Playa Norte Marine Turtle Conservation & Monitoring Programme

Leatherback Season Report 2008

By Diogo Veríssimo, David Jones & Rebeca Chaverri

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Submitted to

MINAE (Ministry of Environment and Energy)

COTERC (Canadian Organisation for Tropical Research and Rainforest Conservation)

GVI (Global Vision International)

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Leatherback Season 2008

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4. Introduction

Tortuguero and the surrounding area have a long history of marine turtle research and conservation. The area was, since 1954, the target of Archie Carr's pioneering efforts in sea turtle conservation that lead, in 1975, to the creation of Tortuguero National Park (TNP).

The Playa Norte Marine Turtle Monitoring and Conservation Programme was initiated in 2004, in the form of a feasibility study, by the Canadian Organization for Tropical Education and Rainforest Conservation (COTERC), after an initial approach by the Caribbean Conservation Corporation (CCC) (Greg Mayne Pers. Comm. 2008). During this and the 2005 season the program had the objective of collecting baseline data on the nesting marine turtle population of Playa Norte, as to determine if it warranted a long term conservation effort.

The findings of the assessment did indeed establish the importance of a long-term effort and a partnership was initiated between COTERC and Global Vision International (GVI) Costa Rica to support data collection and analysis. This substantially increased the human resources available and in 2006, the project started to conduct night surveys and nest excavations in addition to the ongoing morning surveys.

Since 2007, GVI Costa Rica has been responsible for the management of the project. Prior to the beginning of the 2007 seasons the programme managers and director revised the protocol, shifting the focus to a more conservation based approach and its current incarnation as the Playa Norte Marine Turtle Monitoring and Conservation Programme.

This programme will contribute to an informed approach to the management plan of Playa Norte, the Barra del Colorado Wildlife Refuge (BCWR) and the larger Tortuguero area by increasing our understanding of the dynamics of Playa Norte and its associated marine turtle populations.

This report aims at assessing the accomplishments and limitations of the 2008 leatherback season and providing appropriate recommendations for future conservation and research efforts on leatherback turtles on Playa Norte. Furthermore, it is hoped that through the National Network for the Conservation of Marine Turtles ("Red Nacional de Conservación de las Tortugas Marinas") and the Caribbean Leatherback Alliance ("Alianza para las Baulas del Caribe"), the collected information can be used to enhance the knowledge on the nesting marine turtle populations of Costa Rica and the wider Caribbean.

5. Methods

The research protocols used for the duration of the leatherback 2008 season follow the guidelines set out by the IUCN/SSC Marine Turtle Specialist Group and the official "Manual para el manejo y la conservación de las tortugas marinas en Costa Rica; con énfasis en la operación de proyectos en playa y viveros" (R-SINAC-055-2007). For further details, please refer to the 2007 Marine Turtle Monitoring and Conservation Programme Night and Day Protocols (http://www.coterc.org/resources.html).

5.1. Study site

The 3.125 mile (~5 km) long study area is located within Playa Norte and extends from the Tortuguero river mouth (10º35'34.4"N - 83º31'28.6"W) to the north end of Laguna Cuatro (10º38'06.9"N - 83º32'31.7"W).

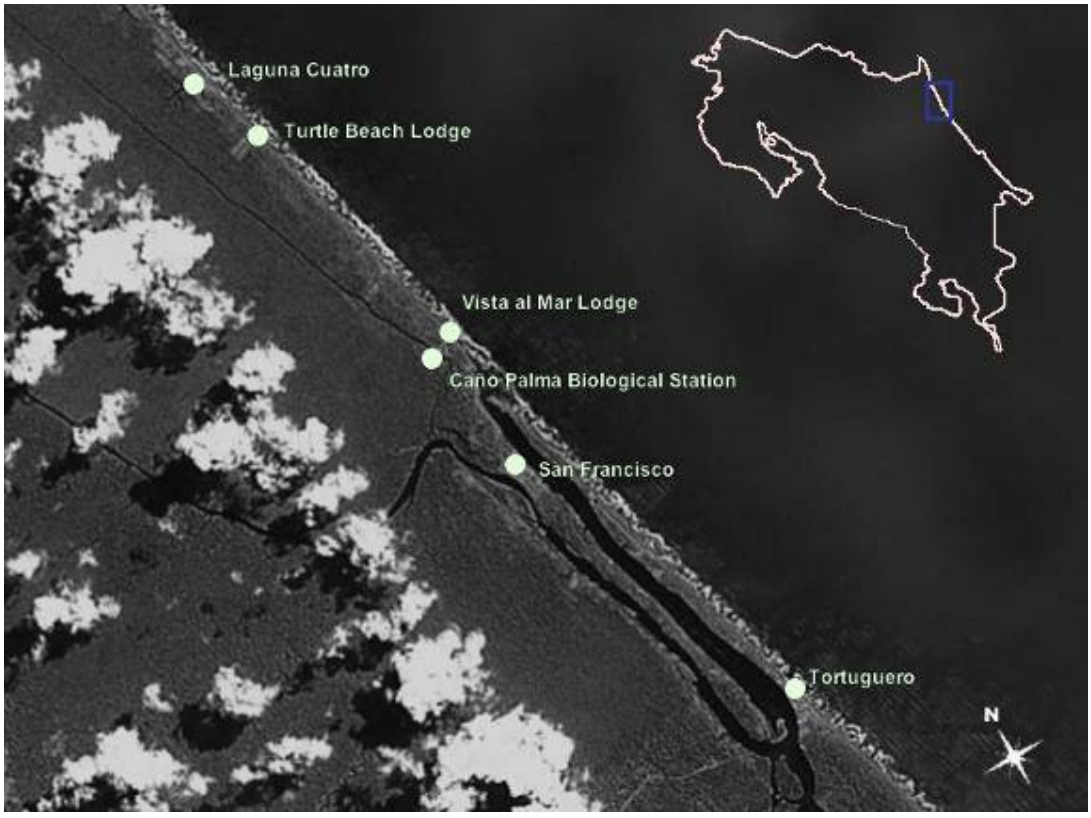

Figure 1. **Study area for the Playa Norte Marine Turtle Monitoring and Conservation Programme, BCWR, Costa Rica.**

The area is located within the BCWR, which is managed by the Tortuguero Conservation Area (ACTo), under the Costa Rican Ministry of Environment, Energy and Telecommunications

(MINAET). The study area is marked with mile-markers at every 1/8 of a mile (approximately 201 meters) to allow for the documentation of spatial distribution along the beach. These run from mile 0 at the Tortuguero river mouth to mile 3 1/8 just north of Laguna Cuatro (figure 1).

The study area encompasses two hotels, Turtle Beach Lodge and Vista al Mar Lodge, several houses and, at the southern end, the northern extent of the village of San Francisco, a growing community of approximately 300 residents (Campos & Schoereder 2008). Additionally, a path used by those on foot, bicycle, horseback or car runs parallel to the beach, connecting all the previously mentioned landmarks.

Botanically, the dominant plants on the study area are morning glory (*Ipomoea pes-caprae*), Rea-purslane (*Sesuvium portulacastrum*) and rush grass (*Sporobolus virginicus*). The berm is bordered by a hedgerow of cocoplum (*Chrysobalanus icaco*) and sea grapes (*Coccoloba uvifera*) along with a mixture of coconut palms (*Cocos nucifera*) and various tree species such as the beach almond (*Terminalia catappa*) and guava (*Psidium guajava*) amongst others.

5.2. Staff and volunteer training

Patrol leaders (PLs) and volunteers were trained throughout the season, with a greater emphasis on the periods of arrival of GVI volunteers on the 20th - 23rd February; 13th April - 16th April and 18th May - 20th May. Each PL and volunteer was trained both in the classroom and in the field in order to ensure proficient data collection and ethical behaviour on the beach.

Classroom training consisted of lectures on marine turtle biology, marine turtle conservation and the discussion of possible beach scenarios. In addition, extensive workshops were held on the contents of both the morning and night protocol. PLs received practical tagging training using dummy cardboard flippers and practical relocation training, digging egg chambers appropriate for leatherbacks and for hawksbills. All personnel completed practical triangulation training, both in the day and at night, together with mimicking the night protocol procedures with dummy sand turtles. Furthermore, four PLs received training in flipper tagging and egg relocation at the CCC and two PLs participated in a night patrol with the CCC to gain additional experience.

All PLs and volunteers were tested on the night and day protocols. Tests consisted of questions for PLs and volunteers, which encompassed all aspects of the protocols, as well as turtle species identification, health and safety and survey kit. Pass rates were set at 100% for PLs and 95% for volunteers. All personnel were tested on triangulation technique by triangulating (at night) and reverse triangulating (by day) buried coconuts on the beach.

Finally, all potential PLs were accompanied by more experienced personnel on both morning and night patrols until they were considered apt to lead patrols independently.

5.3. Beach preparations

Preparations for the 2008 Leatherback Season began on the 18th January and continued until the official beginning of the season on the 23rd of February. These consisted mainly of a complete check of all beach mile markers along the study area, replacing the damaged or absent markers with new ones and verifying their spatial position using a Garmin eTrex Venture HC GPS unit.

Furthermore, beach habitat management for nesting turtles was conducted as to increase the available area available for nesting through removal of obstacles to nesting such as large logs and removing human produced litter such as bottles, shoes, light bulbs and other debris from the beach.

5.4. Morning track census and nest status

Track surveys were conducted daily between the Tortuguero river mouth and Laguna Cuatro (3 1/8 miles), by a team of one PL and one to three volunteers. Surveys started at day break (generally between 05:00 and 06:00) and lasted for up to four hours depending on the volume of data to collect and number of tracks to erase.

During the track surveys, all tracks and nests since the previous survey were recorded and all nests from the previous two nights were monitored for signs of poaching. When all data were recorded, nests and tracks were disguised to decrease the likelihood of poaching and ensure against double counting on future surveys.

During the morning track census tracks were identified as nests, half-moons (non-nesting emergences), or a lifted turtle (turtle was captured before returning to sea). After this initial step, the following information was collected:

- Date
- Global Positioning System (GPS) location and GPS accuracy
- Species
- Closest northern mile marker
- For nests vertical position on the beach was identified either as Open (area of beach which receives 100% sunlight), Border (area where nest is partially shaded by vegetation) or Vegetation (area where nest is constantly shaded by vegetation) (figure

2). Nests were then identified as natural (if it remained in its original state), poached (when eggshells or a cavity were found), eroded or predated by an animal. Nests could also be marked as unknown if the nest had signs of poaching such as flies, stick holes, disturbed sand and human and/or dog prints, and it was suspected to be poached but no conclusive evidence (egg shells or cavity) were present.

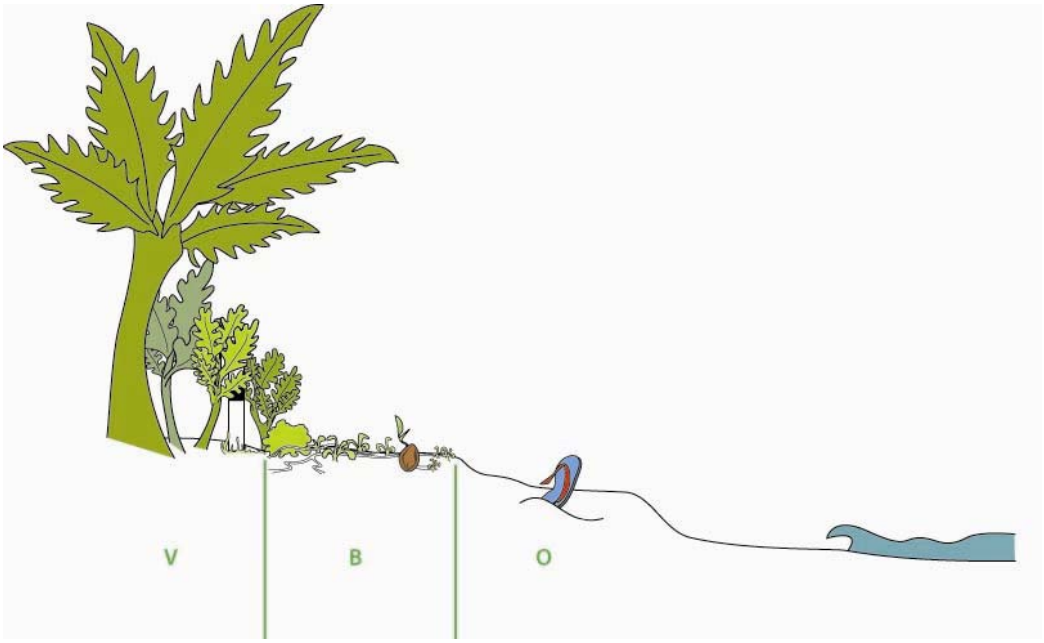

Figure 2. Nests vertical position on the beach. Playa Norte, Costa Rica.

Additionally, a weekly track survey one mile north of the study site was also conducted. This survey counted all tracks since last survey and had the objective of estimating the number of nests and the incidence of poaching in a non-patrolled area adjacent to the study site.

5.5. Night patrols

The night patrols began on 29th February and continued daily until the end of the green season, with the final leatherback recorded on the 7th of July. Each night a minimum of one patrol team, of three to four members walked the beach between mile 0 and 3 1/8 for a minimum of four hours. On nights when only one team was on the beach, the patrols were scheduled from 22:00 to 02:00 since these were the hours of greater leatherback emergence for the previous seasons in the main leatherback nesting beaches in Costa Rica (Chacón & Lopez 2007, Chacón & Senechal 2007). When two teams were scheduled, the first team were scheduled from 20:30 to 00:30 and the second team from 23:00 to 03:00.

When a turtle track was found, the patrol leader determined whether the turtle was still on the beach. If the turtle was not on the beach, the patrol leader determined if the track was a half moon, nest, or lifted turtle. The team then proceeded to collect the following information:

- Date
- Geographical Positioning System (GPS) location and GPS accuracy
- Species
- Northern mile marker
- Time of encounter
- For nests vertical position on the beach was identified either as Open, Border or Vegetation. Nests were then identified as natural, poached, eroded, predated by an animal or unknown (see section 5.4 for details).
- If evidence of a lifted turtle was encountered any useful additional information was also collected.

When a female turtle was encountered on the beach, the patrol would collect additional information depending on the nesting stage of the individual. The PL established what stage of nesting she was in (Emerging from the sea, Selecting nest site, Digging body pit, Digging egg chamber, Oviposition, Covering egg chamber, Disguising, Returning to the sea).

For females encountered prior to oviposition, egg counting was done by touch and/or sight as eggs were laid into the egg chamber (yolk and yolkless eggs counted separately). Egg depth was recorded immediately after the completion of oviposition and a small aluminium tag placed near the surface of the egg chamber to facilitate location of nests during excavation.

Triangulation was only conducted during oviposition, directly over and in clear view of the egg chamber. The distance to the most recent high tide line (HTL) was also recorded.

When the turtle completed oviposition and began to cover her egg chamber, she was then checked for tags, old tag notches (OTNs), old tag holes (OTHs), and tagged if no tags were present. Leatherback turtles were tagged in the membrane between the rear flippers and the tail (Figure 3) using National Band & Tag Co., Newport, USA Monel #49 VA8300 to VA8332 tags. All turtles were double tagged and only nesting individuals that were covering the egg chamber or disguising their nest were considered suitable for tagging.

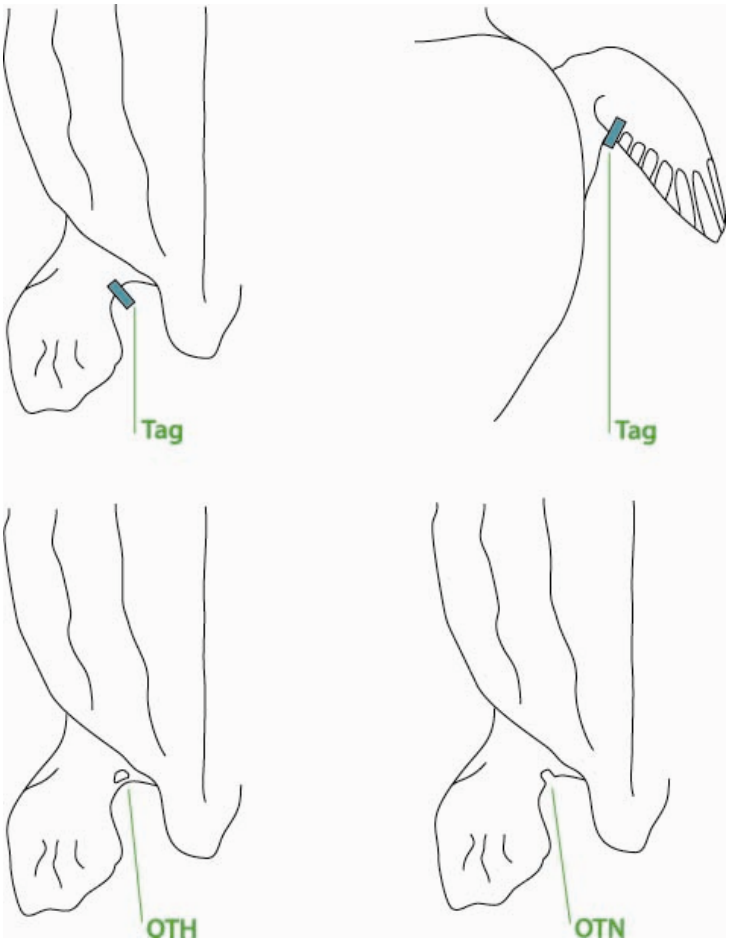

Figure 3. Above: proper position of tags for leatherbacks (left) and other species (right). Below: old tag notches (OTNs), old tag holes (OTHs).

For tagged females, the minimum curved carapace length (CCLmin) and maximum curved carapace width (CCWmax) were measured to the nearest millimetre, using a flexible fibreglass measuring tape. Three measurements within 3mm were recorded for both CCLmin and CCWmax. For leatherbacks, CCLmin was measured from the where the skin meets the carapace at the neck, along the right of the central ridge to the end of the caudal projection.

Additionally the caudal projection was classified as 'complete' if no abnormalities occurred and 'incomplete' if part of it was missing. The CCWmax was measured along the widest part of the carapace to where the carapace meets the skin. Once measuring was completed, the turtle was checked for external abnormalities such as wounds, scars, amputations, tumours, leeches and other irregularities. Abnormalities were recorded as occurring in the sections shown in Figure 4.

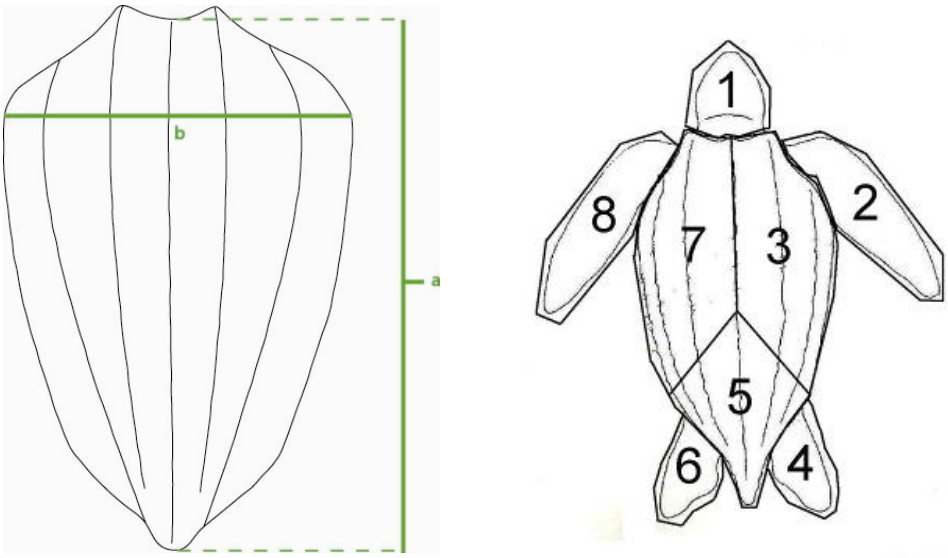

Figure 4. Left: proper position of the minimum curved carapace length (CCLmin) and the maximum curved carapace width (CCWmax). Right: external body exam of leatherback turtles.

5.6. Relocations

Nests at risk of erosion, in areas of high poaching incidence (determined for this season as the areas from mile marker 6/8 to 1 and from 3 to 3 1/8) or laid below the HTL were relocated to safer areas of the beach. The eggs were carried by the patrol leader alone to the relocation site to dig a new egg chamber and deposit the eggs. The new egg chamber would utilise the depth and width measurements of the old egg chamber and ideally be located at minimums of four metres from the HTL and one metre from the vegetation.

Triangulation was conducted after all eggs were transferred to the new egg chamber as to assure the nest could be located for excavation. Patrols leaders have the option of not measuring HTL as to avoid footprints that could lead potential poachers to the new egg chamber.

5.7. Disguising nests

For all leatherback tracks, a considerable effort was put into “disguising” (*i.e.* erasing all signs of presence from the sand). For nests, this was done to diminish the possibility of poachers finding the egg chambers with half moons being disguised to increase the number of disturbed areas as to confound potential poachers.

Nests and tracks were disguised by the first patrol that found them on either morning or night survey after data collection. Teams employed different strategies such as flattening out and

disturbing a large area of sand, digging false body pits and egg chambers after confirming through a GPS map that no other nests were in proximity, and/or dusting the area with a small layer dry sand to hide the tracks and nest.

5.8. Collection of human impact data

During each night survey, the number of red and white mobile lights, fires, locals and tourists on the beach were recorded. Tourists were defined as people on the beach to observe nesting turtles and locals as people with any other purpose. Additionally, each month during the new moon, the number of stationary white and stationary red lights was also recorded.

5.9. Hatchling orientation

For all first encounters of hatched nests for which hatchling tracks were present the following information was recorded:

- Date
- Geographical Positioning System (GPS) location and GPS accuracy
- Species
- Closest northern mile marker
- Nest number
- Number of tracks observed
- Number of alive hatchlings
- Number of dead hatchlings
- Number of circles counted in the tracks (indicating hatchlings might have been confused by light sources other than the waves)
- Number of outliers (tracks found outside of where the majority of hatchlings approach the sea)
- Number lost (tracks heading towards the vegetation)
- Distance to HTL

Four sticks were placed at the distance of 10 metres from the nest to mark the dispersal pattern of hatchlings. Sticks 1 and 4 were placed on the boundaries of the main body of tracks (excluding outliers) and sticks 2 and 3 were placed to demark the highest density of tracks with the main body. Tracks outside the main body of tracks were denominated “outliers” and tracks going in a direction opposite to the sea were called “lost”. Both these types of tracks were excluded from further analysis.

After the sticks were in place, the angle formed between each stick and north was measured from directly above the egg chamber at waist height using a compass. These measures were used to establish, through trigonometry, the average "extra" distance travelled to reach sea by a group of hatchlings from a particular nest. This demanded the estimation of the optimum angle that a hatchling should keep as to cover the smallest distance possible between its nest and the sea. By measuring every half-mile, the angle that a straight line to sea would make to north the optimum angle to sea was determined to be 70º.

It is important to clarify that this methodology assumes for the sake of simplicity that hatchlings travel in straight lines and only calculates the extra distance travelled for the first ten meters; nonetheless, as this should be a linear relationship, any other distances can be easily accounted for.

5.10. Nest fate and hatching success

All nests determined to have hatched due to the presence of hatchling tracks were excavated two days after the first hatchling tracks were encountered. Triangulated leatherback nests that were not seen to have hatched were excavated 75 days after they were laid.

For each excavated nest, the following information was recorded:

- Number of hatched eggs – Only shells corresponding to more than 50% of the egg were counted
- Number of hatchlings – alive and dead
- Number of unhatched eggs - These were categorized as:
    - Without embryo
    - With embryo – These were divided into (figure 5):
        - Stage 1 (embryo occupies less than 25% of the egg);
        - Stage 2 (embryo occupies between 25% and 50% of the egg);
        - Stage 3 (embryo occupies between 50% and 75% of the egg);
        - Stage 4 (embryo occupies between 75% and 100% of the egg)
        - Unknown – Embryo has been predated and it is impossible to determine at what stage development stopped
- Number of pipped eggs – embryo had broken the shell but failed to hatch
- Number of eggs predated by larvae, bacteria/fungi, ants, crabs or other unknown species
- Number of yolkless eggs
- Number of deformed embryos – including albinism or multiple embryos in a single egg

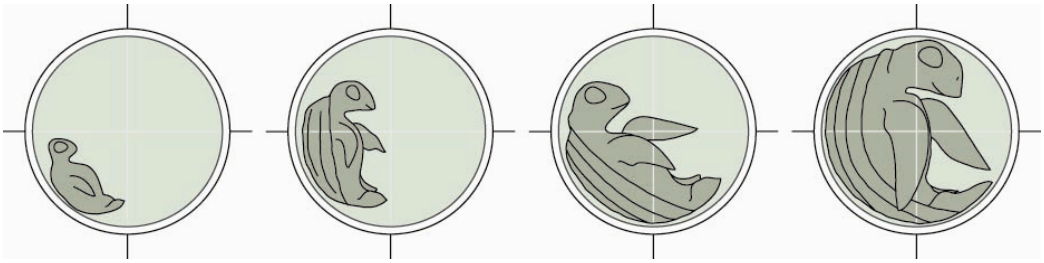

Figure 5. Embryonic development stages used during nest excavations.

For all excavated nests, a nest fate was determined (Eckert *et al.* 1999). Nests that were not excavated were excluded from the analysis. Hatching success refers to the number of hatchlings that hatch out of their eggshell; emergence success refers to the number of hatchlings that reach the beach surface (Table 1).

Table 1. Formulas and definitions to estimated hatching success and emergence success.

Shells = Number of hatched eggs	
UD = Un-hatched egg without embryo	
UH = Un-hatched egg with embryo (stage 1 to 4)	
UHT = Pipped eggs	
P = Unknown	
L = Live hatchlings	
D = Dead hatchlings	
Hatching success	#shells **/** #shells + #UD + #UH + #UHT + #P
Emergence success	#shells – (#L + #D) **/** #shells + #UD + #UH + #UHT + #P

Empty egg chambers were classified as poached nests if only the aluminium tag deposited at the time of egg counting was found, or if only infertile eggs remained. If there was any doubt about the fate of a nest, it was categorized as unknown. In addition, on all excavations, the distance from the surface to the first egg encountered (egg depth) and the distance between the surface and the bottom of the egg chamber (nest depth) were measured to the nearest centimetre.

5.11. Dead turtles

Whenever dead turtles were encountered during surveys, all possible information was recorded as to try to determine the cause of death. This could included species, GPS coordinate, closest northern mile marker, CCLmin, CCWmax, tag numbers (if present), signs of wounds or missing body parts, estimated time since death and condition of the carcase when first found. Photographs were also taken.

5.12. Beach habitat management

Throughout the season, beach cleans were undertaken as to improve the habitat for nesting turtles. These concentrated in areas where poaching and erosion probability was low. Additionally a system of “hatchling watches” took place for all nests, beginning 10 days before their theoretical hatching date, at which time any debris that could affect the normal emergence and movement of hatchlings to sea were removed.

5.13. Environmental education

The project developed communication platforms with the two key stakeholders around the study area. On one side, the local community of San Francisco and on the other, the tourists visiting Playa Norte to see nesting marine turtles. In order to strength communication with the community of San Francisco, the environmental message transmitted during five-weekly community events was improved. This helped to keep up the work developed during environmental education classes. In order to ensure better tourist behaviour while on the beach an information leaflet was created, not only on the biology and conservation of the marine turtle species found on Playa Norte but also the beach rules observed by the programme and the work of patrol teams (appendix 1).

6. Results

The data presented refer only to nesting leatherback turtles. Nonetheless, during the period encompassed by this report other turtle species were recorded nesting on Playa Norte. Please see the relevant species report for this information (Playa Norte Green Season Report 2008 or the Playa Norte Hawksbill Season Report 2008).

N.B: Data for the month of February may not be representative, as only one night survey was completed on the last day of the month.

6.1. Beach preparation

The majority of the beach mile markers had to be replaced before the start of the 2008 Leatherback Season because they had either been removed or destroyed by termites. This season, two posts were positioned at each eighth of mile to improve the durability of the study area division. All mile markers were painted in white with black numbers.

Before the beginning of the season, nesting habitat was managed through a total of 13 beach cleans with an estimated total of 450 person-hours of work.

6.2. Morning track census

The daily morning track census began on 23rd February and continued daily until the end of the season. No leatherback nesting activity was recorded after the 7th of July.

6.2.1. Temporal distribution

A total of 112 leatherback tracks were encountered on Playa Norte, of which 90 lead to a nest and 22 were half moons. Based on morning track census, leatherback activity reached its monthly peak in May with 29 nests recorded. The number of tracks per week is shown in Figure 6. The second week of April (from the 6th to the 12th) contained the highest activity, with 12 nests recorded and three half moons.

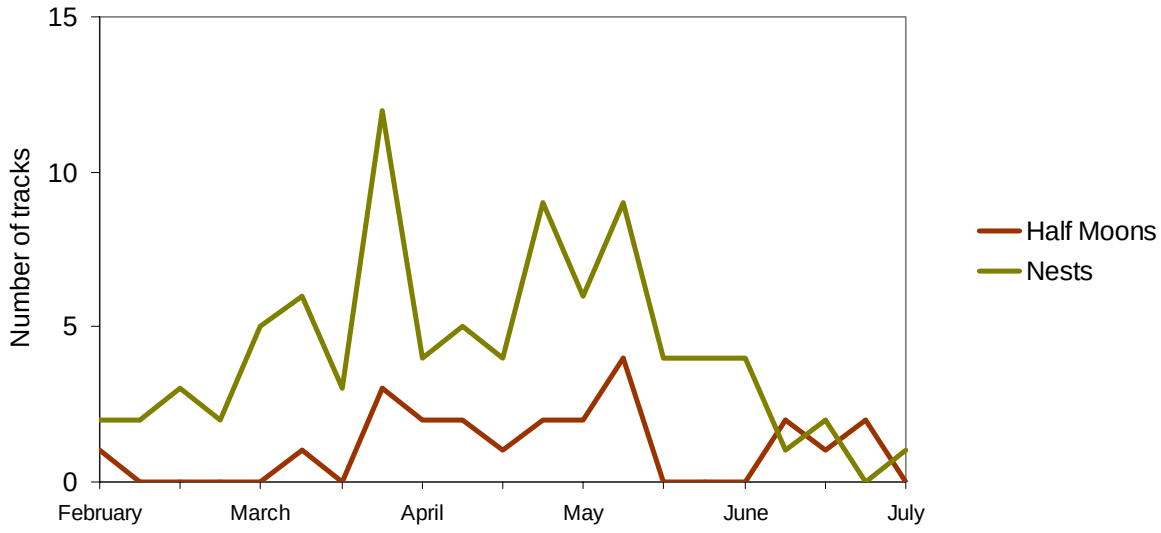

Figure 6 Temporal distribution of leatherback nesting activity on Playa Norte, 2008.

6.2.2. *Spatial distribution*

Only 28% of the beach contained over 53% of the nests. These areas were the eighth of a mile before mile-markers 6/8, 7/8, 1, 2 1/8, 2 2/8, and 3. No trend was observed when analyzing the use of different nesting areas throughout the season, although one should notice that only two nesting available areas did not have any nests, those were mile 2 3/8 and mile 2 4/8. All recorded leatherback nests during either morning census or night patrols were deposited in the Open.

Although only 10 nests had this measurement recorded, the distance to the HTL varied between 4.6 meters to 21.3 with an average of 10.1metres

6.2.3. *Nest status based on morning census*

Of the 88 nests recorded during the morning census survey period (figure 7), 70 were recorded as natural (79.5%), 13 as unknown (14.8%) and five as poached (5.7%). The nest status is based on the information collected during morning censuses on the two days after the nest was laid.

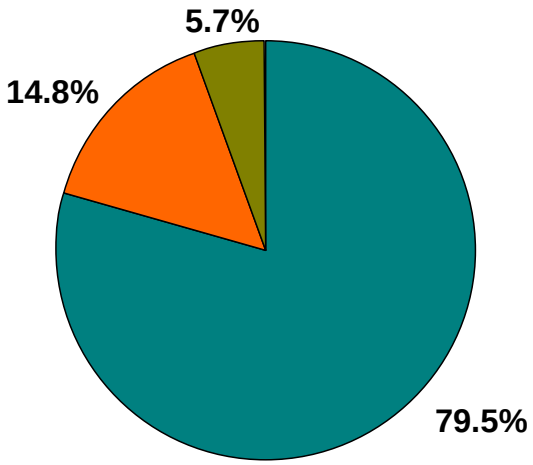

Figure 7. Leatherback nest status based on morning census, Playa Norte, Costa Rica.

Poaching was higher outside the study area. The nest status of the 13 nests found on the one mile north of the study area resulted in a poaching rate of 61.5%, 30.8 were natural and 7.7% were not determined (figure 8).

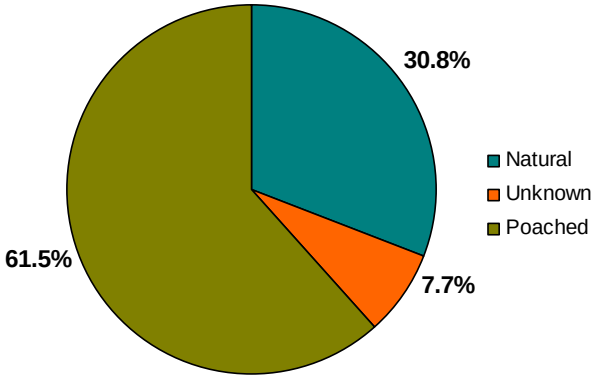

Figure 8. Leatherback nest status outside study area based on morning census, Playa Norte, Costa Rica.

During the 2008 Leatherback Season, poaching activity was spread along the study area. However, nests classified as poached by Morning Census were located between mile markers 4/8 and 1 5/8, this last mile marker being the one with more records of poaching or possible poaching.

6.3. Night patrol

Night patrols began on the 29th of February and continued uninterrupted until the end of the green turtle nesting season. The 7th of July was the last recorded leatherback activity. During the 2008 season, leatherback turtles were encountered 49 times along the total 720 patrol hours with 0.07 encounters per working hour. Of the 90 nesting occurrences the turtle was encountered by a patrol team 47% (n=42) of the times.

6.3.1. Direction nesting

For the majority of the beach, the sea is to the northeast to southeast while the vegetation is from the southwest to northwest. Figure 9 illustrates the direction the turtles were facing while nesting. The majority of turtles were found facing west when nesting.

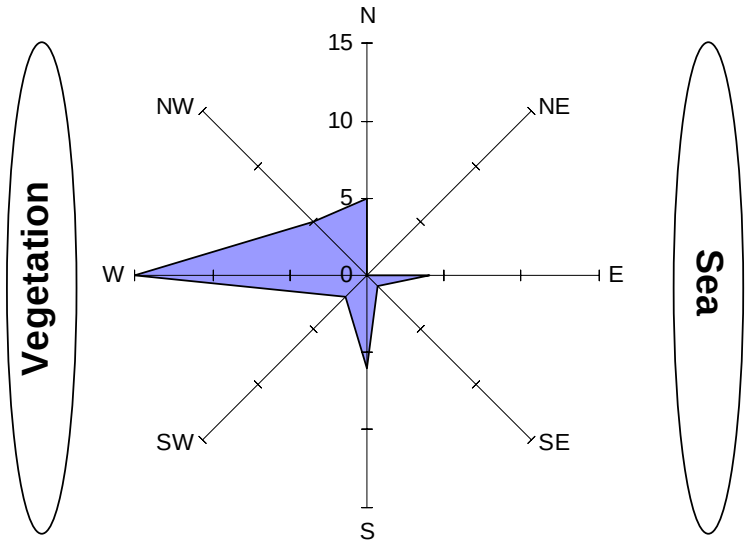

Figure 9. Direction facing during oviposition. Playa Norte, Costa Rica.

6.3.2. Tagging

A total of 31 different individuals were worked, 21 of which were previously tagged and 10 being newly tagged on Playa Norte this season. Of the previously tagged turtles, two had evidence of left old tag holes (OTH) Two nesting turtle were observed who had no tags and were not tagged, one due to a lighting storm and another due to lack of a tangible membrane.

Of the 21 previously tagged leatherback turtles encountered in 2008, the CCC in Tortuguero tagged 15 and one was tagged in Playa Norte during the 2006 season. The remainder had tags from Parismina (n=2), Pacuare (n=2), Gandoca (n=1) and Cahuita (n=1). Two previously tagged turtles had ingrown tags removed and were retagged. From the tag numbers recorded two could not be traced back due to, in one case, a likely missing character (7600), and in another case (VA8632) lack of information from other projects.

A total of seven leatherback individuals were recorded re-nesting within the season on Playa Norte. Four individuals were recorded nesting twice; two were recorded nesting three times and one four times. The re-nesting intervals varied from eight to 35 days, with an average re-nesting interval of 14 days.

6.3.3. *Biometrics*

During the 2008 season CCLmin was measured in 62% (n=26) of all encountered turtles, while CCWmax (n= 24) was measured in 57% of the encounters (n=42). In order to analyse the biometric data obtained from these two measurements, the dataset was first divided between measurements of complete and incomplete caudal projection to determine if this factor was important in the final CCLmin measurements.

Of the seven females observed more than once during the 2008 season, six had their caudal projection consistently classified complete. The remaining female had a caudal projection that was inconsistently categorized on successive sightings. Data from this individual was excluded from an initial comparison of CCLmin between females with complete or incomplete caudal projections.

The two subsets of individuals were compared using a Mann-Whitney test which yielded a non-significant difference (Mann-Whitney test: $z = -0.365$ $p = 0.715$, $n = 25$) between individuals with a complete or an incomplete caudal projection and as such both datasets were pooled together to determine the average CCLmin and CCWmax (Table 2).

Table 2. Mean carapace length and width of leatherback turtles encountered in 2008 in Playa Norte, Costa Rica.

	N	X ± S.D.
Curved Carapace Length (CCLmin)	26	151.2 ± 6.0
Curved Carapace Width (CCWmax)	24	112.3 ± 8.3

A comparison between the CCLmin of newly tagged and previously tagged turtles was also conducted with no statistically significant difference being found (Mann-Whitney test: $z = -0.422$ $p = 0.673$, $n = 25$).

6.3.4. *External condition of nesting females*

A total of 16 nesting females were found to have abnormalities. The most frequent abnormalities detected were small mutilations to the flippers, small being defined as a mutilation that affects less than 25% of the limb. Figure 10 presents the detected abnormalities and their frequency in different parts of the body.

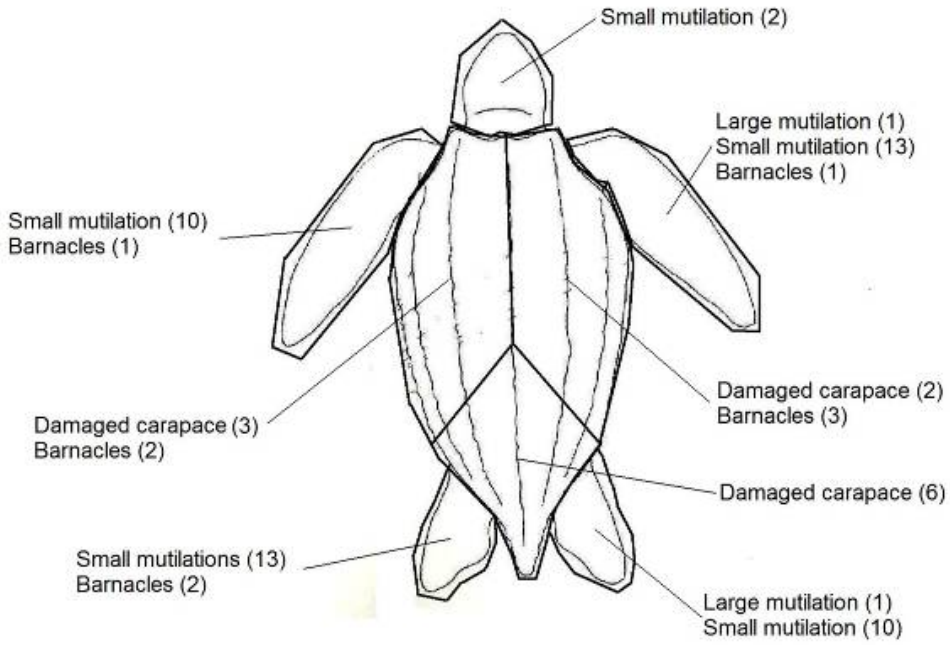

Figure 10. Detected abnormalities in nesting female leatherbacks from Playa Norte, Costa Rica.

6.4. Human impact data

All night patrols collected data referring to the number of locals and tourist seen in each patrol. Figure 11 represents the monthly averages of numbers of tourists and locals found per survey on different months. The average number of tourists per survey was three, with 80% of the surveys recording tourists while average number of locals was two with 79% of the surveys recording tourists.

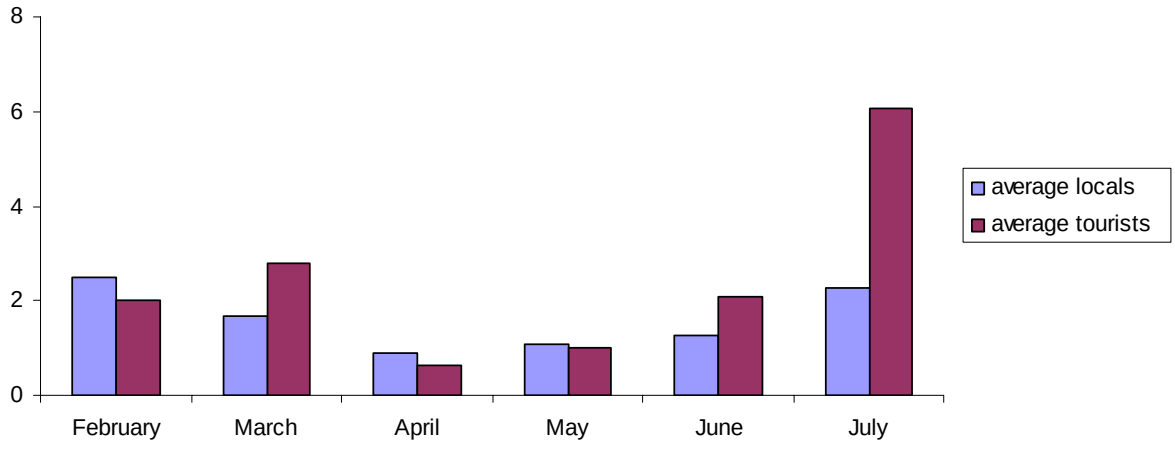

Figure 11. Average number of tourists and locals seen per month on night census

Night patrols also collected data on the number of mobile white and red lights seen on each patrol. The average number of red mobile lights per survey was one while the average number of mobile white lights was two (Figure 12). Red lights increase towards the end of the season when more tourists visit the area while the number of white lights decreased in April and May

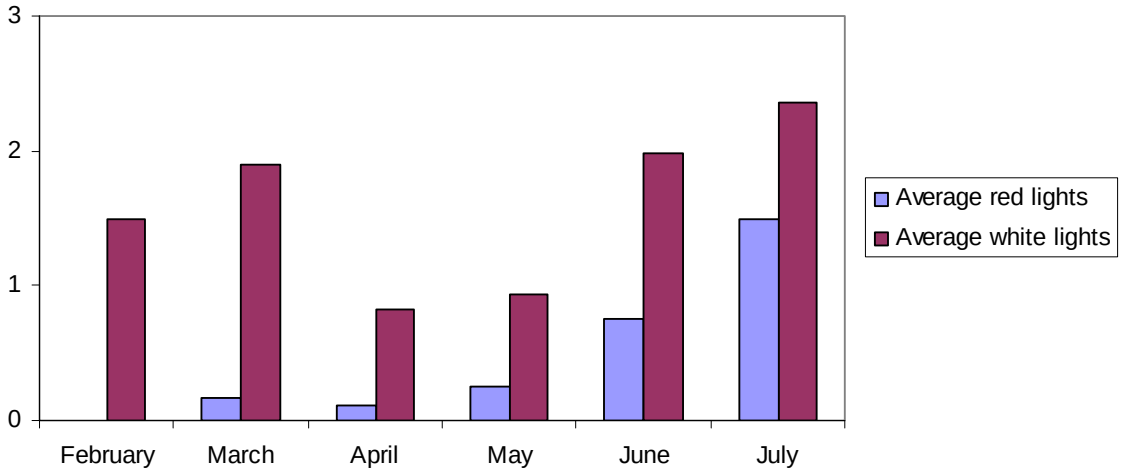

Figure 12. Average number of red and white lights found on night census per month in Playa Norte, Costa Rica.

Table 3 shows the number of stationary red and white lights recorded by the night patrol. White lights are clearly predominant and the number of stationary red lights increased steadily as the season progressed. The number of stationary white lights followed overall the same upwards trend.

Table 3. Stationary red and white lights encountered during night patrol in Playa Norte, Costa Rica.

Date	Stationary red lights	Stationary white lights
06/04/2008	5	36
05/05/2008	11	39
03/06/2008	12	32
03/07/2008	13	47

6.5. Hatchling orientation

The results obtained for hatchling orientation revealed a diverse range of deviation from the optimum route to sea (Table 4). The average extra distance travelled by hatchlings was 56 cm.

Table 4. Hatchling orientation angles and extra distance travelled by hatchlings, Playa Norte, Costa Rica.

Angle 1	Angle 2	Angle 3	Angle 4	Average extra distance travelled by hatchlings (cm)
66	66	74	74	2
50	60	75	90	64
55	70	90	98	84
40	55	65	85	95
50	60	70	85	50
49	49	60	60	43

6.6. Nest fate and hatchling success

Of the nest excavations 12 nests were found due to reverse triangulation 70 days after they were laid and 20 were found because hatchling tracks or signs of hatching were seen.

6.6.1. Nest fate of all excavated nests

Of the 90 nests laid, 32 were successfully excavated. The excavation results are presented in Figure 13. After completion of the excavations, it was found that all nests concurred with morning census status except for one nest that while classified as unknown during the morning survey was in fact natural and hatched.

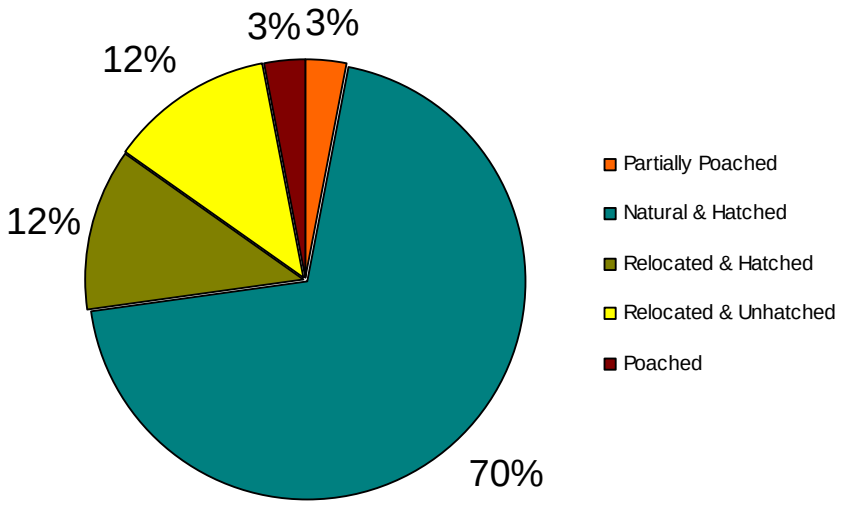

Figure 13. Excavations status of leatherback nests recorded in Playa Norte, Costa Rica.

6.6.2. *Summary of all hatched nest excavations*

Of the 13 nests where hatchling tracks were seen, the average incubation time was 62 days, but ranged from 44 to 68 days. Furthermore, two records previously classified as half-moons were found to be nests after hatchling tracks were seen originating from their vicinity.

A total of 1,865 yolk eggs were excavated, 1,360 of which hatched. This yields an overall hatching rate of 73%. A breakdown of the programme findings per nest fate is detailed in Table 5.

Table 5. Summary of data from leatherback nest excavations during the 2008 season in Playa Norte, Costa Rica.

Nest fate	N	Dead	Alive	Hatched	Yolkless	No Embryo	Stage 1	Stage 2	Stage 3	Stage 4	Pipped	Unknown stage	Mean clutch size	% Hatched	% Emerging
Partially Poached	1	0	0	0	1	0	0	0	1	0	0	0	?	0	0
Natural & Hatched	22	112	77	1170	594	102	47	24	39	97	13	32	69	77	69
Relocated & Hatched	4	2	0	190	100	56	14	1	7	2	0	7	69	69	68
Relocated & Unhatched	4	0	0	0	127	24	50	10	9	8	0	152	63	0	0
Poached	1	0	0	0	0	0	0	0	0	0	0	0	?	?	?

During excavations, 31 nests showed signs of predation (Table 6). Bacteria and/or fungi were the most common signs.

Table 6. Summary of predation per different nest fates found during excavation in Playa Norte, Costa Rica.

Nest fate	N	Ants	Larvae	Bacteria/ Fungi	Crabs	Unknown	Total predation	% of eggs with predation signs
Partially poached	1	0	0	0	0	0	0	0
Natural & hatched	22	9	40	186	12	9	256	17
Relocated & hatched	4	1	6	61	0	0	68	25
Relocated & unhatched	4	1	0	226	0	1	228	90
Poached	1	?	?	?	?	?	?	?

The egg depth (top of sand to top of eggs) and nest depth (top of sand to bottom of nest) recorded during excavation varied considerably between hatched and un-hatched nests (Table 7).

Table 7. Egg and nest depth during excavation for hatched and unhatched nests in Playa Norte, Costa Rica.

	Egg depth (cm)		Nest depth (cm)	
	n	X ± S.D.	N	X ± S.D.
Hatched	22	55.2 ± 12.7	27	75.1 ± 8
Unhatched	3	69.7 ± 16.3	3	89.7 ± 15.6

6.7. Dead turtles

No dead leatherback turtles were found during the 2008 Leatherback Season.

6.8. Beach habitat management

During the 2008 Leatherback Season, 18 beach cleans, totalling 305 working person-hours, were conducted as to improve the habitat for nesting turtles.

6.9. Environmental education

Talks about the marine turtle programme were given opportunistically to groups visiting Caño Palma Biological Station. In addition, patrol leaders David Gonzalez and Diogo Veríssimo implemented environmental education classes at the San Francisco school targeting 5th and 6th grade, which included a visit to the Caño Palma Biological Station. A total of five community events, with a variety of environmental themes, (such as birds or the rainforest) were also organized. The estimated total contact time in excess of 300 hours.

A leaflet was also designed in both English and Spanish for distribution at the two local lodges and inhabitants of Playa Norte with the aim of educating tourists on best practise when observing turtles, the objectives of the monitoring programme and the importance of marine turtle conservation. Although it was conceived with a tourist audience in mind, the leaflet was also used at community events, distributed to the educators at San Francisco School and local residents living along the study site. Unfortunately, due to logistical and financial constrains, its distribution started towards the end of the 2008 Leatherback Season.

7. Discussion

7.1. Preparation of results

The use of more accurate GPS units improved the accuracy of the spatial division of the study site. Furthermore, the use of two mile-markers per eighth of a mile proved effective, with some eighths of mile loosing one of the mile markers but none lost two, ensuring a more durable spatial division of the study area.

7.2. Morning Census

7.2.1. Temporal distribution

The number of nests registered this season (n=90) represents an increase from the two last nesting seasons (n=50; 52) but a decrease from the numbers registered in 2005 (n=110). However, given the remigration interval of the species it is still too soon to extrapolate any trends for the Playa Norte nesting population (Chacón 2004; Chacón & Araúz 2001). Looking at the temporal distribution within the season, the pattern is similar to the two previous seasons with April and May being the months with more nesting activity.

7.2.2. Spatial distribution

Considering the last three nesting seasons, only mile marker 7/8 was noted as a high nesting area in all of them. This points towards a lack of strong spatial nesting that can be used to foresee leatherback nesting activity. Nonetheless, a larger dataset will be needed to draw strong conclusions. In relation to the vertical position of nests, all turtles nested in the open, something that did not happen in previous seasons. In concordance with this conclusion, the average distance to high tide line (HTL) of triangulated nests registered this season was approximately half of the one registered last season, the first where records exist. This situation makes the relocation permit the project acquired even more important in order to improve the survival chances of nests laid below the (HTL). Given the small size of the dataset, it was not possible to analyse if the proximity to HTL produced had any consequences on the hatching success of the nests.

7.2.3. Nest status based on morning census

The status assigned in morning census reveals an improvement in the survival of nests. The major improvement was the absence of erosion, which led to an increase in natural nests and the decrease of nests deemed poached, although there was an increase in nests of unknown status, which enables us to conclude further. An important driver of this change was the

existence of a relocation permit for the full season. This fact allowed for the relocation of nests with the highest risks of erosion and poaching. It is nonetheless disappointing that, with change in protocols, the data from morning census collected during 2005 and 2006 is now not comparable to our present dataset leaving a dataset of two seasons respectively 2007 and 2008.

The spatial distribution of poaching events may be explained by the configuration of the study area and the distribution of the human population around it. During most of the leatherback season, direct access from the path along the beach was only possible from mile-marker 3/8th north, which restricted access to the southern part of the beach. On the other hand and given that the village of San Francisco is situated to the south of the study area and that local residents with a history of egg collecting inhabit the "fincas" along the first one and a half miles of the beach, these results are not unexpected.

Furthermore, the values obtained represent a shift from last year, when poaching was registered mainly around Mile 1 and Mile 3. The changes are thought to be largely due to a change in the residents of the house at Mile 3 and to the already referred particular configuration of the beach during the 2008 leatherback season.

Given that some illegal egg collection is currently largely restricted to a few identified individuals and to particular areas along the study area, a presence from MINAET or the local police could give a significant boost to the conservation efforts on Playa Norte.

7.3. Night patrol

Due to constraints in human resources, the patrolling effort was smaller than last season. This lead to a smaller proportion of nesting turtles found than in the previous two seasons.

7.3.1. Direction nesting

The large majority of nesting turtles encountered choose to nest facing the vegetation.

7.3.2. Tagging

This season, more turtles were newly tagged than last season (n=10), although this is a lower proportion of the nesting turtles for the year. For the first time on Playa Norte, there was evidence of OTH's.

The registered re-nesting intervals, between eight and 35 days. Given that the most common estimates for re-nesting interval are from nine to 10 days (Pritchard 1971; Witt et al. 2008) it is likely that the turtles either returned to nest in another beach or they were simply not found while nesting on Playa Norte.

During the 2008 season, Playa Norte received turtles previously tagged along the entire Costa Rican coast from Gandoca to Tortuguero. This illustrates the need for widespread turtle conservation as turtles nest on multiple beaches within a season and from year to year. It is also important to stress the first remigration with a turtle tagged originally in 2006 returning to nest multiple times during the 2008 season.

7.3.3. Biometrics

An analysis of the measurements of re-emergent individuals taken on Playa Norte reveals that although accuracy of CCL and CCW are overall adequate there are discrepancies, especially in the CCW measurement. This indicates that training should be improved further as to allow for extra accuracy. Nonetheless, a comparison between measurements of the same individuals taken in different nesting beaches by different projects reveals that our results are of a replicable standard, with CCW measurements having a margin superior to that of CCL.

7.3.4. External condition of nesting females

A similar number of abnormalities were detected in nesting turtles during the 2008 season in comparison to the previous season with the exception of tumours, which were not detected this season. This occurrence seems in divergence with the relatively high occurrence of this abnormality in Tortuguero Beach, which shares the same nesting population. More intensive networking between the two projects could be conducted to investigate this situation.

7.4. Hatchling orientation

As the sample size was small, it was impossible to assess if there was any relationship between the extra distance travelled by the hatchlings and external light sources of other potential anthropogenic disturbances. Nonetheless, the establishment of this methodology coupled with a larger dataset from following seasons may allow for an improved understanding of the impact of human development on hatchlings.

7.5. Nest fate and hatchling success

This season the triangulation accuracy increase from 56% last season, to 86%, which may related not only to improved training, but also to the severe floods registered during 2007.

7.5.1. Nest fate of all excavated nests

The nest fate of excavated nests presents a more positive scenario than the one drawn by the morning census status, assigning only 6% of the nests as victims of poaching activity. Although half the relocations made this year remained unhatched, this still yields a total of 82% hatched nests; an impressive number for a project with no ex-situ management and minimal enforcement support from MINAET.

Furthermore, by comparing morning census and excavation results one can see that both methodologies yield very similar results, with morning census having a margin for error since there it is possibility to assign an unknown state, a result of inconclusive information. This increased accuracy is a good indication that the training methodology was effectively improved from last season, although it is important to note that morning census monitors the nests and surrounding activity for only the first two days after been laid.

7.5.2. Summary of all hatched nest excavations

The incubation periods fall generally within what other longer running leatherback projects have recorded, although our season minimum of 44 days is an unusually short incubation period for the species. (Chacón & Lopez 2007; Eckert 1990).

The hatching and emerging rates increased up 20% from the previous seasons records. This could be due to particularly favourable environmental conditions

The percentage of predated eggs in hatched eggs remained stable in relation to last season. The unhatched nests, on the other hand, registered a much higher predation rate. This might however been influenced by the fact that all unhatched nests recorded this season are relocated nests as opposed to normal unhatched and natural nests last season. The major predation problem seems to be fungus and bacteria, although it is impossible to determine accurately if they are the cause of the embryo or simply appear after its death.

In relation to egg and nest depth, the nests recorded this season were on average shallower than the recorded last season. A possible trend for unhatched nests being deeper is detectable, although the sample sizes make relevant statistical analysis impossible.

7.6. Dead turtles

The lack of leatherback carcasses is a positive sign after one individual was killed by poachers in Tortuguero in 2007.

7.7. Beach habitat management

This year adaptive management was implemented for “beach cleans”. Each week the eighths of mile to be cleaned were determined by a weekly census of the different types of debris existing along the length of the study site. The scheme took high areas of poaching and erosion into account as to create better nesting habitat in areas where the nest would be safer. This might have had an impact in reducing the ratio of half-moons to nests from more than 30% in previous years to less than 20%.

7.8. Human impact data

During the 2008 season, an increase in mobile red lights and a decrease in mobile white lights was observed. This is a positive trend and might reflect a higher level of awareness amongst tour guides and locals.

The number of locals using the beach during patrols seems to have remained stable when compared to last season, while the number of tourists found during patrols increased by a third. It would be important to undertake a carrying capacity study similar to that developed in Tortuguero to evaluate how many tourists can reasonably utilise the beach.

Concerning the stationary lights, the number of both red and white lights increased steadily throughout the season as in a similar fashion to that observed last season. The increase in red lights was largely due to the positive relationship between the project and one of the hotels neighbouring the study area and to the distribution of a number of red light bulbs to residents living along the study area.

7.9. Environmental education

Due to a constraint in human resources, it was not possible to maintain continuous environmental education classes during the whole Leatherback Season. Nonetheless, the project tried to be as active as possible and this provided a valuable window for communication between the community and the Biological Station. Through this communication there were a number of denounces of illegal harvesting and other behaviours that were reported to the project and subsequently to MINAET officials.

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9. **Appendix I** – Marine Turtle Leaflet (English version)

North Beach Marine Turtle Monitoring and Conservation Program

How are the turtles monitored?

We patrol the beach every morning and night between March and October. Nests are monitored for poaching, predation and erosion. In addition, we conduct beach cleans throughout the year to increase available nesting area and the likelihood that hatchlings will make it to sea.

What happens when a nesting turtle is encountered?

The turtle is tagged on both flippers for identification purposes, the carapace is measured and the eggs are counted. Any signs of illness and injury are also recorded. Finally, nest hatching success is monitored.

What you can do to help?

Any time you see a turtle you can help our conservation efforts by recording the following:

1. What time you saw the turtle;
2. How far it was from your lodge or hotel;
3. Whether any eggs were laid, and
4. What time she went back to sea.

You can leave this information with reception and your lodge will channel it to us.

When looking for turtles remember:

TOUR GUIDES - Make sure you have a trained guide leading your walk. They will have a better chance of finding a turtle and ensuring the turtle is not disturbed.

UNIFORM - Dark clothing is recommended. Insect repellent and other strong smells should also be avoided.

RED LIGHTS – Use of artificial lights on the beach should be minimized to avoid disturbing nesting turtles. If lights are required for safety, only red lights should be used given that turtles have a minimal perception of red light. Also, it is illegal to take photographs of nesting turtles without a permit as this may disrupt the nesting process.

TIDELINE - Walk as close to the tide line as possible. This will allow you to see turtle tracks and prevent you from walking into a nesting turtle. Turtles are very sensitive to vibrations, so it is also important to keep noise and movement to a minimum.

LOOK - When you do find a turtle do not touch her; however tempting it might be. Avoid standing in front of her, rather stay to her side or behind her.

ENJOY – By using these guidelines we are sure you will have a truly magical experience.

Meet the marine turtles of North Beach, Tortuguero

A guide to responsible turtle watching

Caño Palma Biological Station
Tel: (506) 2709 8052

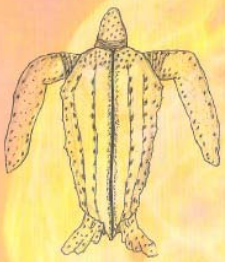
GVI (Global Vision International)
http://www.gvi.co.uk

COTERC
(Canadian Organization for Tropical Education and Rainforest Conservation)
http://www.coterc.org
http://www.coterc.org/

toronto ZOO http://www.torontozoo.com

The Marine Turtles of North Beach

Leatherback (52-70 inches

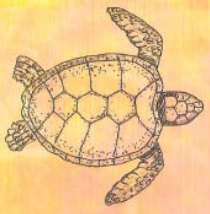


- Critically Endangered
- Nests between March and July
- Eats mainly jellyfish
- Main threats are sea pollution and drowning in drift nets.

Hawksbill (30-35 inches, 75-88 cm)

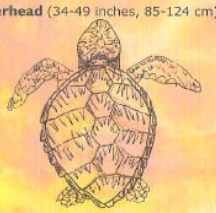
- Critically Endangered
- Nests between April and November
- Eats mainly sponges
- Main threat is poaching for its shell

Green (32-48 inches, 80-122 cm)



- Endangered
- Nests between June and November
- Eats mainly algae
- Main threats are poaching for its meat and drowning in drift nets

Loggerhead (34-49 inches, 85-124 cm)



- Endangered
- Nests between April and November
- Eats mainly invertebrates
- Main threat is poaching of eggs

North Beach and the Marine Turtles

Marine turtle populations have been declining worldwide. In the sea they are threatened by water contamination and drowning in commercial fishing gear. On land, turtle eggs are harvested, often illegally, and females are poached for their meat.

North Beach, Tortuguero is a nesting site for four of the seven species of marine turtles in the world. A monitoring and conservation program has been running since 2005. The program is run through a collaborative partnership between GVI and COTERC. Our goal is to monitor nesting turtle populations in order to aid in the conservation of these endangered creatures.

Enjoy these amazing animals; if you are lucky enough to see them. Please help our conservation efforts by allowing them to nest peacefully.