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**NICARAGUA HAWKSBILL CONSERVATION PROJECT REPORT 2019**

**PEARL CAYS WILDLIFE REFUGE (PCWR)**

**By Karen Joseph, 2019**





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## **LIST OF ACRONYMS**

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

**DNC** Did Not Check the cay

**ES** Emerging Success

**FBD** Found By Depression

**GPS** Global Positioning System

**HCP** Hawksbill Conservation Project

**HS** Hatching Success

**IMP** Intensive Monitoring Period

**IUCN** International Union for the Conservation of Nature

**MARENA** Ministerio del Ambiente y los Recursos Naturales

**MVL** Nests moved from Vincent cay to Lime cay

**PCWR** Pearl Cays Wildlife Refuge

**REC** Newly tagged turtles without previous tags/evidence of tags

**REM** Re-Migrant turtles with existing tags

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

**RACCS** Region Autonoma Costa caribe Sur

**SERENA** Secretaría de los Recursos Naturales

**SD** Standard Deviation

**TG** Territorial Government

**WCS** Wildlife Conservation Society



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**EXECUTIVE SUMMARY**

The Wildlife Conservation Society (WCS) conducted monitoring surveys of hawksbill sea turtles (*Eretmochelys imbricata*) in the Pearl Cays Wildlife Refuge (PCWR), Nicaragua since 1999.

For this 2019 nesting season we have found a total of 1015 new nest, all clutches were recorded during the 2019 season; the greatest number of clutches in the 20-year history of the project reported in Pearl lagoon basin, Pearl Cay Wildlife Refuge, Caribbean Coast of Nicaragua.

During the intensive monitoring period (IMP), from May 3<sup>rd</sup> to November 30<sup>th</sup> 2019, include additional opportunistic surveys in the months of December 2019 to March 2019. WCS teams worked in total 233 days, an approximate of 1,520.5 hours with a mean of 5 hours per day in low season and 8 hours in high season; they completed 1,867 cay surveys (this is defined as number of times cays was surveyed by teams during the period May-November include opportunistic surveys 2019 which represent an 8-11 cays visit per trip, on an average of 8 cays visits per day as a short run survey and 11 cays on a long run survey including opportunistic surveys.

The number of clutches lay in this 2019 represents 9.55% increase from 2018, and more than 500% increase from the first year of the project, (from 1999 when the project begging until now 2019, we have a total increase of 559%), this data represents a continuous increasing pattern, the greatest number of clutches in the WCS history report on the Pearl Cay Wildlife Refuge.

Most nest were located on tree main cays, a continued pattern since the last 5 years whit slite changes but always leading Wild Cane Cay with 325 nests, followed by Water cay with 271 nests, this year returning to 2017 pattern taking the third position is Baboon cay with 132 nests then Crawl with 106 nest. As predicted before, no nest was found on Maroon either Vincent cays, both cays are covered most of the time with water.

Despite of not having nests on Vincent and Maroon we also have good an positive news, we had only 24 nest poach (nest dig up by human), it have been a year of the lowest poaching rate in project history out 1015 nest only 24 was poached, which represents a 2.3% of total nests for this 2019



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season, and also a reduction in 1.6% compared with the 2018 season. this pattern have been show for the last years of the project.

Based on the range of survival rates, 836 nests had at least one baby turtle hatched out. One hundred and seventy nine (179) clutches had 0% survival rate. This caused by fallow: nest with 0% hatched 97, wash away nests 24, nests dig up by dogs 11, nest destroyed by roots 20, nests destroyed by turtles 1, nest destroy and eaten by rats 2, and 24 nets were poached.

Based on the number of empty egg shells >50% found during excavations, an estimated of sixty six thousand five hundred and forty three (66,543) live hatchlings were hatched and release for this 2019 season on the Pearl cays. This data represents a decrease in number of new born in the environment in comparison with previous year, this reduction equivalent to five thousand eighty nine (5,089) new born, which represents a 7.65% reduction. Despite this reduction in number of new born or hatchling's we consider that it was a grade season for Hawksbill turtle. We also had a high number of unhatched eggs due because of uncontrolled reason of nature with represent for 9.9% of unhatched eggs compare with the 2018 season.

During the intensive monitoring period (IMP), the pattern continue to be the same, six of the eleven cays monitored were permanently inhabited by tourist (Baboon, Crawl, Grape, Lime-Calala Resort, Water, and Bottom Tawira), three of the cays were frequently inhabited by residents or fishermen (Buttonwood, Columbilla, and Wild Cane) and two of the cays were not observed to be inhabited (Maroon and Vincent, this is due because both cays are formal cays, they disappeared). Vincent and Maroon are completely eroded with no presence of vegetation and no turtle nest was found on those cays. Both cays were under water most of the time 2019 season of the year.

As similar with previous year, Bottom Tawira recorded the highest mean number of observations for people per cay-survey (by fishers), with Lime now Calala Resort and Crawl second and third highest because an increase of tourism, this phenomenon also occurred on Wild Cane Cay. Tis year a fishers with permit from the territorial government have had establish a fish collection center (mainly fro Sea Cucumber diving, buying and hosting) was established on Wild Cane Cay. This was not good for turtle nesting.





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Based on our daily check recorded in our human activities books, we had less burning events in turtle nesting areas or beaches, they reduced a 50% of burning activity on all cays reported before, and a 100% reduction of burning on Maria Crowcam. It is common to observe vegetation removal on most cays, especially on those that promote tourist activities like Baboon, Crawl, Water, Grape and never the less Lime (Calala Resort) as the main one. This last one also are responsible of digging and removing sand from the beach edge but they reduce their activities in digging and destroying coral reef and sea grass. A platform was fully constructed for helicopter landing out concrete; this was constructed on the Northeast side of the island.

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

This year same as last year, fishers donated a young juvenile green turtle, this was taken to the office in pearl lagoon then release by our team with support of the workers from Calala Resort team who was taking tourist to the main land. A T-shirts was given to all those who give support on turtle conservation activities, in and out the pearl Cay Refuge.

In 2019, WCS staff continued to support Kabu Tours ([www.kabutours.com](http://www.kabutours.com)), the alternative livelihoods project that promotes the transition from green sea turtle harvesting to ecotourism activities. Efforts were made to inform local communities, authorities, and tourists about the hawksbill conservation project and state of turtle conservation in the PCWR before, during, and following the 2019 season. Nevertheless this season was not as prosperous for Kabu Tour like previous years. They run broke, they administrative system collapse because of bad practice but also



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because less tourist booking their package, they are trying to restructure they administration leadership to restart they activities for the 2020 season.

At an educational level, WCS marine coordinator with Turtle team assistant made presentations about the Hawksbill project and turtle life cycle, this presentation was directed to all primary and secondary schools in the communities of Raitipura, Hallover and Pearl Lagoon itself. Include presentation at University levels. After presentations and evaluate students participations we ask schools directors to make a selection for two student per schools, those students farther on participated on a field trip to the Pearl Cay Marine protected Area. We also did two Student University field trips, this in coordination with the University of Bluefields Indian and Caribbean University (BICU) from Bluefields. We teach them how to collect during monitoring and patrolling, and how to managing the bock for data collection, nest check and nest excavation process included. All students that had the opportunity to go out on the Pearl Cays Refuge had experience in see turtles hatching and nesting. These activities were communicated through a variety of mediums (radio, signage, presentations, informal talks, classrooms (primary, secondary and University) visits, Earth and Environmental Day activities, and a march to celebrate the Birthday of when Pearl Cays was declared as Marine Protected Area since 2010.

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 2019, WCS continue giving technical advice support to the process for the Pearl Cay Wildlife Refuge Management Plan. We also continued the process of collaboration and strengthen communication with Corn Island authorities for this to be declared as a Marine Protected Area. A small fund was approved to initiate the process. We expect to have a first draft by the end of the 2020 season.

There were many achievements to celebrate during the record-breaking 2019 hawksbill nesting season, these last three years has been very prosperous, and has shown great progress jumps resulting from 602 nest in 2016 to 1015 nest for this 2019, almost 400 nest difference. Nevertheless we continued facing significant threats to this important rookery, this is not an exception. The state of sea turtle conservation in the Pearl Cays is extremely fragile, sensitive to a number of different





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reasons related most to human activities, human necessity and poverty; include market demands, Social and Political issues and never less, climate change, in addition of those mention economic limitations. WCS presence on the cays during nesting season are essential and crucial to guarantee support the increase of Hawksbill population size by reducing poach and guarantee the well health of the cays. We consider that our long term goals are being fulfilled and visible in the eyes of the owners and resource users for Nicaragua and for WCS and its donor's world wild, it is well seen in our results and our presence in the region which is well accepted by most of fishers and authorities at the communal and regional level.

WCS recommends continue 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, but is necessary to mention that the theme Climate Change is need to be addressed rapidly. Which, it might not sound as interested by some but very important for the Hawksbill population worldwide habitats. We need to take into consideration that Sea turtle are migrant species, but is the same that comes every year to Nicaraguan waters, in this case to the Pearl Cays, not just for a short visit but some to mate, feed and others to bread or nest as is the case of the Hawksbill turtles. The continuation of our project is very important for the hawksbill population size recovery of the world. We will like to expand this project activity to other areas, such as Corn Island and Litle Corn Island, include the Coastal zone of the Bluff Beach nearby Bluefields, as requested by residents of the area.



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#### **INTRODUCTION**

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

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

It is good to mention that Hawksbill reduction is the result of over-exploitation of adult females and eggs at nesting beaches, degradation of nesting habitats, taking of juveniles and adults in foraging areas, incidental mortality relating to marine fisheries, and degradation of marine habitats (Meylan and Donnelly 1999). On the Nicaragua's Caribbean coast, there is an increase trend in the number of nests since 1999 with 154 nests to 105 nests for 2019 more that 500% increase.



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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), with an annual increase in nests.

Estimates from 2016-2019 showed an increasing trend in the Pearl Cays nesting population, with an estimated 97-199 female nesting, that gives an average mean of 137 females nesting per season. This was also showed by (NOAA & FWS, 2013), where they mention Estimates from 2010-2012 show a recent increasing trend in the Pearl Cays nesting population, with an estimated 60-104 females nesting per season. Analysis made from assumption that each turtle nest between 3 to 5 nets per season. According to LeRoux et al, 2012, more than 20 genetic haplotypes of turtles that are using the PCWR, have been identified. Annual report of WCS of Hawksbill project in Pearl Lagoon have shown an increase in population from 154 nests in 1999 to 1015 nets recorded in 2019, with high expectation for an increase of nets for the 2019 season. (Hawksbill annual report 2000 and 2018).

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

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

In 2000, the community and government approved project to protect nesting females and their eggs on the Pearl Cays, this initiative was implemented by WCS ('Hawksbill Conservation Project'). In addition, WCS established a 'Donate A Live Turtle Program' that provides incentives to local fishers



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and inhabitants on the cays to voluntarily donate live turtles to the project for tag and release (including males and juveniles, as well as green ( *Chelonia mydas* ) and loggerhead ( *Caretta caretta* ) turtles). This volunteer program is conducted throughout the years, and helps save turtles while also engaging a wider audience in sea turtle conservation that might be overlooked during typical community outreach activities (i.e. fishers, cay watchmen, etc.).

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

The Pearl Cays hawksbill population continues to face the destruction of its nesting and feeding habitats from increasing human presence in the area. The construction of permanent houses, hotels and/or the installation of temporary structures on cays with nesting habitat negatively affects nesting behavior, as well as indirectly affecting reproduction from the destruction and alteration of habitats (i.e. sand mining, clearing of upper beach vegetation, and construction in nesting areas) (Lagueux et al, 2013). In addition, fishing activities in the Pearl Cays such as the lobster, shark, and sea cucumber fisheries, contribute additional threats to sea turtles (Lagueux et al, 2013), and reconfirm by Joseph K. Hawksbill annual Report 2016, 2017, 2018 and now 2019. The lack of the implementation of the Management Plan and an effective administrative and rules enforcement and application system for the PCWR has led to an increase in human impacts and pressure on sea turtles and other marine resources on the cays. A severe reduction in these populations in the PCWR could have detrimental effects on other resources and overall habitat quality, as seen in other selected marine ecosystems



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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. However the cays were return to the community on October 29, 2016 by the president Daniel Ortega which concede and permit the authorities from the territory to have complete control over the use and management of the cays.

The conservation of hawksbill turtles in the PCWR is important for both the regional and global recovery of hawksbills. In these 20th years of monitoring, conservation, 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 2019 nesting season are provided, as well as results from the 1999 to 2019 effort.



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#### **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. Promote conservation through the media, presentations, and education
7. Build local and regional technical capacity for ecological monitoring and resource management
8. Improve local collaboration and increase government involvement in conservation activities
9. Assist local communities to continue and expand conservation of marine turtles through sustainable turtle watching and eco-friendly tourism in the Pearl Cays
10. Raise awareness of the plight of sea turtles, targeting fishermen to discourage the harvesting of marine turtles, particularly hawksbills and juveniles of all species
11. Provide incentives to local fishers and residents to donate live marine turtles of any species and age class for tag and release

#### **STUDY SITE: the Pearl Cays Wildlife Refuge**

The Pearl Cays are located from 3-22 km east of the mainland, off the central Caribbean coast of Nicaragua, and encompass an area of approximately 700 km<sup>2</sup>. 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. 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 since 2009. Although I do believe that this table needs to be adjusting to actual situation, mapping areas is needed to quantify or measure the lasted habitats and in some cases such as Maroon and Vincent





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cays, has disappeared or eroded completely. Used data is based on a mapping survey conducted in October 2009 (Lagueux et al, 2011). We will like to update this information, because cays condition and dimension have change during these last years. 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, 2009.*

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
Button wood	0.22/226	Water	4.69/460
Cumbilla	3.02/113	Grape	0.46/120
Lime	3.5/393	Wild cane	7.47/517
Maroon	0		

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

In this 2019 season, no nest was reported on Vincent either Maroon Cay, as we mentioned last season, we observed big changes in some of the Cays, mainly on Vincent cay and Maroon, where are completely wash away and now under water, there is no presence of any type of vegetation. Coconuts trees are complete cut down and shown that the sizes of the cays were reduced



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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.

Not everything is negative on cays, we also we continue observe positive changes on Lime Cay (Calala cay), this include the number of nest in comparison of the previous season.

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

No nesting activity has been reported on Black Mangrove, Top Tawiram Litle and Big Sabana either

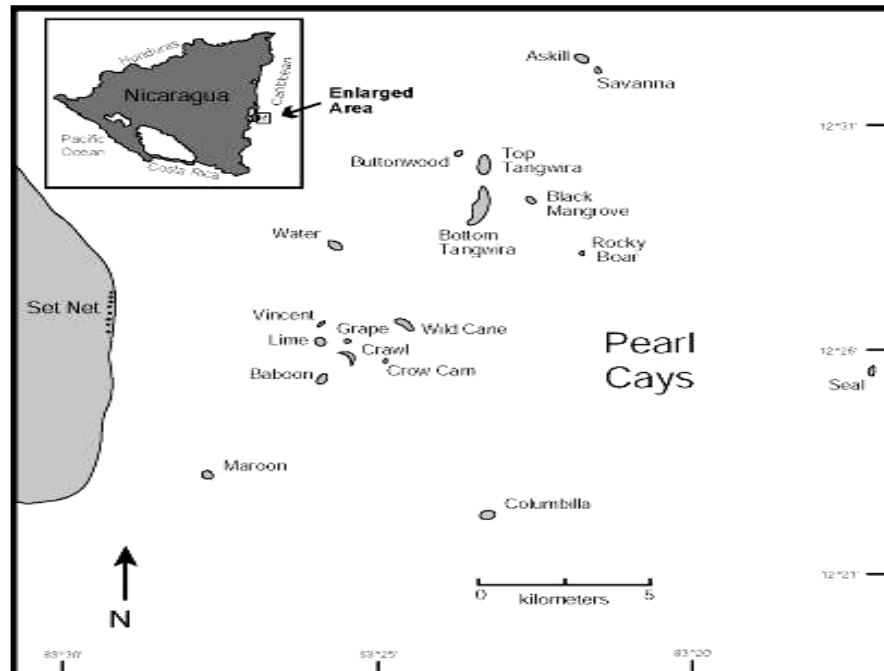


Figure 1 Map of the Pearl Cay Wild Life Refuge

on Esperanza and the two unnamed Cays belonging to the Pearl Cays, this is yearly confirmed by opportunistic surveys and qualitative data collection from temporary residents on the

Cay. Beside the cay do not have any condition to consider as nesting beach, because it surrounded completely by gravels, mangroves and rocks.

The study site is located within the Pearl Cays Wildlife Refuge (PCWR), established as such since 2010;

The PCWR currently have a write-up Management Plan proposal and currently in hands of our authorities to be approve, hopping by the end of 2020, and to be implemented by 2021. Thanks to BICU and Horizont 3000 who's carrying the process and WCS who provide economical and



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technical support and never the less MARENA, Regional Council, Territorial, Communal and Municipal governments.



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**METHODS**

**TRAINING AND TEAM COMPOSITION**

Advertisements for the job of seasonal staff are normally over radio station and local vocal media in March or beginning of April every year, with an application deadline in mid-May. For this 2019, include previous year we circulate application in March, deadline mid-April, training and team selection by the end of April and begging the project fully in the first week of May 2019, precisely 05<sup>th</sup> of May. Since 2017 we been opening the monitoring activity in May earlier than how the project have been set up since 1999, this due because of the number of new nest identify by date, which we can says that there is a change of patter of Hawksbill nesting season; we have had turtle nesting report from fishers from January and evidently we found nest during our opportunistic survey's. This year we close on November 30<sup>th</sup> then we had opportunistic surveys during December, January, February and March.

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

Seasonal staff first received classroom and practical training in sea turtle biology, nesting ecology, and field data collection methods by experienced WCS personnel during a one-day training workshop, it include a practical training. This training activity was done on May 03, 2018. The marine coordinator are responsible to facilitate one whole day training, to teach about biology and characteristic of sea turtles, history and background of the WCS program and its projects, rules and regulation of compliance include functional system of the project itself, team responsibilities, salaries, swap day, holidays, data collection and importance of real data, etc. Old workers, who have already had experience in field work, are those who teach the applicants-candidates about the turtle



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monitoring on field activities, example how to identify turtle track, nest or attempt nesting (test), the uses and objective of each materials and instruments include how to manage the write in rain book and what is it used for in the field, include the practical activity and finally an evaluation/exam.

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

### **NESTING BEACH SURVEYS**

During the 2019 nesting season, monitoring surveys were conducted regularly on 11 of the Pearl Cays where hawksbill nesting occurs annually. A comprehensive survey protocol document produced in 2015 by Laura Irvin, which is still in use, was updated and used again in 2019 to ensure consistency in scientific methods (Karen Joseph 2017-2019). The aforementioned document was developed from a number of different sources, including: descriptions of methods used by project over 19 years from the project team leaders, past databases and field books, and existing literature for new experience is learn each and every year. All methods described below are summarized from the aforementioned document.



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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), and sometimes with the marine coordinator (Karen Joseph). Opportunistic surveys were conducted before and after the intensive monitoring period (IMP) from May to November, recording newly laid nests or any nests found by signs of hatching, including excavations, which is normally in the months of December to April every year.

WCS, obtained an annual permit from the Territorial Government which permit us work and for the team to build a camp for inhabit on Crawl cay during the IMP. Teams carried survey equipment in the Kit Bucket, which included: 50 mt measuring tape, field books and excavation datasheets, two hand-held compasses, one Garmin GPS units, a ACR Personal Locator Beacon, one ACR C-Strobe, one Gun flayer, cell phone for communication, rain coats, three sets of AAA and AA alkaline and rechargeable batteries and charger, one survival blanket, one signal device survivor combo, one handheld signal pack, pencils, sharpeners, ruler, permanent markers (sharpie), orange flagging tape/cinta, white garden sticks to mark nests, excavation gloves, first aid kit, and dry bags for each GPS units and a phone with a list of emergency contacts. **Figure # 2. field materials anequipment.**



*Figure 2 Fieldtrip equipment 2018*





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

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

### **SURVEY EFFORT**

Survey effort indicated team presence on the cay and was calculated to determine hours worked both directly on recording data and working with live turtles. Survey effort was a new addition to the data collection regime in 2014 (Irvin 2015), and continue to do so in this 2019 season; the process entailed the recording of a start time when the team arrived on the cay to conduct a cay-survey (defined as each time a cay was surveyed) and an end time right before the team got back into the panga (skiff) to leave. This data helped estimate the times females were laying depending how recent the nest observed to be and considering the last time a survey was done on the cay (i.e. survey conducted the morning before and track looks very fresh so we can safely conclude that the nest was laid that night). This data also allowed a record of more recent human activities on the cays relative to our survey hours (i.e. nest laid the night before was poached when particular fishermen were observed spending the night on the cay). Finally, the data gave estimated times required for particular survey activities which helps inform survey logistics (i.e. longer surveys during peak season, estimates for how many excavations can be done during a particular time period, etc.).



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**NEW NEST DATA**

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

Once the clutch was found, the nest was given a number in sequence (1, 2, 3 ...). Clutches were left in situ unless there was a significant mortality threat from poachers or environmental factors (i.e. high tides inundating the nest during the incubation period, predators in nest, etc.). Translocation of clutches is a common practice in sea turtle conservation projects all over the world, and can serve to mitigate a variety of threats that negatively affect nest success (Wyneken et al, 1988; Bolton, 1999; Kornaraki et al, 2006; Tuttle, 2007; Pfaller et al, 2008; Pike, 2008). This practice is often done by our team members. Teams dug an artificial nest chamber with the same nest depth and shape as the natural nest. The relocated nest site had similar vegetation coverage and vertical zone to the original nest site, where possible. The relocation process involved careful removal of each egg into a deep pan with sand, transport of the eggs to the new site, placement of the eggs into the artificial nest cavity, and covering the original nest of eggs with lite material (camouflage). We consider an artificial nest, those nest which turtle dint naturally excavated and put eggs, the nest was dig by the team members to protect the clutch from erosion, high tide, poaching etc. When moving the clutch, teams always maintained the eggs in their original vertical orientation so as not to cause movement-induce mortality of the embryos (Limpus et al, 1979; Bolton, 1999; Mortimer, 1999). The moved site was minimally disturbed and then camouflaged to hide the clutch from poachers. In the vast majority



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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



*Figure 3 WCS staff plus student Relocating eggs*

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



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cay (north, west, etc.), and the vegetation coverage type (Vegetation: fully covered, Border: mix of vegetation and natural lack of vegetation coverage, Cleared: vegetation removed by people, or No Vegetation: natural lack of vegetation coverage).

Eggs in each relocated clutch were counted when removing the eggs from the in situ nest and then a second time when placing the eggs into the artificial cavity. Mean clutch size was based on egg counts of relocated clutches because this number is more accurate than eggshell counts during excavations (Miller, 1999). Nest depth was measured in the original nest cavity, from the bottom of the nest to the beach surface level (using a stick across the cavity mouth at surface level). Nest depths were not measured for clutches left in situ until they were excavated. Finally, any notable comments about the nest were added to the field book (i.e. lay date, burst eggs found during relocation, suspicious footprints or dig marks around nest, etc.). Where relevant, nest success data from 2019 were used to influence translocations and moved site selection is conditions of the habitats remained the same (i.e. avoid moving to areas which had 0% or low success, move from areas with 0% or low success, etc.). Or the moving of eggs from one cay to another cay to increase the probability for eggs to hatch well, example, from Maroon to Baboon and from Vincent to Lime.

### **TEST AND TRACK DATA**

Tests (false crawl with attempted egg chambers) and tracks (false crawl without an attempted egg chamber) data were used to calculate the total amount of effort and site preferences of nesting turtles in the study area. These false crawls can also indicate potential disturbances to the nesting female (in the case of artificial light or human presence) or help predict the return of a nesting female to a similar area that night or over the next few days (Richardson et al, 1999). During each cay-survey, teams recorded the cay, type of activity (test or track), series number for tests (first, second, etc. attempt in the series), vertical beach zone, vegetation coverage type, straight distance to high tide from middle of the test event or highest point of track, crawl length from high tide to middle of test attempt or total crawl for tracks, GPS coordinates, and any other comments for each test or track. Crawl lengths for first test attempts were measured along the center of the crawl with a flexible measuring tape or cinta as called in the field, from most recent high tide line to the center of the



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attempted cavity. Subsequent test attempts were measured from the center of the first attempted nest cavity to the center of the second attempted nest cavity, from the center of the second attempt to the third, and so on. In the case of tracks, the measurement began at the most recent high tide line when the turtle visibly re-entered the sea. If a test was connected to an eventual nest, then that nest number was indicated in the comments. All tracks and tests were camouflaged after data was collected, so not to be confused as unrecorded activity in following days. This was especially important on swap out days to avoid double counting of activities by the next team. Beside each nest after been recorded, and marker to locate, there is a white garden stick buried just on top of eggs I nest, this got written with marker date and nest number, to ensure that when the nest is excavated is the right nets recorded.

### **NEST CONDITION MONITORING**

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

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



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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.

#### **Nest conditions and definitions used in daily nest monitoring.**

Example Condition (code)=NAT its definition is: “Nest was in a natural state, undisturbed by the environment, predators or people. Flooded (FLO) Nest was inundated (water in nest). Eroded (ERO) Nest was eroded (saw eggs that have been washed out of the nest or clutch was fully exposed). Taken (TAK) Partially Taken (P.TAK), Nest was fully (TAK) or partially taken by poachers (P.TAK), as indicated by an empty egg chamber with digging marks, footprints, stick holes, sometimes a few egg shells, difference in depth of nest since the nights before, etc. Predated (PRE) Partially Predated (P.PRE) Nest was fully (PRE) or partially predated (P.PRE), known by evidence such as hole dug up near the nest, animal prints, egg shells scattered around the nest, sand spray, lack of footprints or stick holes, crab holes leading to nest, presence of predator itself, etc. Unknown (UNK) Nest was in an unknown condition Hatchlings (HAT) Signs of hatching were observed at nest (hatchling tracks or hatchling cave). Definitions guided primarily by Christen & Garcia, 2013c.

#### **HUMAN ACTIVITY SURVEY**

Human activities were recorded on each cay to identify any negative anthropogenic impacts on nesting beach habitats that might affect turtle nesting or nesting habitat quality/availability. Teams made daily observations of any human activities that were new since the last survey on that cay. Data collected included: number and type of people (watchmen, tourists, fishermen, workers, guides) and location, the number and type of any animals and location, the number of incidents of burning, cutting or clearing – along with location, the number of incidences of taking sand and construction, and the location of each, and any comments on those activities or others which did not fit into the





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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 also Hawksbill turtle, note and report to authorities about the anomalies occurs on cays in relation of green and hawksbill turtle fishing activities.

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

### **NEST EXCAVATIONS**

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

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 2019 was 68 days, this number of days had a slight changes in two days maybe because the season was not as hot as previous years. Nests were checked for signs of hatching at 60 days then after 65 and excavated after 72-76 days or sooner if evidence of hatching was observed during monitoring surveys. Using location data, teams measured nest locations and carefully dug into the nest. If live hatchlings were present, the team checked a few hatchlings for physical development and activity levels. Unhatched and live (or suspected live) unhatched eggs were covered with sand and recorded in the Nest Check Book. If no live hatchlings or live unhatched eggs were in the nest, the nest contents were dug up, separated into categories, and counted. Nest depth was then measured from the bottom of the nest to the surface level (using a flat stick across the cavity mouth at surface level), then the nest is covered back with sand. Also hatched nest were identify by depression, this can happen alter turtles hatch out and crawl out nest then the cavity sink forming a depression of nest.

Once all eggs were categorized, the individual conducting the excavation put on disposable gloves and counted the total unhatched yolk eggs to record on the Excavation Data Form. Each unhatched



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egg was examined externally (searching egg for holes or pips) and internally (opening eggs with no punctures and searching all content for development stage, predation, and deformities).

Seventeen excavation variables were used; those are on the excavation sheets. **Figure 4. Excavation variables.** (Excavation Variables was adapted from Wyneken et al, 1988; Eckert et al 1999; Miller 1999; Christen & Garcia, 2013c., Garcia, pers.com., 2013). And used for WCS annual excavation. A laminated excavation guide was used as a reference to identify development stages, predation signs, deformities, and other important information. This information was recorded in a data base posterior analysis for project result of surveys. Developmental stages were not based on biological stages but used as guides to help investigate timing of any disturbances to the clutch that might have significantly affected hatching or emerging success. All excavations were either performed or supervised by the team leaders, occasionally by the project coordinator when she are out doing surveys with the team. After the data collection was completed and the excavation data was double-checked, all contents were put back into the nest and buried.

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



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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

#### **TAG AND RELEASE PROGRAM**

The tag and release program began in 1999 to collect reproductive and morphometric data on individual turtles. For this 2019, one method were used to obtain subjects; the “Donate A Turtle” incentive program. In efforts to increase capacity building in 2015, both Team Leaders were trained for that season, unfortunate one of the team leader leave the project, for the 2016 until now we count with one of the team leader with tagging capacity to tag with Inconel and PIT tags and collect tissue samples. Note: because of lack of funding, tissue samples and satellite tagging are not implemented any more by our project.

According to Laura Irvin, all members of the two teams in 2015 were trained to do both measure turtles and fill in the datasheet which is easier so all team member have the knowledge to do so, this process continue to be the same, all member are obligated to do as the team leader, who was trained in 2015. The 2019 turtle season, we continued tagging turtle, the team tagged 3 turtles all donated by



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fishers, two on cays and one at the office in Pearl lagoon. We are hoping to continue tag (turtle pin on flippers) and do pit tagging this coming 2020 season. Training should take place.

### **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.

We are still trying to run the Incentive program, a WCS t-shirt is given to each fisherman or person who donates a live turtle to us in this 2019 season. Also having a T-shirt is donated to students and participants in competitions and students' activities in and out of the community.

### **QUALITY CONTROL OF DATA**

Data since 2016 went through several quality control checks to ensure accuracy; when in the field, by the team leader every day after survey. On field trips one person is engaged to write down data usually by the team leader, but also data is recorded by one of the team members assigned by the team leader. Then, the team leader, with the help of another team member, checked the data again after every daily survey and transferred nest data to the Nest Check Book. After every team shift, all information of all activities that take place is delivered formally to the office secretary, who is in charge to review that all data is correctly in all books specially the nest check book to verify the number of nests recorded, this information is photocopied by the office secretary then introduced into the computer data base for the season. The books and information shared is delivered to the team that is ready to get out for their ten-day survey and so on. The Marine coordinator checked data opportunistically while the team is out, to verify and to guarantee that all data are collected appropriately on field and all data is introduced into the computer data base. When we have done over something in



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copy sheets from books, we call the team leader to the office and we double check existing information. When all data is in the computer we do another confirmation check reviewed all physical and electronic information and databases, cross-referencing them with field books, excavation sheets as a final proofing measure at the end of the season. Data for the report was analyzed using the Microsoft Office Excel Program (Microsoft, 2010).



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## **RESULTS**

For this 2019 nesting season we have found a total of 1015 new nest, all clutches were recorded during the 2019 season; the greatest number of clutches in the 20-year history of the project reported in Pearl Cay Wildlife Refuge, Caribbean Coast of Nicaragua.

During the intensive monitoring period (IMP), from May 3<sup>rd</sup> to November 30<sup>th</sup> 2019, include additional opportunistic surveys in the months of December 2019 to March 2020. WCS teams worked in total 233 days, an approximate of 1,520.5 hours. they completed 1,867 cay surveys (number of times cays was surveyed by teams during the season)include opportunistic surveys..

The number of clutches lay in this 2019 represents 9.55% increase from 2018, and 559% increase from the first year of the project in 1999.

Most nest were located on tree main cays, leading Wild Cane Cay with 325 nests, followed by Water cay with 271 nests, this year returning to 2017 pattern taking the third position is Baboon cay with 132 nests then Crawl with 106 nest the other nests were distributed on other cay. No nest was found on Maroon either Vincent cays, both cays are covered most of the time with water.

Only 24 nest poach (nest dig up by human), it have been a year of the lowest poaching rate in project history, which represents a 2.3% of total nests poached for this 2019 season, and a reduction in 1.6% compared with the 2018 season..

Based on the range of survival rates, 836 nests had at least one baby turtle hatched out. One hundred and seventy nine (179) clutches had 0% survival rate. This caused by fallow: nest with 0% hatched 97, wash away nests 24, nests dig up by dogs 11, nest destroyed by roots 20, nests destroyed by turtles 1, nest destroy and eaten by rats 2, and 24 nets were poached.

Based on the number of empty egg shells >50% found during excavations, an estimated of sixty six thousand five hundred and forty three (66,543) live hatchlings were hatched and release to the wild for this 2019 season on the Pearl cays Wild Life Refuge, a reduction equivalent to five thousand eighty nine (5,089) in comparison of the previous year, which represents a 7.65% reduction. Despite this reduction, we consider that it was a great season for Hawksbill turtle.





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**NESTING BEACH SURVEYS**

**SURVEY EFFORT**

Eight candidates (seven men and one woman) were selected to work for the project in 2019 season, from the 20 candidates who attended the training workshop on May 03 2019.

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

Surveys conducted in the 2019 season were classified as either daily surveys during the Intensive Monitoring Period (IMP) (May 03 – December 09, 2019) or opportunistic surveys outside the IMP (in December 2019 two four trips and January to April 2019) first time in the history because of the increase of the number of nest in November include December 2019. The IMP was 233 plus opportunistic surveys days, during this time teams worked a total of 1,520.5 hours (mean = 5.5 hours per day).

A total of one thousand eight hundred and sixty seven (1,867) cay-surveys (defined as each time a cay was surveyed) were conducted in the IMP. Eleven (11) cays were visited during the IMO, with a daily visit of eight most important nesting cays per day and every day from May to December 03 2019. Additional, surveys were conducted opportunistically before and after the IMP. Most surveys on opportunistic activity in relation of time consumption was done on Wild Cane Cay and Water Cay and Crawl Cay for final excavation. Mean survey efforts during IMP were 5.5, but during high season and excavation period team worked up to 10 hours per day. On some days survey activity was null, the primary reason for not visiting cays and doing surveys was because of adverse weather conditions causing unsafe travels. In case of opportunistic survey activities are conducted because of



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### **PEARL CAYS WILDLIFE REFUGE (PCWR)**

new turtle nesting outside nesting season (get late for nesting) and mainly because of nest need to get excavated, we also find new nest in November and December 2019, the formal close up of the turtle fulltime monitoring was December 2019, which mean that we continue with opportunistic survey for the rest of months until season begin again in 2020.

We have positive results in poaching, it have been a year of the lowest poaching rate in project history. Of the 1015 nests only 24 nests were poached or sacked for this season.

During the intensive monitoring period (IMP), the pattern continue to be same, six of the 11 cays monitored were permanently inhabited (Baboon, Crawl, Grape, Lime (Calala), Water, and Bottom Tawira), three of the cays were frequently inhabited by residents or fishermen (Buttonwood, Columbilla, and Wild Cane) and two cays were not observed to be inhabited (Maroon and Vincent- both cays are practically disappeared) these last two are completely eroded with 0% presence of vegetation. Practically, Vincent cay was under water most of the time during the season. As similar with previous year, Bottom Tawira recorded the highest mean number of observations for people per cay-survey (by fishers), with Lime now Calala Resort and Crawl second and third highest because an increase of tourism, this phenomenon also occurred on Wild Cane Cay. Also a fish collection center was established on Wild Cane Cay, but territorial board asks the fishers to move away because of turtle nest in the area.

WCS teams continue to observe human activities harmful to hawksbill nesting habitat and conservation on a regular basis in the PCWR (i.e. harvesting of juvenile marine species, including different species of turtle, sharks, and lobsters). The presence of Exotic animals such as Monkeys and Parrots was also observe on cays. The carrying of dogs on cays it becoming really stressful for turtles, especially when is time to nest including when turtle is hatching. Also we have found turtle nest completely destroyed by dogs, especially on Grape Cay and Crawl cay. The same situation is happening with chicken destroying nest on Crawl and Grape cays.

We formally carry out a control of number of nest find each trip per team per month in the main office, this information is posted up on a white sheet, this also permit us to know exactly how many



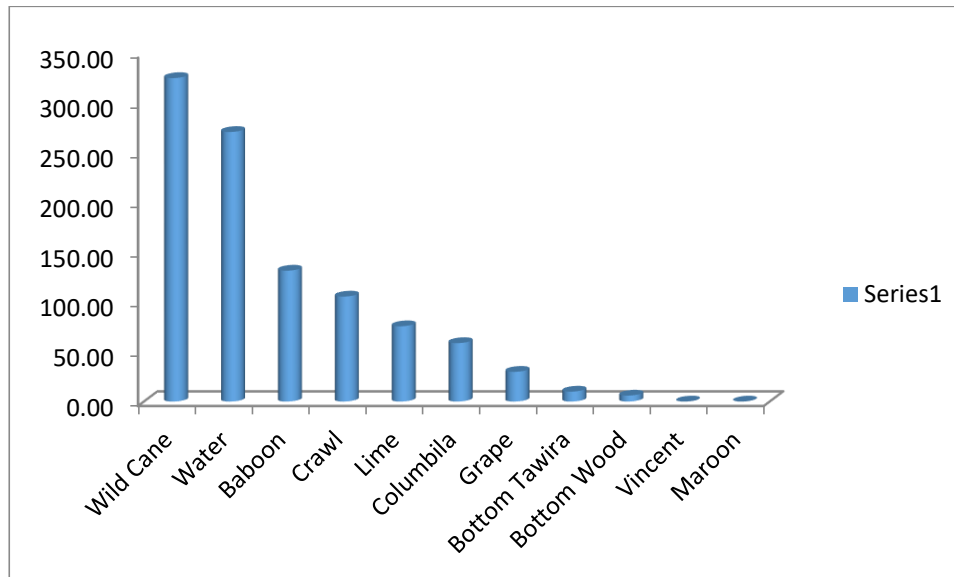
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nest is find and recorded by team and per month. The higher number of nest were located on wildcane cay with 325 nest followed by water cay with 271 nest, then baboon with 132, then Crawl with 106 net, Lime Cay 76 nests, Collumbila 59 nest, Grape with 30 nests, Bottom Tawira with 10 nest and finally Vicent and Maroon with 0 nest.



Graph number of nest per Cay, 2019 season.

The graph represent the effort base on number of nest found on each nesting sight, two cays shows zero nests, ay with highest number of nest is Water Cay..

The number of thirty four (34) nests was found by depression two nets more than last year. There continued to be a significant positive relationship between the number of clutches recorded and the number of years since initiation, which represent a gradual increase in nesting.

Turtle hatching season begging's this year in from the month of May, continuously reaching the highest peak in August, include nesting in December 2019. So excavation of 2019 continues until February 2020.



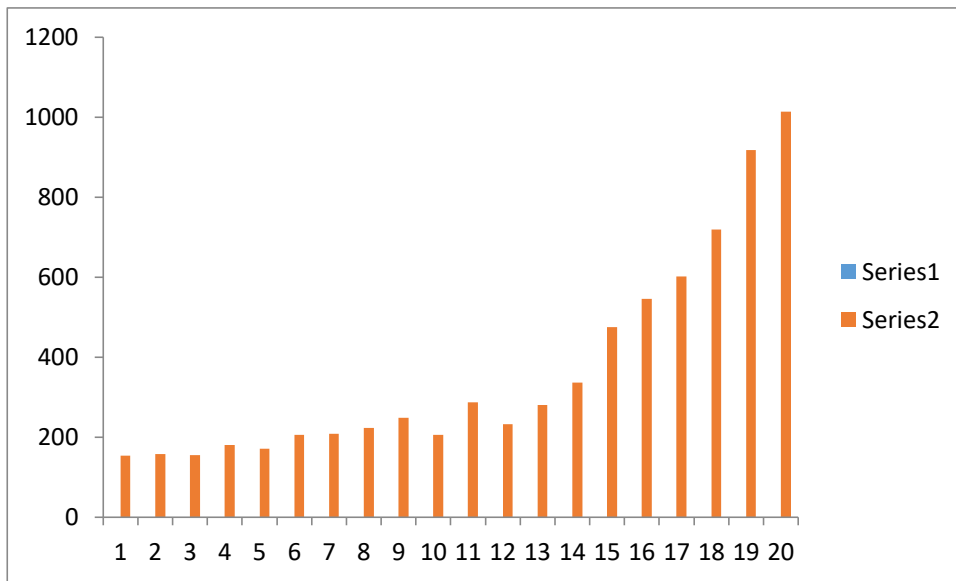
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The number of clutches laid in 2019 represented 9.55% increase from 2018, a number of 97 new clutches more than previous year and 559% increase from the first year of the project (1999, reported in 2000). **See Graph # 2.** Trend of clutches (Number of clutches per year 1999-2019).



*Graph 1 increase of Number of Clutches per year since 1999 to 2019*

We continued finding turtle nets on all turtle nesting ground in the Pearl Cay Wildlife Refuge, except on Vincent Maroon in this 2019 season, Lime, Baboon, Crawl, Grape, Water, Wild Cane, and Columbila Cays, Bottom wood and Bottom Tawira Cays. Bottom Wood and Bottom Tawira cays continue to be the cays where human activities are relatively high, survival rates are low for the turtle nests, poaching are the main theme on both cays; most of poached nest was found on those cays. Most nest were located of find on three cays.

The lowest percentage poaching rate in project history was recorded in this 2019, based on the number of nest found and poached. Out 1015 clutches, 2.36% (24 clutches) were poached, a difference of 12 poached clutch less than the 2018 seasonal, a reduction of the 66.66% in comparison of previous year. Poaching is continue to observed on four (4) of the 9 Cays where clutches were found: leading this time on Columbila, fallow by Bottom Tawira and Bottom Wood and finally Wild



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Cane Cay. These Cays are continuously used by fisher for refuge at night or area use for gathering seafood where it is inhabited by them.

We also observed nest where eggs were destroyed by female's turtles while nesting in this case two nests, where turtle used the same chamber to lay her eggs. Another phenomenon strange but not impossible to find several turtle nesting in the same nest, this time 26 nests, out those, 3 of the chamber has 3 nest in one (turtle lay at three different times/don't know if it is the same turtle of different turtles); 23 nets has two nest in one.

Despite of effort removing nest because of high tide, a total of twenty tree (23) nests was wash away completely, where sand had tremendous shift from one side to another, also tide went up very high and wash away the sandy bank where turtle usually do nesting on.

### **Calculating Clutch size**

Clutch sizes were determined by using data from relocated clutch counts for those not suspected or observed to have evidence of poaching or predation before teams arrived to relocate the nest, the mean clutch size for this year was 104 eggs per nest, in a range of nest with clutch of 55 eggs to clutches with 209 eggs; this information also included data on burst eggs found in chamber during relocation, as mentioned before. And the survival rate mean size for this year was 65.55 individual per nest survive, resulting a total of 66,543 new live turtle entering the sea, beginning their new life cycle. Clutch size average depth was 37.5, nest with depth from 20 cm up to 45 cm depth.

### **NEST CONDITION MONITORING**

Nest condition (environmental and anthropogenic) was checked for each nest during each cay-survey. Clutches incubating on Baboon, Crawl, Grape, Lime, Vincent, and Wild Cane cays checked daily during the IMP, while clutches on Water cay were checked day in between, because owner and workers (guards) are volunteer to do daily check, when team arrive they report how many turtle went up on beach, if turtle nest or do crawling etc. Clutches on Bottom Tawira/Sand fly, Buttonwood, Columbilla, and Maroon cays, were checked two to three times during the ten days survey, this



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situation is due because of bad weather and the difficult access to the cays (rocky area lots of waves). So, consistency in monitoring was based on access to cays, with the latter four cays being more difficult to access in windy/rough weather conditions. Another concern is that on the three first mentioned cays, there is fishermen living and visiting constantly, which increase the level of poaching, the most poaches occurs on these cays mentioned before.

During daily monitoring of environmental and anthropogenic condition, the vast majority of nests equivalent to 894 (eight hundred an ninety four) nests were visibly undisturbed by any environmental or human impacts during the entire incubation period.

### **NEST SUCCESS**

A total a number of 920 (nine hundred and twenty) excavations were conducted for the 2019 season. 95 (ninety five) nests were not included in the nest success analysis, this represents nests affected by poaching thirty six (24), nest eroded or wash away by high tides or storms equivalent to eleven (24), and nest destroyed or dig up by dogs were five (12). We also had nest eaten by rats (2), destroyed by roots (20) or other unknown predator (11), but these was also excavated. We also had Clutches disturbed by other turtles (more than one clutch mixed in the same nest cavity). Nests were relocated most because of high tide or visible to poachers.

Based on the number total egg count an estimated of 105,810 (one hundred and five thousand eight hundred and ten) eggs were laid by hawksbill turtles in this 2019 season on the Pearl cay Wildlife Refuge, out those 66,543 (sixty six thousand five hundred and forty tree) live hatchelling approximately were release in the wild in 2019 season, this information is based on the count of empty egg shells >50% found during excavations. Out of the total egg count, 39,267 (thirty nine thousand two hundred and sixty seven) did not hatched out.

Unhatched eggs are mainly related mostly with biological issues, especially because of the absence of embryo with 12,395, yolkless 42, embryo reaches to different stages and dint hatched out the egg are: Stage #1= 2,317, Stage #2= 314, Stage # 3= 214, Stage # 4= 160, eggs affected by microbes 8,121, eaten by crab= 1422, ants=749, dead in nests = 67, and other unknown predators with 13,230 eggs. We recorded twenty seven individual's albinos (27), some deformities such as twin baby turtles, only one.





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**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 (Bottom wood, Columbilla, and Wild Cane) and two cays were not observed to be inhabited (Maroon and Vincent) during the IMP this can be because of all coconut trees were cut down. Leading to uniform observations of each cay-survey for Baboon, Crawl, Grape, Lime, and Water cays, Lime cay were leased in 2016 to foreigners to construct a Resort now named Calalla Cay Resort. On cays were permanently and frequently inhabited (Lime cay, Wild cane, Bottom Tawira and Bottom wood) a few nests on the nesting beach were cover with construction material for lobster traps also seasonal house for fish stockpiles. In 2018, we had increase of tourist on all cays at the beginning of the year, then a reduction by the ending of the year. For 2019 tourist activity was less but high in fishing activity, more fishers was on cays working, specially to capture sea cucumber. In addition, the WCS surveys teams, (four to eight people) were permitted to inhabit Crawl Cay from June to December 2019 as previous years. WCS staff was excluded from the number of people observed per cay-survey.

On Cays, such as Baboon, Crawl, Grape, Lime and Water people continually been raked ('cleared') regularly, sometimes two or three times per day, this action impede the new growth and regeneration of native vegetation that could help secure/stabilize the substrate and avoid erosion in nesting areas. Despite this situation we continue with an increase of new nests in nesting areas, Wild cane represents and constant and significant increase annually in numbers of nest for hawksbill turtles for these lost years. Wild Cane, the site with highest turtle nests in 2016, 2017, 2018 and now 2019. A new fish center was establish on cay for sea cucumber and lobster diving; this cay are continuously been visited by fishers and been use for refuge and temporary home for them, we continued observed all types of vegetation's destructions and trees cut down with no control or conservation issues. Fishers continued saying that they cut and burn vegetation on Wild cane cay because of insects,



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mainly sand flies and mosquitos that bites them, also they says that cutting trees, create space so breeze can passes true.

Meetings with the watchmen of cays, shared information among fishers, bosses and other workers was done during the season, this sharing and teaching information related to the Hawksbill project and conservation activities was done by both team and occasionally by the marine coordinator every time she are out on the fields. We explain about our role in conservation activities and how resource users can also help us and be part of this process, all together with everyone help can reduce all harmful activities on the cays.

### **TAG AND RELEASE PROGRAM**

#### **FLIPPER TAGGING and SATELLITE TAGGING**

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

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

### **INCENTIVES PROGRAM**

#### **DONATION OF LIVE TURTLES**

The WCS team continued to encourage fishers, watchmen, and divers to donate live turtles in exchange for a WCS t-shirt, or a lifejacket for every 15th donation by the same individual. Donated turtles were then tagged and released. To date, there have been over 1074 T-shirts and 18 life jackets rewarded for turtle donations throughout the project's 19 years. In the 2019 season, we had received four turtle donated by fishers on cays and one young green turtle donated by a commercial boat



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driver with a community member. According to them, they found it in the lagoon and repeating the same story, they were trying to raise it in their house, but turtle was not happy been there and they dint had time to take care of it as how it should be, they decided to donate it to WCS.

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

### **AWARENESS AND OUTREACH**

WCS staff regularly shared information with local and regional communities, authorities, students and tourists. These activities were completed through a variety of mediums and in three different languages (English, Spanish and Creole) in order to reach a large and diverse audience. Also we have been doing educational activities at different schools and level of education (primary and secondary schools) in Peal lagoon and Bluefields. A selected team from different secondary school of pearl

lagoon had the opportunity to go on one day trip to the Pearl Cays Wild Life Refuge.



Teaching activities directed to children and youth about the work of WCS, biology of sea turtles and the importance that Hawksbill represent for the community of Pearl lagoon, the Nicaraguan Coast and the world. For youth, WCS marine coordinator prepare different



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educational activities in pearl lagoon and also on cay, also the turtle team show them how to do turtle walk and watch to identify track, turtle nest check and turtle excavation during they one day stay on cay. Formal presentation about the history of WCS in Pearl Lagoon and biology of marine turtles the workshops was given by WCS marine coordinator, followed by an evaluation to the students. This was consisting by doing competition activities “Who knows more, win a WCS T-shirt or a cap”. Students were very excited about learning and all the different activity we done with them on the cays.

Also WCS in coordination with the Environment and Natural Resources Ministry (MARENA/ Ministerio de Ambiente y Recursos Naturales-in Spanish) we make some presentation at schools and parade in the community of Pearl Lagoon, where all students from all schools came out and march on street in name of turtle conservation activities, using posters and pamphlets with announcement saying, stop eat turtles, this is our resources etc. additionally we had the participation of the Municipal government of Bluefields and pearl lagoon. Celebrating one more year of anniversary when Pearl Cay was declared as Marine Protected area in October was done in coordination of the

municipality and schools..



Presentations was also done again in the city of Bluefields at the Moravian primary school, where children were interested to learn about sea turtles, the marine coordinator also made presentations about turtle life cycle, the pearl lagoon and the pearl cays and WCS in Nicaragua. Children were really enthusiastic to know more about marine life and sea turtles but also land turtles.

The same thing occurs with student





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from the University of BICU, mainly with students from Marine Biology and Ecology; those students had the opportunity to go out to the refuge and learn about sea turtle activity done by WCS team. This is a joint venture between WCS and the University of BICU which continue for 2019 also 2020. See photo when students are making nest removal.



### **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). The marine coordinator is asking to update the website and also update information posted on WCS web page.



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But also radio activities have been done in the community, to inform people what is going on with the project, what difficulties and what good activities been taking place on the cays in relation with the project itself. The hawksbill team, also visited radio station and share their experience with the radio audience. Radio announcement was done during the baseball series in the municipalities. We expect to continue and better the communication level for this coming 2020 season.

### **RADIO ANNOUNCEMENTS**

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

These announcements were made by one of the seasonal staff or by the marine coordinator. Also announcements are made during baseball tournaments and local sport activities in and out the community.

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 especially during the annual transmission of the baseball series. Those announcing aimed to go on the air at the busiest listening times of the day to increase the likelihood of reaching more people at once.

Turtle was painted on the stadium wall since 2010, and a written information saying “EAT MORE CHICKEN” – LETS PROTECT SEA TURTLES. Radio announcements were also aired before the 2019 season begin, to encourage community people to apply for WCS seasonal staff positions.

### **NEST TALLY SIGN**

The sign, was first developed in 2014, located in front of the WCS office in Pearl Lagoon walling in 2019 the main objective is to update people passing by about the season’s running nest tally for every ten days survey. Each time team come from field trip the sign board is change and update with the





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number of nest recorded on that date. Throughout the season, local community members and visiting tourists were regularly seen reading or commenting on the sign. The running count allowed people to track nesting in real time. The updating each time team enter to mainland boosted staff moral and made teams feel proud to have worked an increasing the number of nests each rotation also it gives the team an animus of competition to see which team (1 or 2) recorded more nest during the season. this tally was also reflected on the intern part of the office, where Lilja our secretary carry control of number of nesting per team.

When the project broke the all-time record for number of nests in a season for this year 1015 nests was found, both teams are invited to the WCS office to celebrate and change the sign together. The sign often sparked discussion and comments from people passing by and even motivated some people to come into the office and learn more about the project, most of the time by foreign tourist. There was a community bulleting also posted on wall, but this is not happening since 2015 because of lack of funding, hopping to change this situation of limitations to do more communication activities with community members and rest of society.

### **TOURIST OUTREACH ACTIVITIES**

Throughout the 2019 nesting season, national and international tourists visited Pearl Lagoon and the Pearl Cays and WCS office in Pearl lagoon. Formal presentations or informal discussions about the hawksbill conservation project were held with unknown number of tourist between May and November 2019 in and out the Cays, especially on Lime Cays (Calalla resort) although this year there was less tourists visiting the area. Based on qualitative data collected during these interactions, many tourists came to the Pearl Cays specifically to see turtles. Wherever possible, tourists would be invited to join staff on surveys of Crawl for live demonstrations of project activities. Also some experimented turtle hatching out from its chamber on Crawl cay also on Lime cay where the Callala Resort are located. Large groups of tourists, mainly from Europe and United State including a few from the Pacific side of Nicaragua, were able to witness a nest hatching out on Crawl cay during the month of August, September and October where season is high, many tourists and local watchmen also observed nest excavations, nest check, and the recording of new nests.



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#### **LOCAL OUTREACH ACTIVITIES**

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



The Marine Coordinator in coordination with Lilja Williams (wcs secretary) visited the Ministry of education to obtain legal approval to do some turtle's educational activities at all local schools (primary and secondary) in Pearl Lagoon, Haullover and Raity Pura during the 2019 educational program. WCS had reach out to more than one thousand youth and children. During the presentations student from secondary school have participated in knowing competition and then win a WCS t-shirt. Smaller children do coloring turtle.

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

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



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The idea after this educational process was to make a selection of 8 student and take them out to the Pearl Cays for one day and one night for them to have the experience of the project itself, process that we been doing since 2017, which have been very successful and interesting for the Pearl lagoon community members and students from different school of the pearl lagoon basin. WCS staff will explain the work that we have been doing and the importance of doing it on the Pearl Cays. Also for them to experiment the moment when young babies turtle were hatching on cays, after that we made an evaluation to student to know how much they have learn during they stay and how important it was to them for the future. It's a way to encourage them to be a wildlife conservation person. We have high expectation for this coming season.

### **DISCUSSION, RECOMMENDATIONS AND CONCLUSION**

It was another record-breaking season in 2019 in terms of number of clutches and hatchlings, the highest during the history of the project. It was also the season with the lowest poaching rate in project history out 1025 nets only 24 nest was poached equivalent to 2.55%, is the fourteen (15) consecutive years to record over 200 clutches from the previous recorded, six consecutive year to record over 400 clutches, the fifth to record over 500 clutches, the fourth to record over 600 clutches the third to record more than 800, the second to record over 900 and the first to record over 10000 clutches in one season in the Pearl Cays Wildlife Refuge.

Although some fishers continue killing hawksbills and the juveniles of multiple species, the Incentives Program is believed to have resulted in an overall decrease in their mortality in the PCWR. Also considered the work that BICU and WCS are promoting in establishing a management plan for the refuge, has help a lot in creating consciousness and awareness among resource users, hopping this plan can be implemented for 2020 and beyond. This will includes stricter regional and international regulations for commercial fisheries targeting areas that overlap with sea turtle distribution, such as the requirement for Turtle Excluder Devices on shrimp trawlers implemented by INPESCA authorities and monitored annually by the NOAA. But also it is required the implementation of penalties to reduce turtle killing and malpractices on cays.



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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. WCS Nicaragua is also one of the effort done by local communities and local working members that also have benefits the population size as human development itself. Never the less this population increase is also result of local authority effort in law enforcement at certain level during the close season for conservation purpose. We have had the Nicaraguan navy making surveillances during this time and it have been very successful for the us.

Again it have shown the trend of some cays to leading the first or second place for highest turtle nesting on cays such as Wild cane cay, fallowed be Water but with a change for Baboon then Crawl cay for this 2019 season.

Human activity brought by acopios (lobster and sea cucumber buying stations) is more frequently found on cays with a history of documented poaching specially on Lime, Bottom Tawira, Buttonwood and Collumbila, these last cays are also further away from the WCS temporary base camp and they are not monitored as our daily monitoring like others which are closer to the camp. Also the, regional authorities carry out legal process against the poachers and turtle killers. On Wild Cane, Bottom wood, Bottom Tawira and Columbilla, WCS teams was careful in marking or putting a cinta (flagging tape) to indicate where ever nest was recorded, because we put in risk the position of nest to poachers or to be destroyed. A T-shirt was giving to all those donors, that have donated turtles to the team or take care of a turtle nest avoiding poaches.

The relationship between poaching, WCS presence, and human activity in the cays continues to emphasize the fragility of conservation success from year to year in the Pearl Cays. Although, WCS and BICU are putting strong effort to construct a functional and successful management plan for the refuge, hopping that this can be not the complete solution, but a way to reduce negative impact and negative incentive on the cays.

We reconfirm if these human activities and associated poaching violations are not regulated appropriately, and if WCS monitoring activities are decreased or suspended in any way, there will be



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no doubt that poaching rates will increase substantially and return to what historically occurred in the past. Even though, some fishers are also becoming more involve in turtle conservation activities because of tourism, which can be and alternative for turtle conservation activities. Some fishers have discover that they can also do tourism activities with visitors, and teach them about turtles and other sea animals around the cays, so in some way this can be positive for sea turtle on the PCWR in the absence of the management plan. Some have learn that all sea turtles value more alive than dead.

Continued efforts towards education and building strong partnerships with stakeholder Regional institutions such as INPESCA, MARENA and MINED include other local groups and local communities using the cays, as well as maintaining WCS' presence during the nesting season, are essential for conservation success for the short- and long-term. Not just for turtle but also for other marine species and the cay itself.

Maintaining nesting habitat in a natural thermal state, as well as in any condition ideal for nesting, will also depend on the regulation of human activities in the cays that directly affect the quality of this habitat as we are evidently seen on some cays. Community movements are worry about the destiny of the Cays, wanting to implement some activities empirically and hoping WCS to have all solution, unfortunately we do not count with the swan that will permit us to do so. But I hope we can develop some alternative to reduce the negative impacts on deforestations and washing away of some of the cays.

Bottom Tawira, Bottom Wood and Columbila are cays most used by fishers for fish resource storage and buying, because of the presence of most fishers, most poaching take place on those cays, although the number of nest are lower than other cays because of the rocky beaches.

Unfortunately these last year's two cays had eroded to the point where no available nesting habitat was present for the majority of the season (Vincent and Maroon). 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





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tracking all sea 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, also to implement other incentives programs and activities to schools (primary and secondary) in and out Pearl Lagoon to get more people involved in the process, and kept in mind that the children is the future and education is the success for development and conservation.

I conclude that this 2019 season were very interesting, people becoming more aware of the situation and understanding about the importance for conserve our natural resources and Hawksbill turtle is never the less. People have reached us from other municipalities requesting our participation and to provide information of our work, and how this can be developed also in their areas such as Corn Island and Puerto El Bluff. It was intense in the sense that we had develop educational activities to different schools and at different level including educational process for staff, fishers, community members, secondary and university students, this process have serve us to share our experience with so many people who wants to learn and contribute to conservations activities in class rooms and out on the field in our region.

This season we started on time, it took seven (7) intensive months to get this information update beginning from the month of May to November 2019 and conclude in conducting opportunistic monitoring in December 2019, January to April 2020, for December we record a few new nest which gets excavated in February 2020.

I do think that on the cays we and others, all together can make big changes in habitat of the whole cay flora and fauna and we don't need to find the solution or to do something after unravels damage is done. We need to keep supporting the process of the Management plan for the Pearl Cay Wildlife Refuge.

The management plan might not be the solution of all problems, but it may be the path to identify clearly some of the problems and base on the finding can be the recipes to address some of the existing problems of the cays, related with the way of use by the users. We are hoping to continue working, providing, supporting and facilitating information for best practice to conserve and protect the Pearl Cay Wildlife Refuge.





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

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



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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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