, with page by page design and content additions, a draft version of the website was created with a consistent stylistic structure of other WCS websites. The website was launched in November 2015. The website links to the WCS Caribbean and Latin America programs page. The webpage was a tremendous help in outreach and was useful as a reference for tourists or potential partners, as previously all explanations of all aspects of our work would have to be given in person or via e-mail. Now those who browse the website can access information about WCS and WCS Nicaragua projects, focal species and ecosystems, current staff, project partners, publications and other shared resources,

photos, news stories, and contact information. There is also a section informing people how to donate money to WCS Nicaragua. Laura Irvin 2015.

But also radio activities have been done in the community, to inform people what is going on with the project, what difficulties and what good activities been taking place on the cays in relation with the project itself. The hawksbill team, also visited radio station and share their experience with the radio audience. Radio announcement was done during the baseball series in the municipalities. We expect to continue and better the communication level for this coming 2019 season.

RADIO ANNOUNCEMENTS

Monthly radio announcements were aired from September to December to share progress about the project, update number of nest each time team come in and thank staff members and collaborators and community audience, re-emphasize the importance of participatory conservation efforts in the Pearl Cays Wildlife Refuge, and to remind residents of the law prohibiting the harvest of hawksbill turtle eggs, meat, include the conservation of the habitat of the Pearl Cays, and the role it plays for the social, economic wellbeing of all communities members who depend direct and indirect way.

These announcements were made by one of the seasonal staff or by the marine coordinator. Where possible, announcements were made in Creole, English, and Spanish. Also WCS payed a radio Spot to make shore the information is share always with the communities specially during the annual transmission of the baseball series. Those announcing aimed to go on the air at the busiest listening times of the day to increase the likelihood of reaching more people at once. The project results and daily activity was also mentioned on the Radio la Costeñicima and Zinica, Regional Radio Stations base in Bluefields, considered of the most popular radio stations listen on the Nicaraguan Caribbean Coast. Also WCS continued pay for turtle project announcement in the community stadium during the whole year and baseball series 2018, where a turtle was painted on the wall, and a written information saying “EAT MORE CHICKEN” – LETS PROTECT SEA TURTLES. Radio announcements were also aired before the 2018 season begin, to encourage community people to apply for WCS seasonal staff positions. We had trained 18 applicants this year, we recruited 4 (four)

new members for the 2018 season. The marine coordinator kept visiting these regional radio stations and update information on advance of the project.

NEST TALLY SIGN

The sign, was first developed in 2014, located in front of the WCS office in Pearl Lagoon walling in 2018 the main objective is to update people passing by about the season's running nest tally for every ten days survey. Each time team come from field trip the sigh board is change and update with the number of nest recorded on that date. Throughout the season, local community members and visiting tourists were regularly seen reading or commenting on the sign. The running count allowed people to track nesting in real time. The updating each time team enter to mainland boosted staff moral and made teams feel proud to have worked an increasing the number of nests each rotation also it gives the team an animus of competition to see which team (1 or 2) recorded more nest during the season. this tally was also reflected on the intern part of the office, where Lilja our secretary carry control of number of nesting per team. This year team 1, found 457 nest and team 2, found 449, and 12 nest was found when both team get together for the closing of sensing with the coordinator. See figure #

When the project broke the all-time record for number of nests in a season for this year 918 nest found, both teams are invited to the WCS office to celebrate and change the sign together. The sign often sparked discussion and comments from people passing by and even motivated some people to come into the office and learn more about the project, most of the time by foreign tourist. There was a community bulleting also posted on wall, but this year it was not possible. We will try to do so for this coming 2019 season so people can get updated of all activities to be done in the community towards the turtle project.

TOURIST OUTREACH ACTIVITIES

Throughout the 2018 nesting season, national and international tourists visited Pearl Lagoon and the Pearl Cays. Formal presentations or informal discussions about the hawksbill conservation project were held with unknown number of tourist between May and November 2018, although this year there was less tourists visiting the area. Excursions booked through Kabu Tours included a stop at the WCS office, where WCS staff would explain the hawksbill conservation project and WCS conservation efforts to visitors. Since the vast majority of tourists going to the cays visited Crawl cay where the project base camp is located, WCS staff had opportunities to share information about the project. Staff gave tourists a summary of the project history, outlined the project activities and objectives, shared statistics about the season (current number of nests, how many nests have hatched, nests on any particular cay, etc.), listed local and international threats to sea turtles, and talked about the importance of local and global sea turtle conservation efforts in three languages (English, Creole and Spanish).

Based on qualitative data collected during these interactions, many tourists came to the Pearl Cays specifically to see turtles. Wherever possible, tourists would be invited to join staff on surveys of Crawl for live demonstrations of project activities. Also some experimented turtle hatching out from its chamber on Crawl cay also on Lime cay where the Callala Resort are located. Large groups of tourists, mainly from Europe and United State including a few from the Pacific side of Nicaragua, were able to witness a nest hatching out on Crawl cay during the month of August, September and

October where season is high, many tourists and local watchmen also observed nest excavations, nest check, and the recording of new nests.

LOCAL OUTREACH ACTIVITIES

A variety of different initiatives were undertaken by WCS staff to participate in information sharing or education within the local communities.

The Marine Coordinator in collaboration with Ally a local Peace Corp volunteer member visited the Ministry of education to obtain legal approval to do some turtle's educational activities at all local schools (primary and secondary) in Pearl Lagoon, Haullover and Raity Pura during the 2018 educational program. Sadly the member of Peace Corp had to leave the country, but the WCS coordinator with the secretary, continued the process of outreach activity in the different schools. As result of this coordination, WCS had reach out to more than four hundred (800) youth and children. During the presentations student from secondary school have participate in knowing competition and then win a WCS t-shirt. Smaller children do coloring turtle. Sea figure #

Coloring pencil and paper was giving to all students in the class rooms, presentation was done using projector. These educational activities were done also with MARENA with the participation of CARLITOS the Bluefields municipality local mascot, a green sea turtle. Carlitos visited he schools in

Hallover and then we had a parade on the main street in Pearl lagoon with all schools from Pearl lagoon, Hallover and Raitipura.

The idea after this educational process was to make a selection of 8 student and take them out to the Pearl Cays for one day and one night for them to have the experience of the project itself; where the WCS staff will explain the work that we have been doing and the importance of doing it on the Pearl Cays. Also for them to experiment the moment when young babies turtle were hatching on cays, after that we made an evaluation to student to know how much they have learn during they stay and how important it was to them for the future. It's a way to encourage them to be a wildlife conservation person. We have high expectation for this coming season.

DISCUSSION, RECOMMENDATIONS AND CONCLUSION

It was another record-breaking season in 2018 in terms of number of clutches and hatchlings, the highest during the history of the project. It was also the season with the lowest poaching rate in

project history out 918 nets only 35 nest was poached equivalent to 3.81%, a 0.5% less than the previous year. This is the fourteen (14) consecutive years to record over 200 clutches from the previous recorded, fifth consecutive year to record over 400 clutches, the forth to record well over 500 clutches, the third to record over 600 clutches the second to record more than 800 and the first to record over 900 clutches in a season in the Pearl Cays Wildlife Refuge. Change in nesting levels between years is not uncommon, especially considering the reproductive biology of sea turtles, and can often be attributed to changes in environmental factors (Lagueux et al, 2014). As hawksbills have a reproductive age of ~25 years (Mortimer & Donnelly, 2015), higher survival rates rather than an increase in nesting population is likely the cause of increased nesting activity (Campbell et al, 2009). Although some fishers continue killing hawksbills and the juveniles of multiple species, the Incentives Program is believed to have resulted in an overall decrease in their mortality in the PCWR. Also considered the work that BICU and WCS are promoting in establishing a management plan for the refuge, has help a lot in creating consciousness and awareness among resource users. This also includes stricter regional and international regulations for commercial fisheries targeting areas that overlap with sea turtle distribution, such as the requirement for Turtle Excluder Devices on shrimp trawlers implemented by INPESCA and monitored annually by the NOAA visiting the institutions and the fishing industries in Nicaragua and other central American countries, this also have proven to decrease sea turtle mortality (Crowder et al, 1994; Lewison et al, 2002; Epperly, 2003), and increased protection on a regional and global level, could also be contributing positively to increased survival of regional sea turtle populations (Bjorndal et al, 1999). Increasing trends for number of clutches per season have also been reported for regional hawksbill populations in other long-term monitoring projects of nesting beaches in Antigua (Richardson et al, 2006), Barbados (Beggs et al, 2007), Brazil (Marcovaldi et al, 2007), and Mexico (Garduño-Andrade et al, 1999), which reflects positively on regional and international conservation efforts for this critically endangered species. Never the less, the population increase is also result of local authority effort in law enforcement during the close season for conservation purpose.

Again it have shown the trend of some cays to leading the first or second place for highest turtle nesting on cays such as Wild cane cay, fallowed be Water but with a change for Crawl cay for this 2018 season.

Human activity brought by acopios (lobster buying stations) is more frequently found on cays with a history of documented poaching specially on Bottom Tawira, Buttonwood and Collumbila, these cays are also further away from the WCS temporary base camp and thus are not monitored as often as other closer cays due to difficult access during rough weather. This year we continue to have direct coordination with the navy, they were also doing monitoring to avoid poaching and other ilicit activities on and around the cays. Also the, regional authorities carry out legal process against the poachers and turtle killers. On Wild Cane, Bottom wood, Bottom Tawira and Columbilla, WCS teams was careful in marking or putting a cinta (flagging tape) to indicate where ever nest was recorded, because we put in risk the position of nest to poachers or to be destroyed. Also they observed that most of fisher was visiting the cay not for poaching but most for coconut, cays are continued to be destroyed by fishers and other resource user by cutting down the mangroves and coconuts tress including other trees and vegetation where turtle go and nest by. This year a sea cucumber commercial center was establish on Wild cane, some nest was destroyed because of building camp over nest. After talking with the owner he understands that what he was doing was not good, he leave a few days later. Despite the presence of this group of workers on Wild cane, these catch and donate two live turtles to the project; a T-shirt was giving to both donors, turtle was tag and release.

The relationship between poaching, WCS presence, and human activity in the cays continues to emphasize the fragility of conservation success from year to year in the Pearl Cays. Although, WCS and BICU are putting strong effort to construct a functional and successful management plan for the refuge, hopping that this can be not the complete solution, but a way to reduce negative impact and negative incentive on the cays. If these human activities and associated poaching violations are not regulated appropriately, and if WCS monitoring activities are decreased or suspended in any way, there are no doubt that poaching rates will increase substantially and return to what historically occurred in the past. Even though, some fishers are also becoming more involve in turtle

conservation activities because of tourism, which can be and alternative for turtle conservation activities. Some fishers have discover that they can also do tourism activities with visitors, and teach them about turtles and other sea animals around the cays, so in some way this can be positive for sea turtle on the PCWR in the absence of the management plan. Some have learn that all sea turtles value more alive than dead.

Continued efforts towards education and building strong partnerships with stakeholder Regional institutions such as INPESCA, MARENA and MINED include other local groups and local communities using the cays, as well as maintaining WCS' presence during the nesting season, are essential for conservation success for the short- and long-term. Not just for turtle but also for other marine species and the cay itself. This year WCS have reach out direct to more than 1000 young boys and girls, include children's and adult at different events at primary and secondary schools, University and Institutional level or in some community activity such as management plan consultations, more than two thousand radio listener have heard about the Hawksbill turtles, in and out the community which have had positive effect and well seen and accepted by community members in the communities in and out the basin. The Regional Municipal, Territorials and communal authorities, play an important role for this to be success. They are the one who will take enforcement actions and decision towards protecting, using and conserving those cays along with the resource users. Every day we have people interested in be part of this project and team, people from all around the basin are encourage about the work we do, and how it have help families economically and socially.

Despite of controversial issues with the construction of the Resort on Lime Cay "Callala Cay" this year we had an increase in number of nest and also had the support from the administration of the resort, we hope to continue strengthen this for turtles health and well been, avoiding the elimination of vegetation on cay and under water around the cay to give a better condition to tourist, include the reduction of daily sand removal. We continue providing some recommendation and also teaching tourist about turtles on the cay. Our aim is to continue implementing some activities to keep reducing the level of destruction, contamination and bad practice around the cay that will permit the increase of the number of nest on Lime cay for the future; sadly we cannot say the same for Vincent cay and

fallowed by Maroon cays, the first are under water during raining season the other are almost the same. If the Pearl Cays nesting site is confirmed as a male-producing beach due to these lower temperatures, this site can be an important focal point for conservation measures of this critically endangered species in the face a changing climate. Used by Irvine 2015 – Hawksbill conservation project 2015. Then its mean that we need to implement other activity to conserve not just the species but also its habitat, the cays mentioned before need strong attention from all parties, local, regional and central government, include nongovernment such as WCS, which our main goal is to save Wildlife and Wild places. The management plan in process may not cover all problem or possible solution, but it may cover some issues such as the disappearance of other cays, project such as open say brake walls can be a possible solution to this problem which are affecting not only Vincen and Maroon but also other cays such as Baboon, Crawl, Water and Wild cane cay. These affections was clearly seen in these last years 2017 and 2018 season.

Maintaining nesting habitat in a natural thermal state, as well as in any condition ideal for nesting, will also depend on the regulation of human activities in the cays that directly affect the quality of this habitat as we are evidently seen on some cays.

Bottom Tawira, Bottom Wood and columbila are cays most used by fishers for fish resource storage and buying, because of the presence of most fishers, most poaching take place on those cays, the 3.8% poached in this 2018 practically comes from those cays. We are asking the local and regional authorities to do approaching to those fishers to avoid increase of poaching. On the other hand we continue observing on Pearl Cay that all vegetated upper beach vertical zones are a preferred nesting area for hawksbills as mentioned also by (Horrocks & Scott, 1991; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998; Kamel & Mrosovsky, 2006). Alteration of these habitats can negatively affect hawksbill nesting behavior and embryonic mortality in other following ways: increase temperatures for incubating clutches in areas with no vegetative cover, increase predation rates with greater exposure of nests, reducing diversity and abundance of cay vegetation, and further increase the already rapid speed of erosion of coastal habitats.

Unfortunately these last years two cays had eroded to the point where no available nesting habitat was present for the majority of the season (Vincent and Maroon). Despite of this, turtles kept nesting

on both cays for the 2017 we recorded 8 nets on Vincent and 6 nests on Maroon; but for this 2018 we recorded 11 nest for Maroon and 1 nest on Vincent; rapid erosion continues taking place on these cays, due to a combination of effects that include vegetation clearing and construction on some of the cays. Evidence of clearing on other cays was observed in 2018, nevertheless, these relevant observations are evidently decreasing on some cays, people are coming more involve in the process that they become volunteers in some cases. Example women on cay find a nest, she took care of it until the team arrive and after until it hatched out. I consider with the time and continue education poaching will continue reduce. Although residual damages will always be evidently and continuously because the Pearl cays are source of income for many families who live in communities nearby and depend of it for economic and social living. However, more outreach to watchmen and residents on the cays of the impact of these behaviors could help reduce or stop these activities that will result in a long term effects of habitat degradation, destruction and disappearance of cays, include a changes in thermal profiles of nesting beaches. We hope with the development and implementation of the PCWR management plan, this whole situation can change not only for the wellbeing of the Hawksbill turtle and its nesting site but also for other marine turtles and the rich marine biodiversity of the zone.

I highly recommend, continuously training activity to all Nicaragua WCS staff, annually, include the Marine coordinator to continue tagging pin and Satellite device that will contribute to keep on tracking all see turtle around the world, as one of the main activity to be done also to have an estimate of population size that come around the area and existing worldwide. This include also the incentive program for fishers to donate a turtle to the staff on cays, also to implement other incentives programs and activities to schools (primary and secondary) in and out Pearl Lagoon to get more people involved in the process, and kept in mind that the children is the future and education is the success for development and conservation.

I conclude that this 2018 season were very interesting, people becoming more aware of the situation and understanding about the importance for conserve our natural resources and Hawksbill turtle is never the less. People have reach us from other municipalities requesting our participation and to provide information of our work, and how this can be developed also in their areas such as Corn

Island and Puerto El Bluff. It was intense in the sense that we had develop educational activities to different schools and at different level including educational process for staff, fishers, community members, secondary and university students, this process have serve us to share our experience with so many people who wants to learn and contribute to conservations activities in class rooms and out on the field in our region. This season we started on time, it take us seven (7) intensive months to get this information update beginning from the month of May to November 2017 and conclude in conducting opportunistic monitoring in December 2018, January to April 2019, for December we record a few new nest which gets excavated in February 2019. This year we dint recruit any new member, we use the same staff from the 2017 season, both team had shown a lot of enthusiasm on the job. As result we continue increasing the numbers of turtle nests found, resulting as the highest record in nesting turtles after 19 years of history working on the Pearl Cays, 918 nests were recorded during a hard working together hand to hand with bad weather and storms that occurs during the season. We have had good hatchling but still, high number of eggs without embryos, probably female turtles are not mating on time or not finding super male turtles that can complete fecundation on time. Fewer nests were poached by fishers, more people know about the work we as WCS are doing. People are more conscious but still need more guidance and information to make the correct decision toward conservation of the Pearl Cays as a refuge. Issues such as not permitting team to enter some of the Cays to do monitoring are solve, tourist and tourist guides look for the turtle team to provide information that can serve them for knowledge and later sharing. The cutting down of mangroves, coconut trees and other native trees, include natural vegetation's are still a problem to be addressed. Solution for restoration of some of the cays and protection from erosion is a emergency need to preserve this natural beauty known as Pearl Cays. I do think that on the cays we and others, all together can make big changes in habitat of the whole cay flora and fauna and we don't need to find the solution or to do something after unravels damage is done. We need to keep supporting the process of the Management plan for the Pearl Cay Wildlife Refuge.

The management plan might not be the solution of all problems, but it may be the path to identify clearly some of the problems and base on the finding can be the recipes to address some of the existing problems of the cays, related with the way of use by the users. We are hoping to continue

working, providing, supporting and facilitating information for best practice to conserve and protect the Pearl Cay Wildlife Refuge.

VINCENT CAY 2016

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First, I give God thanks to permitting us life, health and strength to conduct and carry out this intensive 2018 season surveys on the Pearl Cays Wildlife Refuge.

I will like to give grateful, but grateful thanks to our entire donor, without your support we couldn't keep on with all these activities, in or out of the Pearl Lagoon basin. WCS marine program give you thanks. Without your kind contribution" Paul M. Angell Family Foundation, Millstone and Falcon wood funds also to individual donors who believe in conservation activities".

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NICARAGUA HAWKSBILL CONSERVATION PROJECT REPORT 2018
PEARL CAYS WILDLIFE REFUGE (PCWR)

Thanks WCS Pearl Lagoon staff to be with us, for trust in us and for your hard work and time and dedication towards hawksbill conservation in the Pearl Cays.

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Never the less, a deserve credit for the conservation achievements we describe in this report especially to the formal WCS Hawksbill Conservation Project founder in Nicaragua: Dr. Cynthia J. Lagueux, this should be done all year around.

WCS kindly appreciates the interest and support of local community members of the Pearl Lagoon basin and out in the Pearl Cays, as well as the Communal and Territorials Authorities of the Indigenous and Ethnic Communities of the Pearl Lagoon Basin, the Municipal Council of the Pearl Lagoon Municipality, the South Atlantic Autonomous Regional Council (CRAAS), the Secretariat of Natural Resources (SERENA), and the Ministry of Natural Resources (MARENA).

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