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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

By Karen Joseph, 2018





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PEARL CAYS WILDLIFE REFUGE (PCWR)

Contenido

LIST OF ACRONYMS	4
EXECUTIVE SUMMARY.....	5
INTRODUCTION	8
PROJECT OBJECTIVES.....	11
STUDY SITE:	11
METHODS.....	14
TRAINING AND TEAM COMPOSITION	14
NESTING BEACH SURVEYS	15
SURVEY EFFORT	17
NEW NEST DATA	17
TEST AND TRACK DATA	20
NEST CONDITION MONITORING.....	21
Nest conditions and definitions used in daily nest monitoring.....	22
HUMAN ACTIVITY SURVEY.....	23
NEST EXCAVATIONS.....	24
TAG AND RELEASE PROGRAM.....	26
SATELLITE TAGGING.....	27
INCENTIVE PROGRAM - DONATION OF LIVE TURTLES.....	28
QUALITY CONTROL OF DATA	28
RESULTS.....	29
NESTING BEACH SURVEYS.....	29
SURVEY EFFORT	29
NESTING ACTIVITY.....	30
NEST CONDITION MONITORING	34
NEST SUCCESS.....	34
HUMAN ACTIVITIES SURVEYS	39



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

TAG AND RELEASE PROGRAM.....	43
FLIPPER TAGGING and SATELLITE TAGGING.....	43
INCENTIVES PROGRAM.....	44
DONATION OF LIVE TURTLES.....	44
ALTERNATIVE LIVELIHOODS PROGRAM.....	45
AWARENESS AND OUTREACH.....	45
WCS NICARAGUA WEBSITE AND COMMUNICATION ATIVITIES.....	47
RADIO ANNOUNCEMENTS.....	47
NEST TALLY SIGN.....	48
TOURIST OUTREACH ACTIVITIES.....	49
LOCAL OUTREACH ACTIVITIES.....	49
DISCUSSION AND RECOMMENDATIONS AND CONCLUSION.....	51
ACKNOWLEDGEMENTS.....	58
REFERENCES.....	60



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

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

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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

EXECUTIVE SUMMARY

The Wildlife Conservation Society (WCS) conducted monitoring surveys of hawksbill sea turtles (*Eretmochelys imbricata*) in the Pearl Cays Wildlife Refuge (PCWR), Autonomous Region of the South Caribbean Coast, (RACCS) acronym in Spanish, Nicaragua, during the 2017 nesting season. A total of 719 clutches were recorded in the 2017 season, the greatest number of clutches in the 18-year history of the project.

During the intensive monitoring period (IMP), from June 01th to November 30th 2017, and additional opportunistic surveys, from December 2017 then fallow from January to April 2018. WCS teams worked a total of 1,050 hours (mean = 5 hours per day, some times more) and completed 1,680 cay surveys (defined as each time a cay was surveyed) on an average of 8 cays visits per day. The number of clutches laid in 2017 represented a 19.43% increase from 2016, and a 368.55% increase from the first year of the project (2000). As previous years, it shows a continuous pattern, the greatest number of clutches and nest were located on tree cays, Wild Cane with 212 nests, Water cay with 176, followed by Baboon cay with 112 nests.

The lowest poaching rate in project history was recorded in 2017. There were 4.72% clutches affected by poaching. These poaching were done by fishers. All nest had at least base on survival rates, 35 clutches has 0% survival rates, 684 clutches have at least 1 egg survived in nest.

Based on the number of empty egg shells >50% found during excavations, an estimated of 52,706 live hatchlings were produced in 2017, a number of 18,274 young babies turtles more than the previous year, equivalent to 52.54% increase of previous year. We had experiment an increase from 3,197 to 5,208 eggs not hatched because microbe, also an increase of number of eggs affected because of the absence of embryo from 8,381 to 9,857, eggs eaten by crabs, ants and unknown predators also an increase from 8,404 to 11,129 from this 2017 season.

During the intensive monitoring period (IMP), 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 (Buttonwood, Columbilla, and Wild Cane) and two cays were not observed to be inhabited (Maroon and Vincent) these last two are completely eroded and no vegetation's are on them. In fact Vincent Cay are despairing. As similar with previous year,



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

Bottom Tawira recorded the highest mean number of observations for people per cay-survey (by fishers), with Lime now Calalla Resort and Crawl second and third highest because an increase of tourism. Also it is good to mentioned that since November 2016, on Lime Cay was lees number of nest or nesting turtle on cay, due to removal of sand and vegetation's, noise and light.

Based on our daily check recorded in our human activities books, a total of 13 burn events went on in turtle nesting areas or beaches, and every week 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 on and around Lime Cay and Wild Cane cay. Vegetation clearing events, mangroves cutting inclusively, and two (2) construction activities plus two (2) reappearance of shed on Vincent cay was observed during the IMP, along with frequent clearing of vegetated areas on different cays.

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). 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. A Constant removal of sand and vegetation on Lime cay. A total of six turtle were tagged this year (pin) by the team, two small hawksbill turtle and one Loggerhead turtle was donated by fishermen in this 2017 season, also a baby green turtle were donated to the project on main land in Pearl lagoon, this was release hour after by members of the hawksbill team.

In 2017, 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. 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 2017 season. These activities were communicated through a variety of mediums (radio, signage, presentations, informal talks, website, classrooms (primary, secondary and University) visits, Earth Day activities, etc.) and in three different languages (English, Spanish and Creole).



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

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

This 2017, WCS continue giving technical and economic support to the process to create the Pearl Cay Wildlife Refuge Management Plan, with the intention to count with a first draft by the end of 2018. Meetings and workshop was done at different level with the resource users. Hawksbill project and summary of results were presented at the Moravian Primary School in Bluefields. Document of result of Hawksbill project 2016 were distributed to different authorities in the municipality of Pearl Lagoon and Bluefield's.

There were many achievements to celebrate during the record-breaking 2017 hawksbill nesting season, but multiple activities still pose 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, market demands, and climate change, WCS presence on the cays during nesting season are crucial as to reduce poaching, and volunteer compliance of regulations. We consider that our goal is being fulfilled and visible base on our results in the region.

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.



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

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). 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, take 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 show a recent increasing trend in the Pearl Cays nesting population, with an estimated 60-104 females nesting per season (NOAA & FWS, 2013). More than 20 genetic haplotypes of turtles using the PCWR have been identified thus far (LeRoux et al, 2012). But also, annual report of WCS of Hawksbill project in Pearl Lagoon have shown an increase in population from 154 nests in 1999 to 602 nest in 2016 and for 2017 season, they have recorded 719 nests, with high expectation for an increase for the 2018 season, (Hawksbill annual report 2000 and 2016).

Hawksbill turtles on Nicaragua's Caribbean coast are severely threatened by decades of unregulated harvesting of nesting females and taking of their eggs, and by the opportunistic capture of foraging juveniles and adults (Nietschmann, 1981; Lagueux, 1998; Lagueux et al, 2003; Lagueux &



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Wildlife Conservation Society

NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

Campbell, 2005; Campbell et al, 2012; Lagueux et al, 2013). 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; and, (2) nesting females were often killed for their meat and scutes (Lagueux et al, 2003). In 2000, a community and government approved project to protect nesting females and their eggs 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 year 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, there has been a steady increase in the number of clutches laid annually and, although variable, a significant decrease in percentage of nests poached since initiation of the project. In addition to protecting females and eggs, WCS 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 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



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

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 this 17th year 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 2017 nesting season are provided, as well as results from the 17-year effort.



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PEARL CAYS WILDLIFE REFUGE (PCWR)

PROJECT OBJECTIVES

Project objectives have maintained since the project beginning, 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. Collect reproductive and morphometric data on nesting females
7. Promote conservation through the media, presentations, and education
8. Build technical capacity at the local level for ecological monitoring and resource management
9. Improve local collaboration and increase government involvement in conservation activities
10. Assist local communities to continue and expand conservation of marine turtles through sustainable turtle watching and eco-friendly tourism in the Pearl Cays
11. Raise awareness of the plight of sea turtles, targeting fishermen to discourage the harvesting of marine turtles, particularly hawksbills and juveniles of all species
12. 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 are located from 3-22 km east of the mainland, off the central Caribbean coast of Nicaragua (Figure 1), 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.



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

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).

We had observed in this 2017, 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



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

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.

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.

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.

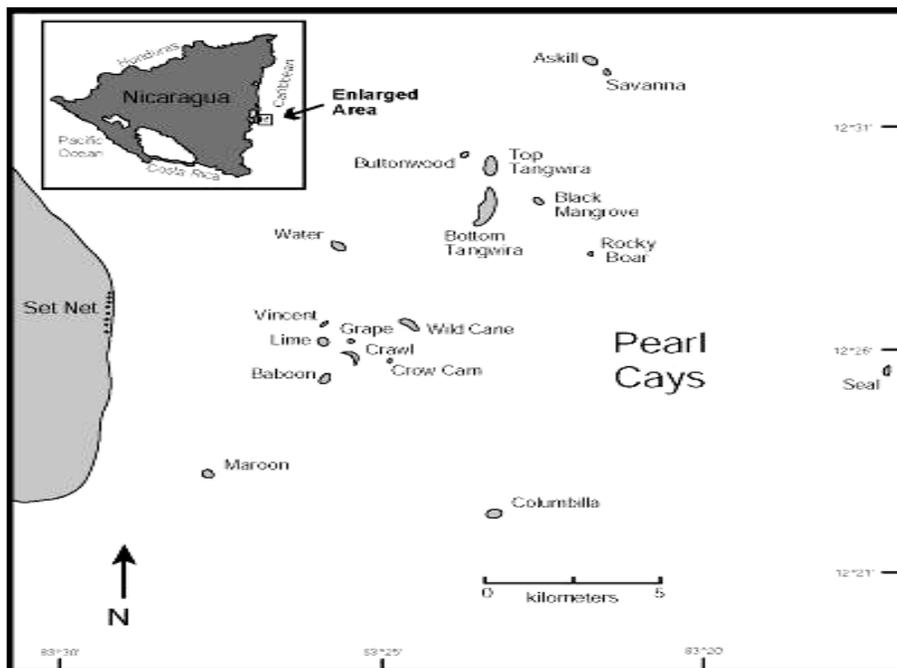


Figure 1 Map of the Pearl Cay Wild Life Refuge

No nesting activity was reported on Black Mangrove in 2013 or 2014, 2015 and 2016 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 rocks.

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 one by the ending of 2018. This may be fulfilling because of the effort and support of WCS international funds in coordination with the Bluefields Indian and Caribbean University (BICU), National, Regional, Territorial, and Communal governments.



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PEARL CAYS WILDLIFE REFUGE (PCWR)

METHODS

TRAINING AND TEAM COMPOSITION

Advertisements for the job of seasonal staff are normally circulated in March or April, with an application deadline in mid-May. For this 2017, we circulate application in March, deadline mid-April, training and team selection by the end of April and begging the project fully on May fifth 2017. We started a bit early than previous year because of the number of new nest identify by that date, and because fishers were asking for us to get out because there were turtle nesting early, this year. But also we close on November 30th a few days before in comparison of previous year.

To complete the 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 the 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, but also a practical training. This training activity was done on April 28, 2017. The marine coordinator are responsible to facilitate the training, to teach about biology and characteristic of sea turtles, history and background of the program and its projects, rules and regulation of compliance include functional system of the project itself. Old workers who have already has experience in field are those who teach the participants-candidates about the turtle monitoring on field, the use and objective of each book use in the field include the practical activity 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, verbal, written and practical. The eight team members selected, included a mixture of people from as many local communities as possible. The group of eight was split into two teams of four based on skill sets and experience, and each team would alternate for 10-day rotations from June to November. Teams



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PEARL CAYS WILDLIFE REFUGE (PCWR)

were then intensely trained in the field during their first 10-day rotation by the project coordinator and field team leader, as well as receiving continued mentoring by the aforementioned experienced staff members throughout the season. Nicaragua national police also accompanied project staff on nesting beach surveys at different shifts throughout the intensive monitoring period. Police from the Pearl Lagoon station were assigned to the project, with different officers each shift. Police were given a brief orientation during each rotation by the Marine coordinator; this was done also with members of the Army. (Fuerza Naval de Nicaragua), who have gave us a lot of support during this 2017 season)

NESTING BEACH SURVEYS

During the 2017 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 was updated and used again in 2017 to ensure consistency in scientific methods (Irvine, 2015). The aforementioned document was developed from a number of different sources, including: descriptions of methods used by project over 16 years from the project team leader, past databases and field books, and existing literature. 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), and more that 50% surveys a national police officer from the Pearl Lagoon police station and the Navy. 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.

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, AA rechargeable



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PEARL CAYS WILDLIFE REFUGE (PCWR)

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 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 (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



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

location. Teams did not use flagging tape to mark nests on these cays, but instead used more discrete markers for each nest, include GPS position and specific record position in book.

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



Figure 3 WCS staff plus student Relocating eggs

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 plus student Relocating eggs to artificial nest.

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



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

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



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

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 2015 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.).

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 (Irvine, 2015). Crawl lengths for first test attempts were measured along the center of the crawl with a flexible measuring tape, 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 exited the sea to 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.



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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, '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.



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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.



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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 giving to the local authorities evidencing the abuse of the catch of green turtles. **Figure #4. Green turtles on Collumbila Cay during close season 2017**



Figure 4 Green turtles on Collumbila cay during close season 2017.



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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 2017.**



Figure 5 Nest excavation process 2017

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 2014 was 66 days (Irvine et al, 2015), this number of days maintain for the 2017 season. Nests were checked for signs



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of hatching at 60 days and excavated after 75 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. **Figure 6. Excavation variables.** (Adapted from Wyneken et al, 1988; Eckert et al 1999; Miller 1999; Christen & Garcia, 2013c., Garcia, pers.com., 2013).

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.



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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. Three methods were used to obtain subjects: opportunistic night surveys, rescue of turtles caught in drifting nets, and the “Donate A Turtle” incentive program. Night surveys consisted of patrolling beaches on selected cays with high density nesting (i.e. Wild Cane, Water, Crawl) every 1.5 hours from approximately 7:00 pm until sunrise in search of nesting females. Field staff was trained to locate, observe, and capture nesting females on land. During encounters with these individuals, care was taken not to disturb the nesting process. Once the nesting attempt was completed, WCS field staff approached the turtle to restrain it for data collection. When teams saw unidentified buoys drifting in the ocean in the study site, they collected the drifting net from the ocean and rescued any turtle caught in the net. These turtles were brought back to Crawl cay for tag



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PEARL CAYS WILDLIFE REFUGE (PCWR)

and release. In efforts to increase capacity building in 2015, both Team Leaders were trained to tag with Inconel and PIT tags and collect tissue samples, and all members of the two teams were trained to both measure turtles and fill in the datasheet. The 2017 turtle season, we had no tissue sample, but only tagged turtles. We are hoping to do pit tagging this coming 2018 season.

SATELLITE TAGGING

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



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PEARL CAYS WILDLIFE REFUGE (PCWR)

transmitting in August 2015. Tagging did not take place in 2016 either 2017 season. Hopping that for this coming 2018 season we can continue with tagging process, team leaders and drivers were capacitated to do tagging.

INCENTIVE PROGRAM - DONATION OF LIVE TURTLES

The “Donate A Turtle” incentive program began in 2009 and was used to encourage 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.

QUALITY CONTROL OF DATA

Data in 2016 as well 2017 went through several quality control checks to ensure accuracy. When in the field, the data recorder and one other team member checked all data for completeness and legibility. Then, the team leader, with the help of another team member, checked the data again at night, when transferring nest data to the Nest Check Book. The Marine coordinator checked data opportunistically when in the field and then systematically for each variable when entering the data into the Excel database, often with another team member, team leader or team driver, resolving any issues with team immediately. After having all data in order and understandable information, data is recorded in computer by Lilja Williams (secretary) in coordination with the Marine Coordinator then double check and reviewed all electronic 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).



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PEARL CAYS WILDLIFE REFUGE (PCWR)

RESULTS

NESTING BEACH SURVEYS

SURVEY EFFORT

Eight candidates (six men and two women) were selected to work for the project from the 15 candidates who attended the training workshop in April 2017.

The teams included: Keffrey McCoy-team leader 1, Arton Lam team leader 2, Byron Blandon “Coco”-boat driver 1, Anthony Sambola-boat driver 2, Ciomara Blandon-team member 1, Arleth Cayasso-team member 2, Roger Julio- team member 3, and Sheiby Tinkam – 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 three communities in the Pearl Lagoon basin: Haulover, La Fé, and Pearl Lagoon.

Surveys conducted in the 2017 season were classified as either daily surveys during the intensive monitoring period (IMP) (May 05 – November 30 2017) or opportunistic surveys outside the IMP (in December 2017/ two trips and January to April 2018). The IMP was 210 days long, during this time teams worked a total of 1050 hours (mean = 5 hours per day).

A total of one thousand six hundred and eighty (1,680) cay-surveys (defined as each time a cay was surveyed) were conducted in the IMP. Eight (10) cays were visited during the IMO, with a daily visit of eight most important nesting cays per day every from May to November. An additional, surveys were conducted opportunistically before and after the IMP, total of 11 (eleven) cay-surveys. Most surveys on opportunistic activity in relation of time consumption was done on Wild Cane Cay and Water Cay for final excavation. Mean survey effort during the surveys were nine hours per day. Some days we didn't do surveys on all cays, the primary reason for not visiting all 11 cays each day was adverse weather conditions causing unsafe travels. In case of opportunistic survey was because some nests were to hatch out in those months and we also find new nest in November and December 2017, and the closing of the season were November 2017.



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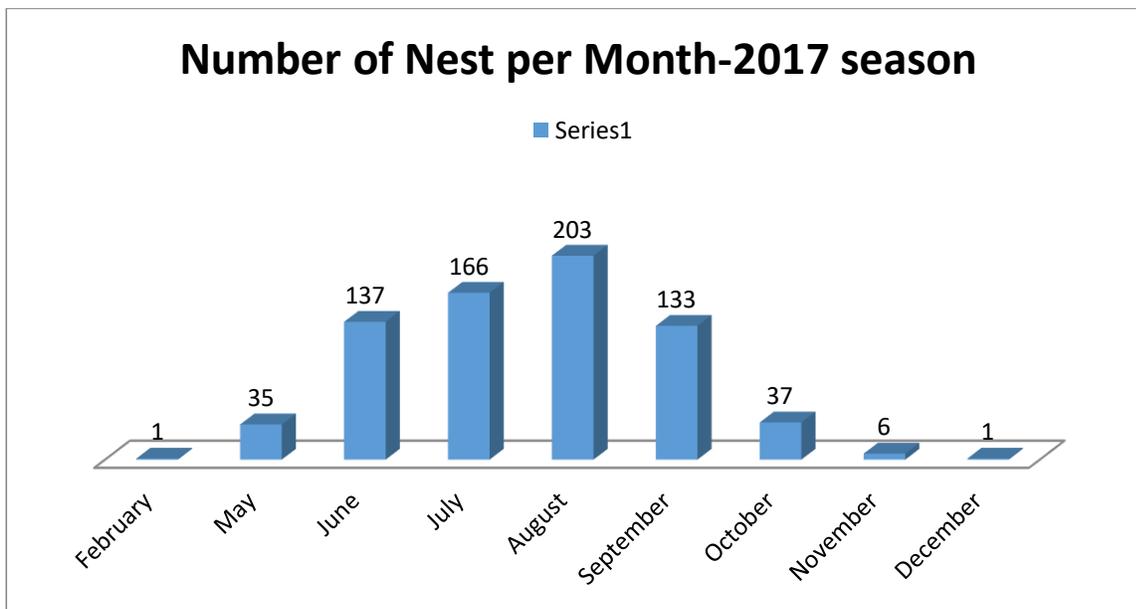
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NESTING ACTIVITY

In 2017, the greatest number of clutches in project history was recorded with seven hundred and nineteen (719) clutches. A nineteen point forty three percent (19.43%) increase in nesting in comparison with 2016 nesting season and three hundred and sixty eight point fifty five percent (368.55%) increase since project started in 1999. The temporal distribution of clutches conformed to past project seasons, with peaks from June with one hundred and thirty seven (137), July with one hundred and sixty six (166), August with two hundred and three (203) and September with one hundred and thirty three respectively (133), information are based on estimated and confirmed lay months. We also find turtle nesting in month of February, May, October, November and December 2017. **Graph # 1, shows the** number of Clutches found per month in 2017.



Graph 1 Number of Nest per month 2016

Teams confirmed exact lay dates for clutches (90.69% of all nests) to accurately calculate incubation periods and excavation dates. The mean incubation period for nests fully monitored during the IMP in 2017 was 64.4 days. There continued to be a significant positive relationship between the number



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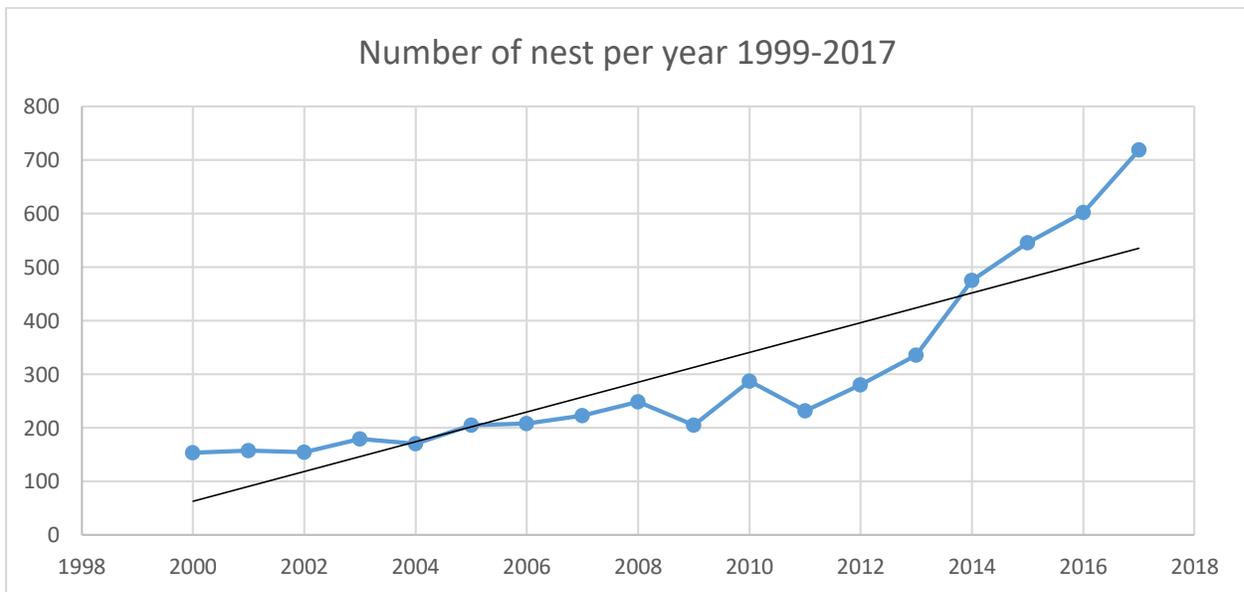
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PEARL CAYS WILDLIFE REFUGE (PCWR)

of clutches recorded and the number of years since initiation, which represent a gradual increase in nesting. Highest peak were in August.

The number of clutches laid in 2017 represented a 19.43% increase from 2016, a number of 117 new clutches more than previous year, and 368.55 % 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 Number of Clutches per year 1999-2016

We have found turtle nesting on eleven (11) cays in this 2017 season, Lime, Baboon, Crawl, Grape, Water, Wild Cane, Maroon and Columbila Cays, Vincent, Bottom wood and Bottom Tawira Cays for this 2017 season an increase of 2 cays more in comparison of 2016.

All nests were removed from Vincent and put on Lime Cay, due to disappearance of Vincent. Almost the same happen on Maroon 50% of nest were removed to Baboon cay. Bottom Wood and Bottom Tawira cays are use mainly by fishers for camping, and fish gathering center. Human activities are relatively high on both cays, so survival rates are low, nest poaching was high on both cays.



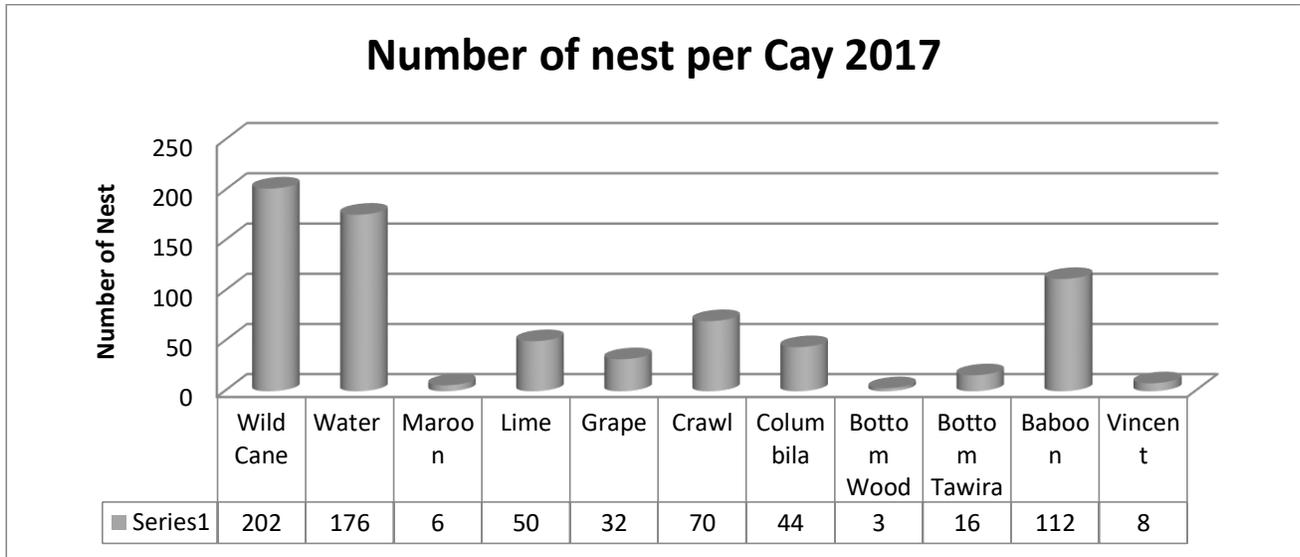
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Most nest were located on two cays, Wilds Cane Cay, had the greatest with two hundred on eleven (n=211 nest) followed by Water Cay with one hundred and seventy six (n=176) nest. Graph # 3. Show number of nest/clutches per cay for 2017 season.



Graph 3 Number of nest/clutches per cay 2017

Of the 719 clutches, 568 were left in situ and 185 nests were relocated, because of high tide human poaching and other predator visibility. In the case of Vincent 100% of nest were relocated on the nearest cay, in this case it was Lime cay, for Maroon 50% of the nest were relocated on Baboon. The 719 clutches were removal was done, were distributed on 9 out 11 nesting cays (Wild Cane, Water, Maroon, Lime, Grape, Crawl, Columbila, Bottom wood , Bottom Tawira, Baboon and Vincent) nest were not relocated on Bottom Wood either Bottom Tawira, because either they were poached or had days since they were laid by turtles, which is not recommended to do . Clutches were relocated primarily when significant mortality threats were posed; we also relocated clutches because of inundation or because of predation by animal and human.

The lowest percentage poaching rate in project history was recorded in 2017, in based on the number of nest found. Out 719 clutches 4.72% (35 clutches) were poached, a difference of 7 poached clutches more than 2016 but less in percent's base on the correlation between the total numbers of



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PEARL CAYS WILDLIFE REFUGE (PCWR)

nest related with poached. Out those, four (4) nests were partially poached, clutches with at least one egg remaining to incubate, the others were completely poached.

Poaching was observed on five of 11 Cays where clutches were found: Wild Cane with the highest rate = 17, followed by Columbila = 9, Bottom Tawira = 5, Bottom wood= 2 and finally Grape = 2 for a total of 35 clutches. Cays mentioned are Cays were fishers used for refuge at night or area use for gathering seafood, except Grape Cay where there is a watch man that dedicates his self to disturbed turtle and its nests.

For those nests that were partially poached, at least between one to fifteen eggs were remained in clutches for incubation. We also observed nest where eggs were destroyed by female's turtles while nesting. For example, we had observed two (2) nests with three (3) clutches each one. Four (4) nests were found with burst eggs because of female turtles; eight (8) nests were dig up and destroyed completely by dogs (two on Grape and 6 on Bottom Tawira). A total of fourteen (14) nests was wash away completely by high tide, this happen on Water cay and Wild cane cay.

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, and included data on burst eggs found in chamber during relocation, 27,724 eggs were relocated equivalent to 185 nest with a success hatch rate of 12,977 young turtle born (base on egg count more than 50% egg shell remained in chamber). The mean clutch size was 149 per nest and survival rate mean size was 70 individual per nest. Relocated clutches had a mean in situ nest depth of 39 cm.

All in situ locations for nests including those left in situ, later relocated or taken had a mean straight distance from the center of the nest cavity to the most recent high tide line of 6.29 meters.

The mean crawl length from the high tide to the center of each clutch was 12.24 meters. An accurate crawl length could not be measured unless the entire up-track was visible to teams. In some cases, the track was difficult to locate due to heavy rains, tides, vegetation, or human activity on the cay.

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 were find nested in locations with no vegetative cover, this was observe on Vincent and Maroon Cays where no vegetation are actually exists, these nest were relocated. But also we found nest under houses, in the case of Grape, these nest were leave in situs.



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The cays with highest number of nest were Wild Cane Cay then fallow by Water Cay, then Baboon. In previous year it was Wild cane, Water then followed by Lime, we observe a decline in number of nest on Lime Cay, now name Calala Cay.

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 (n=176) were checked less regularly, because owner and workers (guards) are volunteer to do daily check to guarantee nest safe, then later, team go and do formal and final check and record nest. Clutches on Bottom Tawira, Buttonwood, Columbilla, and Maroon cays, were checked even less frequently, most of the time because of bad weather also because of the number of nest to be recorded. 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.

During daily monitoring of environmental and anthropogenic condition, the vast majority of nests five hundred and sixty eight (n=568) nests were visibly undisturbed by any environmental or human impacts during the entire incubation period.

NEST SUCCESS

A total a number of six hundred and fifty (650) excavations were conducted for the 2017 season. Sixty nine (69) nests were not included in the nest success analysis, this represents nests affected by poaching thirty four (34), nest eroded by high tides as result of different storms equivalent to eighteen (18), nest destroyed by roots were five (5), eight nest dig up by dogs, and the other four (4) were eaten or destroyed by other predator such as rats, possum and crab. 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 twelve thousand nine hundred and seventy seven (12,977) individuals out twenty seven thousand



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PEARL CAYS WILDLIFE REFUGE (PCWR)

seven hundred and twenty four (27,724) eggs. Based on data recorded, most eggs not hatched didn't have embryo.

Twelve (12) nests were removed from one cay to another cay; six (6) were removed from Vincent to Lime cay and the other six from Maroon to Baboo cay. This represents the sums of eight hundred and fifty six (856) eggs from Vincent with an average clutch size of one hundred and forty two (142) eggs per nest, it had a survival rate of three hundred and eight (308) individuals hatch, eggs more than 50% equivalent to fifty one (51) eggs per nest. In case of Maroon the survival rate was higher, we had a total of eight hundred and ten (810) eggs removed with average clutch size of one hundred and thirty five (135) eggs per nest, and a survival rate of four hundred and forty two (442) individuals with a result of seventy three (73) survival rate per nest. Two (2) nests were moved on the same cay because it has had already few days nested the team consider not moving them, most of them were exposed to high tide.

Based on the number total egg count an estimated of eighty one thousand six hundred and seventy five (81,675) eggs were laid by hawksbill turtles in this 2017 season, and fifty two thousand seven hundred and six (52,706) live hatchlings were produced in 2017, this information is based on the count of empty egg shells >50% found during excavations. Out of the total egg count, twenty eight thousand nine hundred and fifty six (28,956) were unhatched eggs.

Unhatched eggs are mainly related mostly with biological issues (absence of embryo, nine thousand eight hundred and fifty seven (n=9,857), yolkless forty two (n=42), embryo reaches to Stage #1, one thousand seven hundred and eighty two (n=1,782), Stage #2, four hundred and one (n=401), Stage # 3, two hundred and thirty (n=230) and Stage # 4, one hundred and forty (n=140). But also we found that eggs were attacked by microbes (n=5,208), eaten by crab, ants, and other unknown predators (n=11,129). We also had forty two (42) individual's albino, some deformities such as turtle with no eyes three (3), and one (1) twin baby turtle. **See Table 2 .** Unhatched eggs (classification) 2017. This year we had an increase of live hatchlings in comparison of 2016 season.



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Table 2 -Unhatched eggs 2017

Reason of unhatched egg	Number of unhatched eggs	% of unhatched eggs
Yolkless	42.00	0.15%
no embryo	9,857.00	34.13%
stage 1	1,782.00	6.17%
stage 2	401.00	1.39%
stage 3	230.00	0.8%
stage 4	140.00	0.48%
Microbe	5,208.00	18.03%
eaten by crabs	1,124.00	3.89%
eaten by ants	1,183.00	4.1%
other unknown	8,822.00	30.55%
dead in nest	92.00	0.32%
		100%

Table 2:Unhatched eggs (classification) 2017

With gathered information from 2000 hawksbill report until 2017, we were able to create a graph where you can appreciate how is the fluctuation of live hatchling result in the year by year surveys on the pearl cays. In the following graph we can appreciate the increase and decrease of hatchelling versus year. This 2017 had experimented the highest live hatchling rate through the history of the project, and then followed by 2015 report hen 2014. For the 2016 we had a dramatic fall.

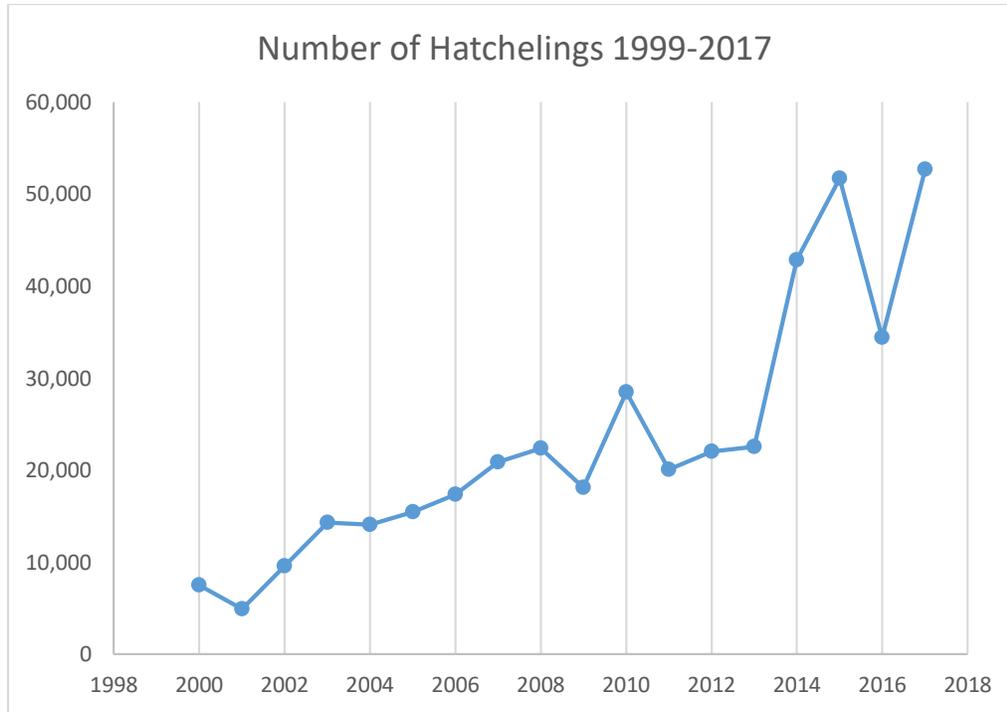


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PEARL CAYS WILDLIFE REFUGE (PCWR)



Graph 4 Trend, number of hatchelling 1999-2017

Also you can appreciate an estimated trend of number of nest per year with the following graph. **(graph # 5 / Number of Nest per year)** Beginning with one hundred and forty four (144) nests in 1999, and for 2017 we recorded seven hundred and nineteen (719) nests. Five hundred and seventy five (575) nests more since the project begging represent an increase of clutches more than 300% since the project begins

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, because they vulnerability to be catch and eaten by the people. Some alternative livelihood activity can be propose and implement by us.

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



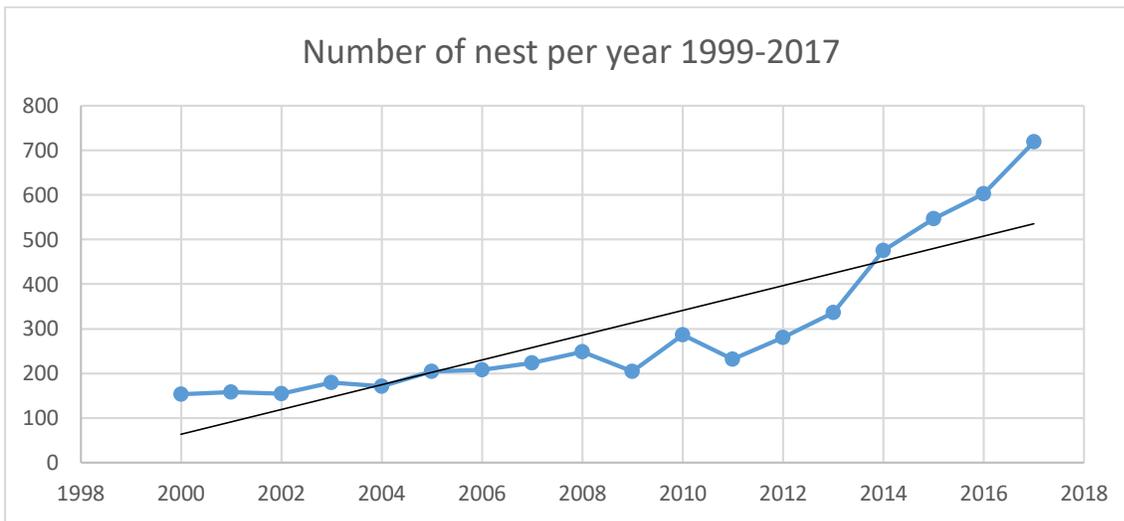
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Navy, Police and other institution have enforce the law toward protection of sea turtles, all good actions that they have been don. As result, they have capture fishes trafficking green and hawksbill turtles to be sell in Bluefields during the close season, these were capture by the navy, police and other authorities form the region, process and fined by the corresponding authority and turtle were release back out to sea. This was published on local media (TV and radio).



Graph 5 Trend of number of nest per year 1999-2017

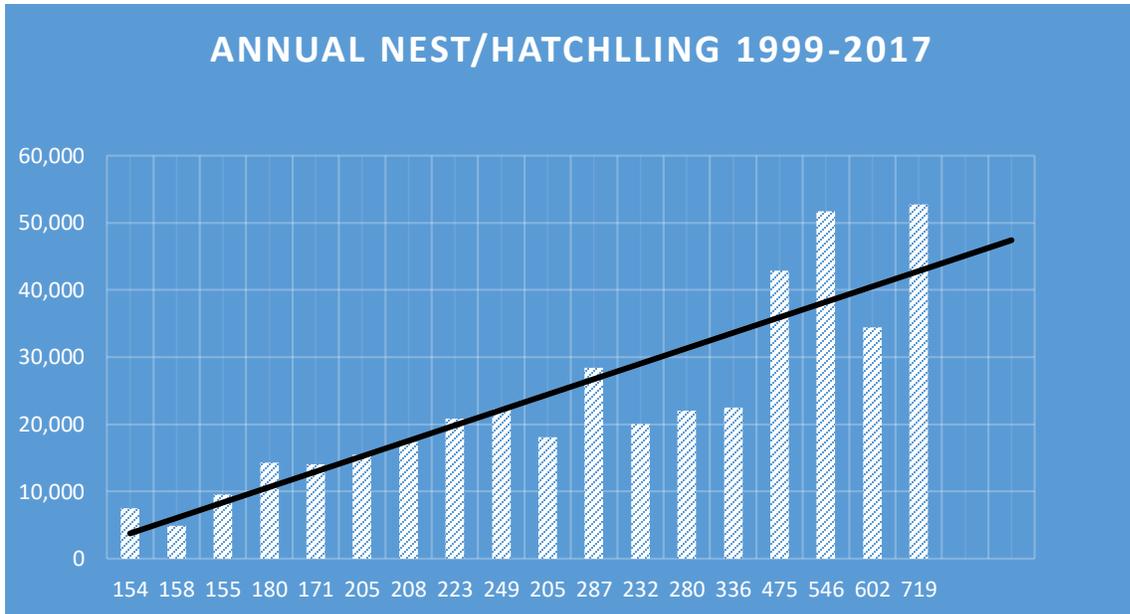


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Graph 6 Annual nest/hatchling 1999-2016

This graph (**graph #6/ Annual nest versus hatchling 1999-2017**) represent the fluctuation observed in the increase of number of nest and increase or decrease of number of eggs or new hatchling each year since 1999 until 2017. The 2017 result have report the highest number of nest but also the highest number of hatchling since the history of the program, followed by the second highest in number of nest in 2016 with six hundred and two nests (602) but it hold a fourth place in hatchling, although it has the third place in highest number of nest but holding second place in hatchling in 2015.

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



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PEARL CAYS WILDLIFE REFUGE (PCWR)

Baboon, Crawl, Grape, Lime, and Water cays, Lime cay were leased to foreigners to construct a Resort now named Calalla Cay Resort; This resort beginning its construction activity in October 2016, and beginning his tourism activity in January 2017. On cays where were permanently and frequently inhabited (Bottom Tawira and Bottom wood) a few nests and nesting beach were cover with construction material for lobster traps. In this 2017, we had increase of tourist and a decrease of number of nest specially on Calalla Cay. In addition, the WCS surveys team (four to eight people) were permitted to inhabit Crawl Cay from June to December. WCS staff was excluded from the number of people observed per cay-survey.

This year we had founded sixteen (16) nests on Bottom tawira cay, in the 2016 season we did not found any, same with Bottom wood, we find three nests. Most tourist visit and stay on Lime cay, Followed 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, chicken mainly on Crawl, bottom Tawira and Grape cays. Include pigs on Bottom Tawira. A Monkey and parrot on Grape cay. Despite of no vegetation's, Vincent also had people visiting because Calalla Resort, they had constructed two huts for tourist to relax and an area to take sun bath on cay. 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 burning garbage on Maria Crowcam cay. Also we observed almost everyday vegetation clearing events, cutting and taking sand events and construction activities Calalla Cay during the IMP. On Crawl cays where vegetation was burned in 2016, shows a recovery from damage, which is very important for sea turtles nesting. All these burning and cays destruction were reported to Regional and local authorities, who been working in coordination with others authorities, especially with BICU-WCS in the process of the construction of the Management plan of the Pearl Cay Wildlife Refuge.



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Figure 7 constructions and materials over nesting area.

Some areas of Baboon, Crawl, Grape, Lime and Water continue to be raked (‘cleared’) regularly, but permanently on Lime cay, impeding the new growth and regeneration of native vegetation that could help secure/stabilize the substrate in nesting areas. Wild cane represents an increase annually in nest for hawksbill turtles. Wild Cane, the site with highest turtle nest in 2016 and now in 2017 with (nest=202) were continuously been visited by fishers where we have observed all types of vegetation’s destructions and trees was cut down without mercy for coconuts mainly. Others because of high level of sand flies (fishers says that they need to create space where breeze can pass true). On Bottom tawira and Bottom Wood cays, the nesting area were cover with fishing gears (lobster traps) and other material for construction. **See figure # 7**, where we found evidently turtle nest dig up and



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PEARL CAYS WILDLIFE REFUGE (PCWR)

turtle egg shell throw all around the spot. The number lost nets were reduce in comparison of the 2016 season, (high number of nest ere lost because of storms and hurricane Otto), teams try to guarantee that all nest were located in the upper area where they can be out of reach of high tides. Regardless of of this, in 2017 all nest were found, but in some cases, when digging eggs were still under water in which we had cero percent (0%) of survival rates. evidently an increase of sea level or salt water entering to higher area that once was considered secure for turtle nesting. (this was evidenced on the north side of Water Cay. Similarly we found turtle nest in swampy area of the same cay. On the other hand Wild Cane Cay were also used by more tour guides for tourist stay over at night and more fisher were camping at least for three days on the cay.

On Bottom Tawira (known as Sand fly Cay), year by year they cut down mangroves of the cay, to dry the swamp and to reduce sand flies that is in the center part of the cay, this year there were no difference, mangroves and other vegetation was cut down. Figure # 8 cutting mangroves.



Figure 8 cutting of mangroves, coconut and other vegetation for the drying of swamp in Bottom Tawira (Sand fly Cay)



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Police joined WCS teams for shifts in July, August, September, October and part of November on every cay survey in 2017. Meetings with the cay watchmen, boss of the workers was done during the season, information related with the Hawksbill project was shared among fishers by both team and the marine coordinator. We explain about our role in conservation activities and how they can help us all together with everyone helped to reduce all harmful activities on the cays. Although there were still incidents throughout their time on the cay. For this 2017, the responsible of Calalla Cay become more understanding about the program and how this can benefit him in the future with his tourist, despite of the negative respond from him months before. Even though, the numbers of nest were decrease for this season on Lime cay (Calalla), from sixty eight (68) nests in 2016, now we recorded fifty (50) nests for 2017. We had also some anomalies that took place on the Lime Cay, example, on our daily intensive monitoring activity, one of the team release some baby turtle that was held on Lime Cay by workers to show tourist when they go by, the turtles were evidently week after kept in captivating for some time without feeding and environmental condition for survival.

On the other side of the story, in March 2017, the Marine Coordinator, Karen Joseph, had a visit from New York staff, Jeremy Radachousky and the formal Country Director Estuardo Secaira, they travel to the cays and also had meetings with the team members in Pearl Lagoon, include members from Kabu Tour project.

TAG AND RELEASE PROGRAM

FLIPPER TAGGING and SATELLITE TAGGING

No turtle was tagged or tracked by satellite in 2017 by WCS Nicaraguan Marine program. But we tag 5 turtles this 2017 with pins.



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PEARL CAYS WILDLIFE REFUGE (PCWR)

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 1065 t-shirts and 18 life jackets rewarded for turtle donations throughout the project's 17 years. In the 2017 season, we had received four turtle donated by fishers and one young green baby turtle donated by a young girl in Pearl lagoon. People are still trying to sell us tags (turtle pin), but this was abolishing since 2014 because of having a negative incentive to fishers who catch turtles just for an additional five Us dollars tag. **See graph # 9, young Green turtle** donated by youth at WCS office.



Figure 9 Young green turtle donated to WCS for release



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PEARL CAYS WILDLIFE REFUGE (PCWR)

ALTERNATIVE LIVELIHOODS PROGRAM

In 2017, 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. 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. 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 local for office lodging, light and internet for they daily work.

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. 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 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. The following figure resumes youth activity on cays. **See figure # 10, students on Pearl cays.**



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Figure 10 and 11 students on Pearl cays

Presentations was also done 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. **See figure 12 and 13, children activity in class room.**



Figure 12 and 13 children activity in class room



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PEARL CAYS WILDLIFE REFUGE (PCWR)

WCS NICARAGUA WEBSITE AND COMMUNICATION ACTIVITIES

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. We expect to continue and better the communication level for this coming 2018 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.



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

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. 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. Announcement were also done during baseball direct transmission during the baseball season. 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 Caribbean coast of Nicaragua. Also WCS continued pay for turtle project announcement in the community stadium during the whole year and baseball series 2017, 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 2017 season began to encourage people to apply for WCS seasonal staff positions. We had trained 16 applicants were we recruited 3 (tree) new members for the 2017 season. The marine coordinator kept visiting these regional radio stations and update information and advance of the project.

NEST TALLY SIGN

The sign, first developed in 2014, was again put in front of the WCS office in Pearl Lagoon walling in 2017 to update people passing by about the season’s running nest tally. 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. When the project broke the all-time record for number of nests in a season, both teams came 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. Since people were already drawn to the sign, we added the community



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PEARL CAYS WILDLIFE REFUGE (PCWR)

bulletin (see below) just next to it for those interested in more detailed information on monthly results.

TOURIST OUTREACH ACTIVITIES

Throughout the 2017 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 2017. 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. 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 October, 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 collaborated with local Peace Corps volunteers **Julian Crashman** in order to arrange education activities in local schools in Pearl Lagoon and Haullover in August 2017. As



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

result of this coordination, WCS carry out 8 students from secondary schools (Pearl Lagoon, Hallover and Raitypura), who had the experience to pass a night on Crawl cays, experience the moment to do turtle monitoring, where WCS staff explain the work that we do and the importance of doing it. Also they experiment the moment when young babies turtle were hatching on cays, after 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. The student who participated had to make a drawing or write a poem to become selected, them with a team we select the best poem and drawing. We had one drawing among the participants that reflect the harmonic interaction of sea turtles and other sea animals in the ecosystem. **See figure # 14, drawing from student.**



Figure14, drawing from secondary student



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PEARL CAYS WILDLIFE REFUGE (PCWR)

DISCUSSION AND RECOMMENDATIONS AND CONCLUSION

It was another record-breaking season in 2017 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 in comparison with the number of new nest (719), equivalent to 4.3% poaches less than 2016 season. This is the thirteen (13) consecutive years to record over 200 clutches, fourth consecutive year to record over 400 clutches, the third year to record well over 500 clutches, second to record over 600 clutches and first to record more than 700 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). Mentioned in Irvin 2015. 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. 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, 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.



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PEARL CAYS WILDLIFE REFUGE (PCWR)

When interpreting poaching rates, fluctuations have been statistically correlated with intensity and type of human activity in the PCWR and presence of the WCS teams during the nesting season. For example, a higher poaching rate (24.7%) relative to trends since the initiation of the project was reported in 2013 due primarily to the presence of sea cucumber fishers that actively poached nests on Wild Cane compounded by a later monitoring start by WCS teams (Lagueux et al, 2014, unpublished data). This cay typically has the highest or second highest number of nests per season, as we see in 2015, 2016 and now 2017, for this year the number of nest on this cay was 204 and was without the presence of watchman or permanent resident for many years. Human activity brought by acopios (lobster buying stations) is more frequently found on cays with a history of documented poaching specially on (Bottom Tawira and Buttonwood). 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 list also include Columbila Cay where most turtle fisher from Hallover use as refuge and keep turtle alive before returning back to their community as shown in figure # 4.

This year we have done some coordination with the navy, because of poaching on Columbila Cay and it had result in taking away and release of 37 (thirty seven) sea turtle (green and hawksbill), also, 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, but at the same time they were destroying the cay by cutting down the mangroves and coconuts tress including other trees and vegetation where turtle go and nest by.

There were an increased human activity leading to increased poaching was tempered, likely because of further increased presence and active measures by WCS team in coordination with the navy and police and the successful partnerships with the lobster fisher bosses – both elements not present in past years of increased human activity. 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,



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

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, poaching rates could increase as substantially – as observed in the past. Even though, some fishers are also becoming more involve in turtle conservation activities because of tourism, they have found out 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.

Continued efforts towards education and building strong partnerships with stakeholder 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. 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.

Despite of the establishment and construction of the Resort on Lime Cay “Callala Cay” where no precautions were done to protect or conserve the nest on the cay, turtles are continually kept nesting. WCS team at some point had to put formal denounce about all elicited activities taking place on the cay, mainly with environmental issues. Vegetation were eliminated on cay and under water around the cay to give a better condition to tourist, sand removal daily, according to them they do beach cleaning. Young turtle kept by them in captivity to show tourist etc. etc. WCS gave some recommendation before the construction begging that at some point these was ignored by the owner. We continue providing some recommendation, but also protest every time we do monitoring on the cay. We are hoping that we can better this relation for this coming 2018 season with owner and managers, to develop some educational activities with workers and also visitors on the cay. Likewise our aim is to implement some recommendations to reduce the level of contamination and bad actions around the cay that will permit increase the number of nest on Lime cay.

As result of not taking into consideration our recommendations, we had a decrease in number of nesting on the cay for this 2017 and an increase in loss of nest in 2016 season were the number of nest was recorded but no excavation was done, most nest was lost because of sand removal.



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

As sex is determined by temperature during a critical phase of development for sea turtles, lower temperatures result in more male-producing opportunities (Godfrey & Mrosovsky, 1999; Merchant Larios, 1999; Wibbels, 2003). Beaches in the Caribbean, as well as many other regions around the world, are observed to be warmer than pivotal temperatures and thus have widely been reported as female producing (sometimes as much as over 90% females) (Godfrey et al, 1999; Wibbels et al, 1999; Mrosovsky & Godfrey, 2010). As data continues to be collected on thermal parameters of nesting habitat and within nests, longer-term patterns and predictions can be made. The results can be vital to management and conservation strategies, according to experts (Mrosovsky & Godfrey, 2010). 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.

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 seen on some cays. Observations of clearing, cutting and burning events in or around nesting habitat, continue to damage the quality and size of areas available for nesting an ideal incubation, example of this is Vincent and Maroon Cays that for this 2017 is patch of sands in middle of the water, when high tide they are completely under water. Bottom Tawira, Bottom Wood are use to put lobster traps. Directions of current are washing away sandy area and putting it on other areas in some case beaches are wash away.

Vegetated upper beach vertical zones are a preferred nesting area for hawksbills (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. This is the first year in history that a cay has 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



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PEARL CAYS WILDLIFE REFUGE (PCWR)

nesting on both cays for the 2017 season, we recorded 8 nests on Vincent and 6 nests on Maroon. 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 2017, 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. (when they find a nest, they take care of it until it hatch out), with the time and continue education I do think that poaching will be reduce compared to previous years. Although residual damages will always be evidently and continuously because these cays are source of income for many families who live in communities nearby. 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 guarantee 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. This include also the incentive program for fishers to donate a turtle to the staff on cays.to implement other insentives programs and activities to schools (primary and secondary) in and out Pearl Lagoon to get involve more people, and kept in mind that the children is the future and education is the success for development and conservation.

I conclude that this 2017 season were very interesting, intense and educational for staff, fishers, community members, secondary and university students, it have serve to share experience with so many people who wants to learn and contribute to conservations activities in the 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 conducting opportunistic monitoring in January to April, including December where we got and record one new nest. We had three new members entering into the process to be part of the WCS staff, who had shown a lot of enthusiasm on the job.



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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

As result we had the highest record in nesting turtles after 18 years of history working on the Pearl Cays, 719 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. More than 9 (nine) thousand eggs were observed with no embryo. On the other hand, we had high hatchling. People are more conscious but still need more guidance and information to make the correct decision toward conservation of the Pearl Cays, Cays were leased 2016 for construction of resort, is 2017 and still there are no clear understanding of the importance of these cays for the pearl lagoon people and the role that these cays play in their daily living activities. Communications with owners and managers of Calalla Cay is battering little by little. In addition the cutting down of mangroves, coconut trees and other native trees on the cays can make big changes in habitat of the whole cay flora and fauna and the solution may be found after unravels damage is done.

The management plan might not be the solution of all problems, but it may come to solve 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.



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PEARL CAYS WILDLIFE REFUGE (PCWR)

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NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

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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Wildlife Conservation Society

NICARAGUA HAWKSBILL CONSERVATION PROJECT 2017

PEARL CAYS WILDLIFE REFUGE (PCWR)

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Page 51 of 53 WCS Hawks bill Conservation Project - 2015 Season Report

Page 52 of 53 WCS Hawks bill Conservation Project - 2015 Season Report

WCS Hawksbill Conservation Project - 2015 Season Report Page 50 of 53

WCS Hawksbill Conservation Project – 2016 Season Repor.