Playa Norte Marine Turtle Conservation & Monitoring Programme

Green Season Report 2008

By Wing Tsui, Diogo Veríssimo, David Jones & Rebeca Chaverri

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Leatherback Season Report 2008

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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Playa Norte Marine Turtle Monitoring and Conservation Programme

2008 Seasons

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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 green 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 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" (Chacón *et al.* 2007; 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).

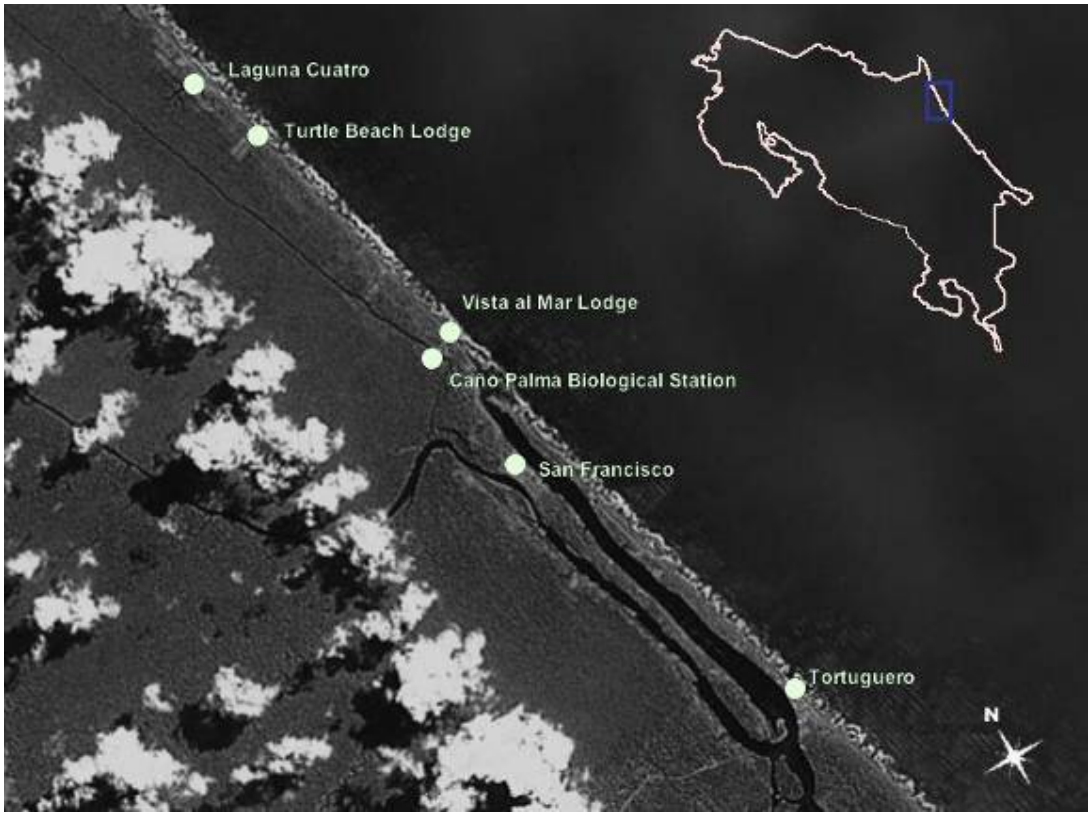

Figure 1. **Study area for the Playa Norte Marine Turtle Monitoring and Conservation Programme, BCWR, Costa Rica.**

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 - 16th April; 18th - 20th May; 13th – 16th July; 10th – 13th August and 5th – 8th October. Each PL and volunteer 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, several 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 nesting seasons 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.

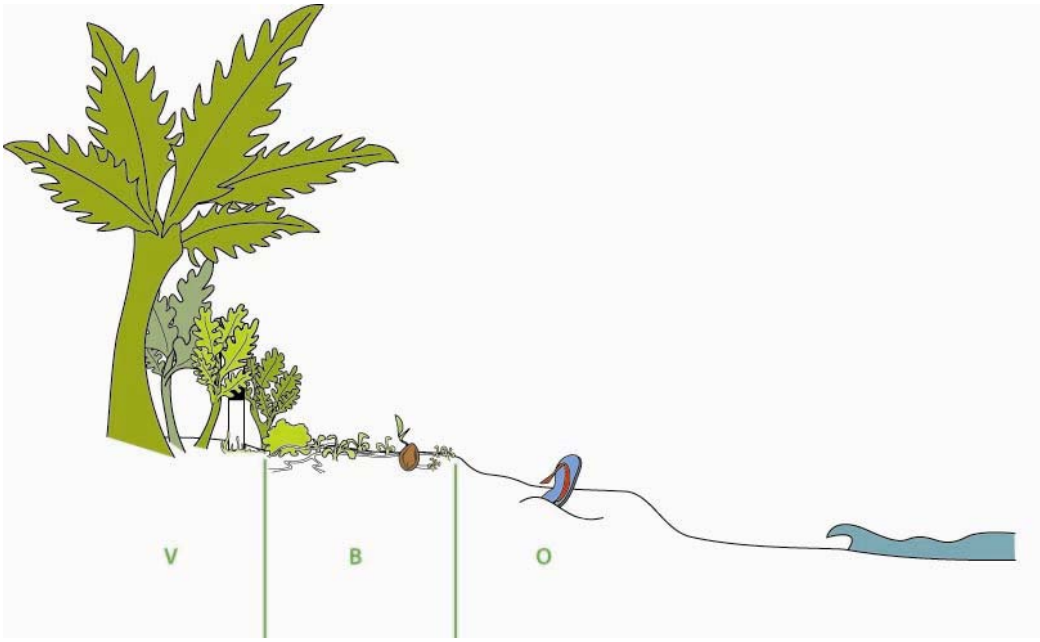

Figure 2. Nests vertical position on the beach. Playa Norte, Costa Rica.

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 for the beginning of the leatherback nesting season and continued daily until the end of the green season, at the end of October. 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 emergence for previous seasons. When two teams were scheduled, the first team was normally scheduled

from 21:00 to 01:00 and the second team from 23:00 to 03:00. These times were given some flexibility based on encounter times and rates, together with poaching activity.

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. Green, hawksbill, and loggerhead turtles were tagged in the membrane between the front flippers and the body just before the primary scale (Figure 3) using National Band & Tag Co., Newport, USA Inconel #681 CP600 to CP900 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.

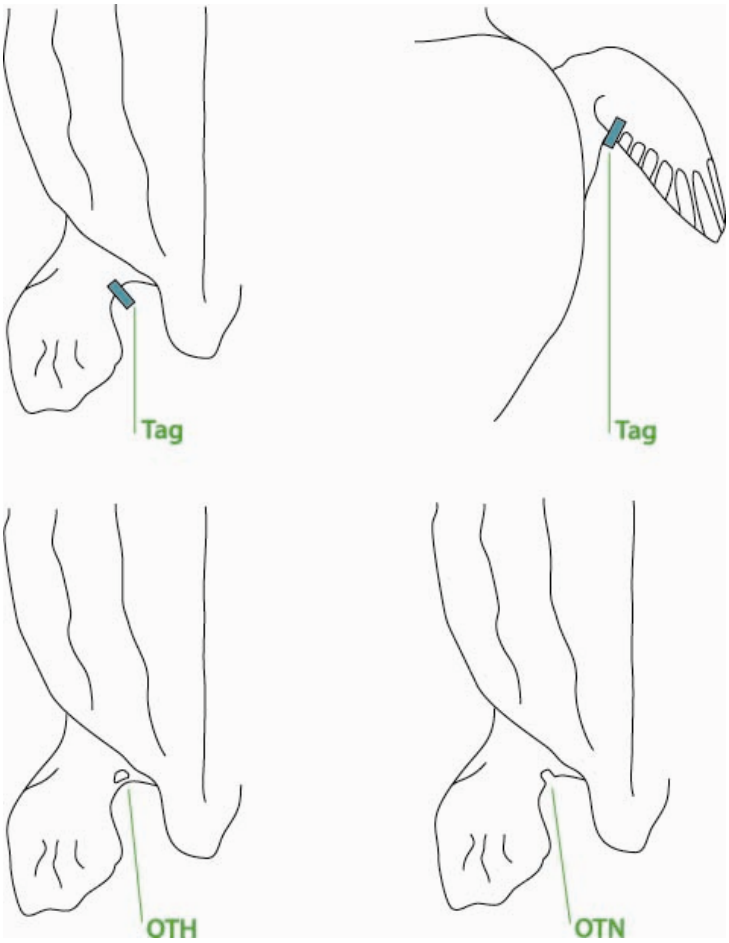

Figure 3. Above: proper position of tags for leatherbacks (left) and other species (right). Below: old tag notches (OTNs), old tag holes (OTHs).

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 green, hawksbill, and loggerhead turtles, CCLmin was measured from the nuchal scute where the skin touches the carapace, along the centre of the carapace until the notch at the posterior end.

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.

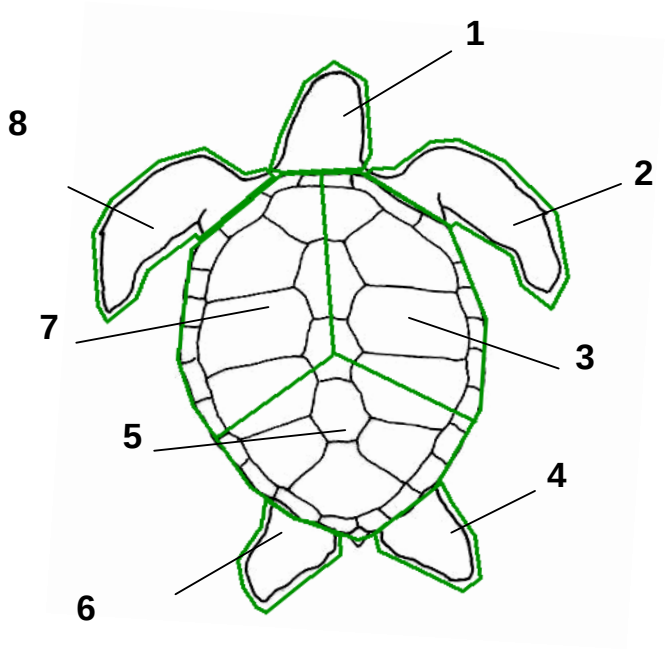

Figure 4. External body exam of green turtles.

5.6. Disguising tracks and nests

All green turtle tracks were marked at the time of initial data collection during night patrols so as to avoid double counting. During the green season, it is the job of morning census to erase all turtle tracks on the beach to help to disguise the location of fresh nests on the beach.

No disguising of green body pits takes place on Playa Norte due to the lack of the available information as to how this may affect the clutch.

5.7. 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.

5.8. 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.

5.9. 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 green nests that were not seen to have hatched were excavated 70 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

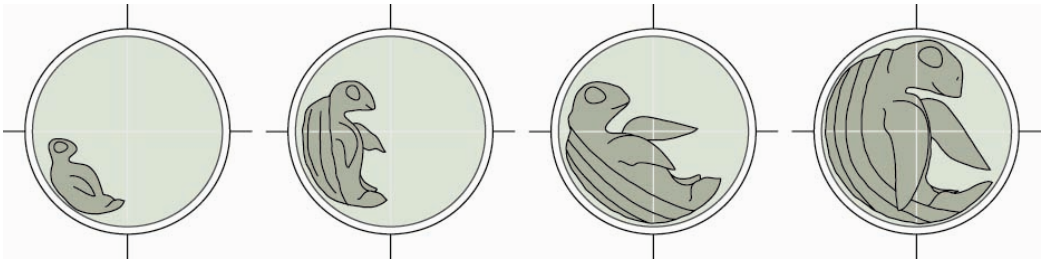

Figure 5. Embryonic development stages used during nest excavations.

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 = Unhatched egg without embryo	
UH = Unhatched 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.

5.10. 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.

5.11. 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

the theoretical hatching date, at which time any debris that could affect the normal emergence and movement of hatchlings to sea were removed.

5.12. 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 green 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 Leatherback Season Report 2008 or the Playa Norte Hawksbill Season Report 2008).

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. No mile markers were replaced during Green Season with all previously set-up markers from Leatherback Season 2008 still in place.

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 was conducted from 23 February to 11 December 2008. Nesting activity of green turtles was observed from 11 March to 5 November. Temporal distribution

A total of 1195 tracks were recorded throughout the season, with 446 nests and 735 half moons. Based on morning track census, the peak month was September, with 190 nests and 333 half moons observed; and the peak nesting day was on 31 August, with 24 nests and 34 half moons recorded (Figure 6).

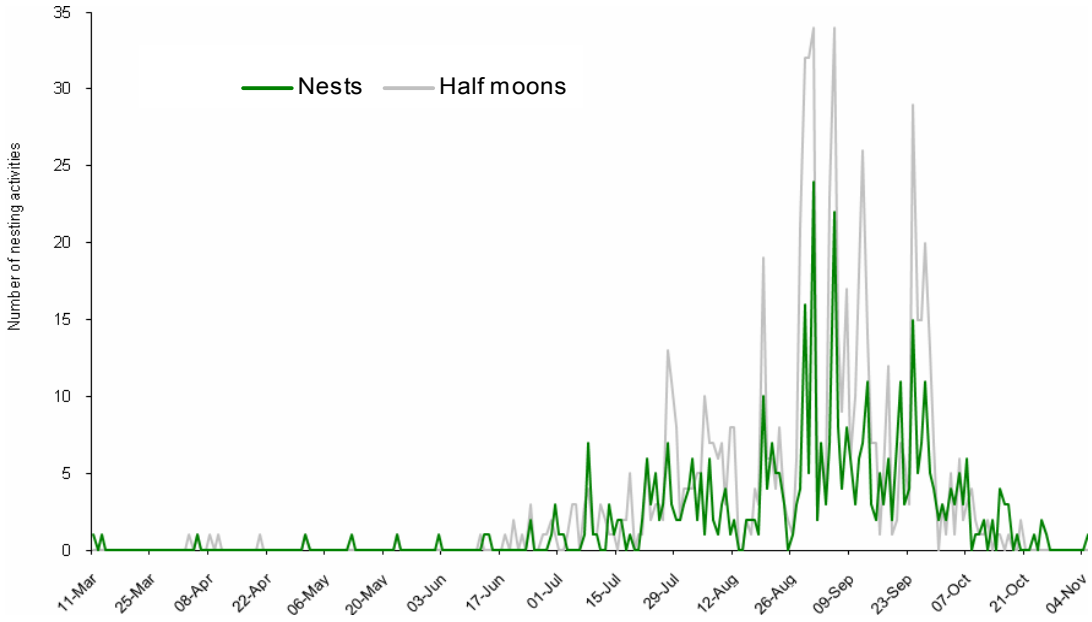

Figure 6. Temporal distribution of green nesting activity on Playa Norte, 2008.

6.2.1. Spatial distribution

The spatial distribution of nests and half moons along Playa Norte is illustrated in Figure 7. No apparent trend was observed despite the fact that mile markers 1/8, 2/8 and 3 1/8 received the lowest nesting activities. Number of nests was highest at mile marker 2 6/8 with 38 occurrences, and lowest at mile markers 1/8, 2 4/8 and 3 1/8; and the number of half moons was highest at mile 5/8 with 51 occurrences. Half moons were generally higher than nests in every 1/8 mile with an exception of mile 2, 2 6/8 and 2 7/8.

Vertical positions of nests (n=399) on the beach are found to be mainly at the border (Figure 8), with an average distance of 22.4m to the high tide line.

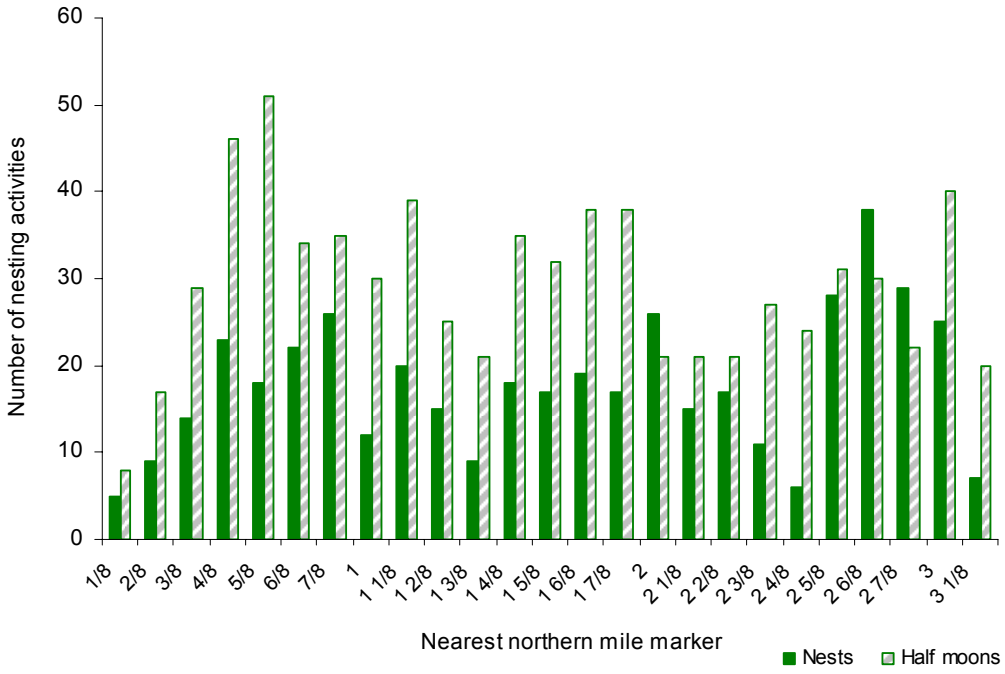

Figure 7. Spatial distribution of nests and half moons of green season on Playa Norte, Tortuguero, 2008.

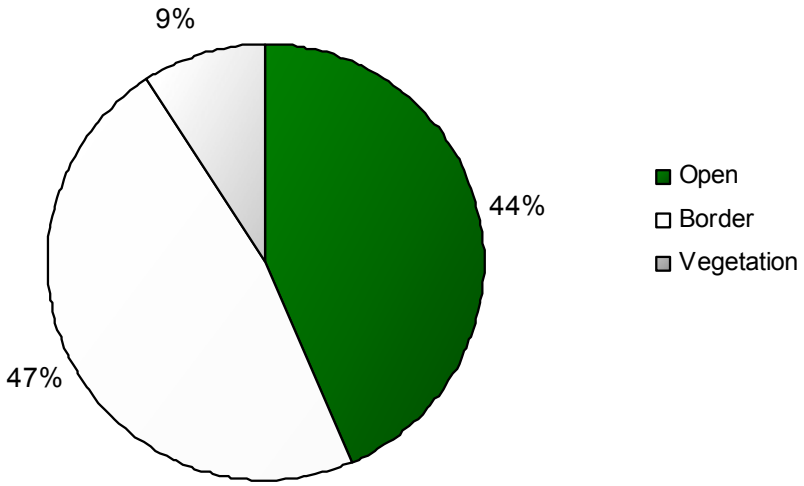

Figure 8. Percentages of vertical position of green nests on Playa Norte, Tortuguero, 2008

6.2.2. Nest status based on morning census

Of 436 green nests monitored during morning census, 350 were found to be natural on the first two days after being laid; 52% were determined poached and 33 were classified as unknown.

Only one nest was eroded and none of the nests had signs to prove to be subjected to predation (Figure 9).

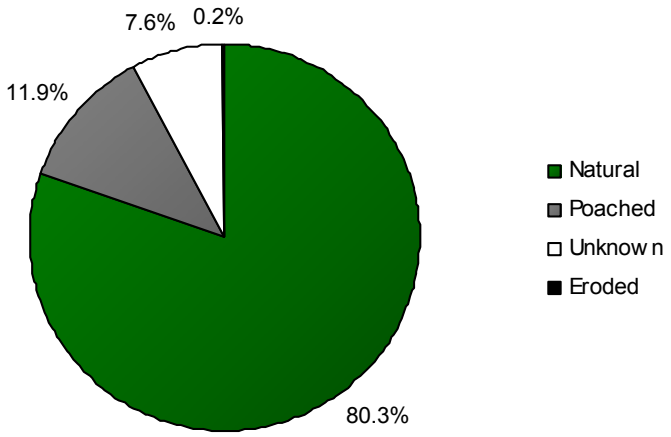

Figure 9. Percentages of green nest status determined by morning census on Playa Norte, Tortuguero, 2008; n=436. Zero percent of nests were determined predated.

Regarding spatial distribution, mile 1/8 and 2/8 had the highest poaching rate in relation to their total number of nests on the beach, while mile 2 1/8 and 2 4/8 had no poaching activity observed. Figure 10 illustrates the total number of natural, poached, unknown, and eroded nests per mile marker.

A comparison on nest status of one mile north of the study area is shown in Figure 11.

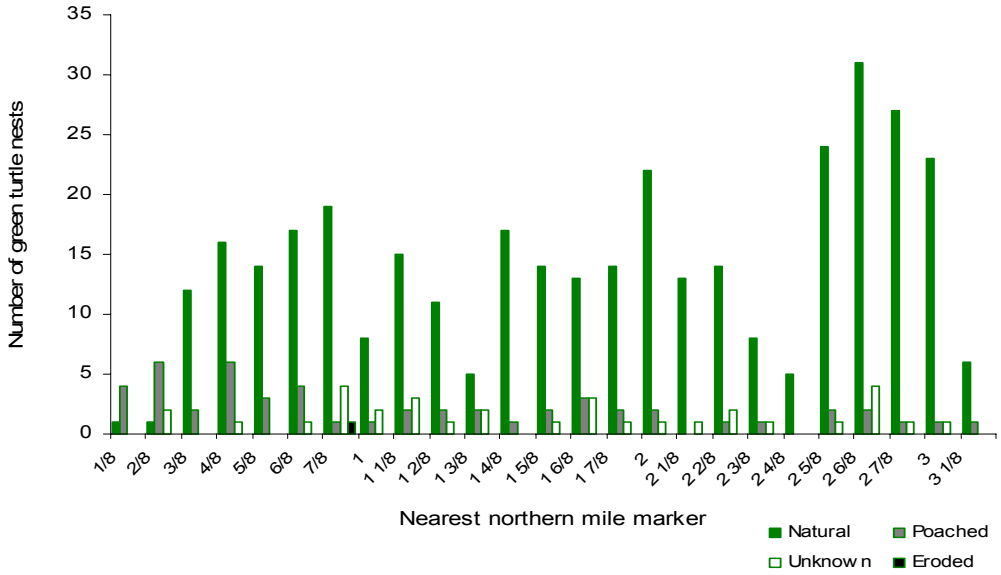

Figure 10. Spatial distribution of nest status of green turtles on Playa Norte, Tortuguero, 2008.

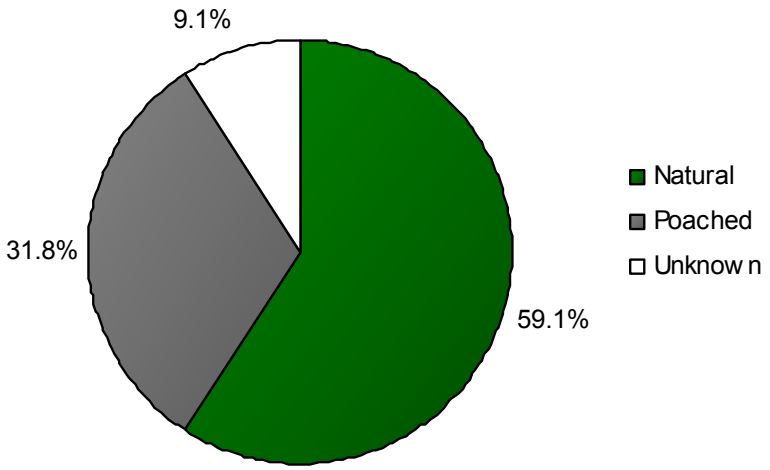

Figure 11. Percentage of green nest status determined by morning census on one mile north of Playa Norte, Tortuguero, 2008; n=22. Zero percent of nests were determined eroded or predated.

6.3. Night patrol

Night patrol started on 29 February and ended on 30 October. There were 328 night patrols in total throughout the Green Season. A total of approximately 1400 patrol hours were achieved at the end of the Green Season 2008.

Throughout all the patrols, 216 turtles were encountered; in which 173 nested (38.8% of total nesting occurrence) and 43 were half moons. Majority of turtles were encountered by night patrol teams except three nesting turtles were found by morning census team.

The peak encounter time for nesting turtles was 23:00 to 23:59 and 01:00 to 01:59 (Figure 12).

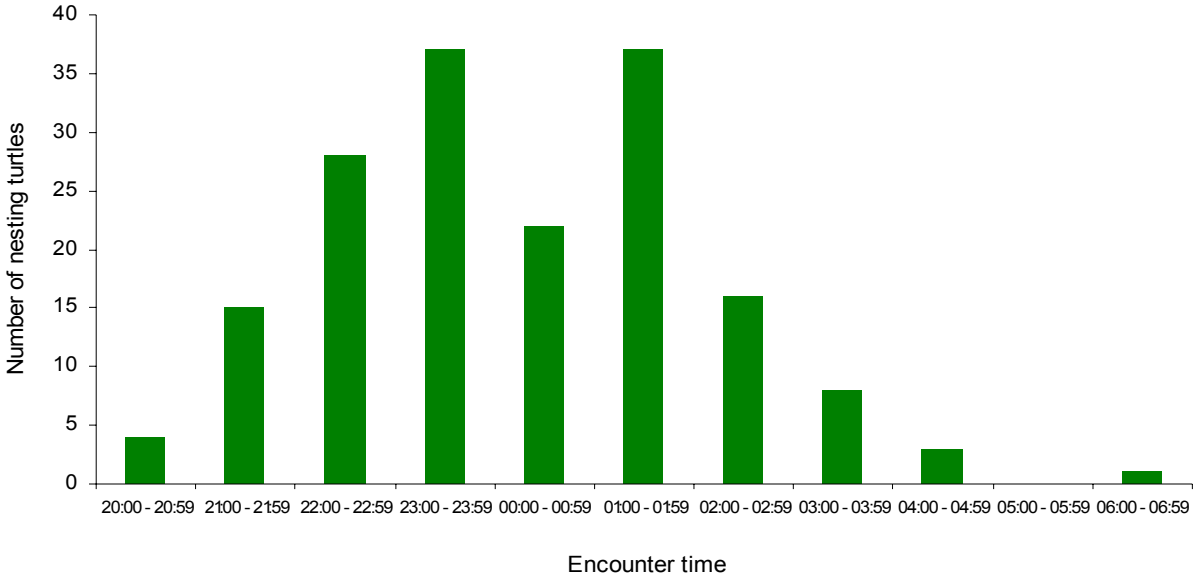

Figure 12. Encounter time of nesting green turtles by night patrol on Playa Norte, Tortuguero, 2008; n=173.

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. Most turtles were encountered disguising (Table 2), and their direction of nesting was found to be mainly towards the west (Figure 13).

Table 2. Encountered nesting activities of green turtles by patrol teams on Playa Norte, Tortuguero, 2008; n=167.

	Encountered occurrence	*%*
Emerging from sea	14	8.4
Selecting nest site	8	4.8
Digging body pit	22	13.2
Digging egg chamber	34	20.4
Oviposition	23	13.8
Covering egg chamber	8	4.8
Disguising	53	31.7
Returning to sea	5	3.0

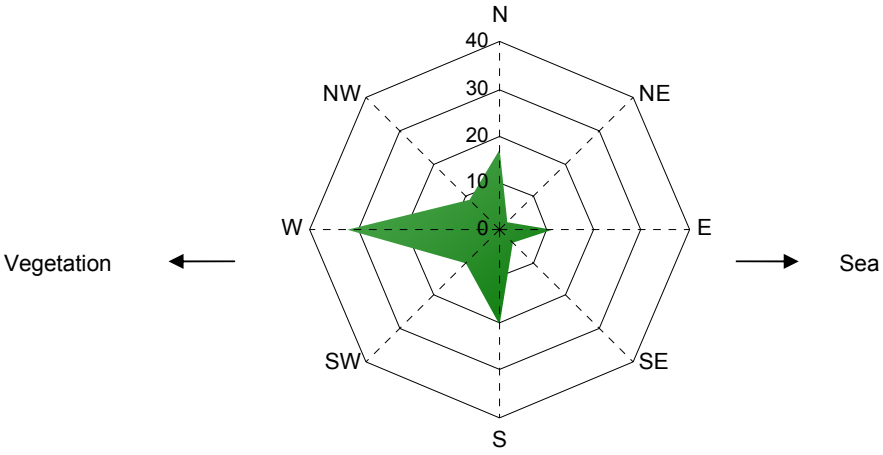

Figure 13. Direction facing of green turtles during oviposition. Playa Norte, Costa Rica, 2008.

6.3.2. Tagging

Of all the turtle encountered by patrol teams, 128 individuals were identified; 122 nested and six were half moons. Eighty turtles came up without tags and were tagged by patrol teams; 42 came up with tags and were tagged previously either on Playa Norte (previous Green Seasons) or other regions nearby. Fifteen individuals showed evidence of old tag notches (OTNs) and nine had old tag holes (OTHs). Eight turtles had their tags removed due to overgrown skin or illegible tags, and were retagged.

Out of all the identified nesting turtles, 18 individuals were recorded re-nesting on Playa Norte within the season. One was recorded nesting four times; four nesting three times and 13 nesting twice. The re-nesting period varied from 10 to 64 days, with an average of 23 days.

6.3.3. Biometrics

Table 3 illustrates the mean CCLmin and CCWmax of all measured green turtles. Only nesting turtles with tag information were measured. CCLmin and CCWmax were measured in 86.9% and 77.0% of total nesting individuals respectively.

Twelve individuals were measured more than twice and it was found that the average standard deviations for CCLmin and CCWmax were 1.35cm and 1.55cm respectively.

Comparison of biometric data between newly tagged turtle and previously tagged was also done and no statistically significant result was found (CCLmin: t_{104}=0.473, p=0.316; CCWmax: t_{92}=0.449, p=0.220).

Table 3. Mean carapace length and width of green turtles encountered in 2008 in Playa Norte, Costa Rica.

	n	*x*	*s.d.*
Curved carapace length (CCLmin)	106	104.2	5.7
Curved carapace width (CCWmax)	94	94.6	5.8

6.3.4. External condition of nesting females

Only nesting turtles with tag information were examined for their external condition, and abnormalities were detected in 88 individuals; the most frequent abnormalities detected were barnacles. One turtle was found to have no notch at the end of carapace.

Small anomalies includes irregularities such as scars and scratches; small being defined as a mutilation that affects less than 25% of the limb; large being defined as more than 25% of the limb; and damaged carapace includes mating claw marks and missing parts on carapace. Figure 14 presents the detected abnormalities and their frequency in different parts of the body.

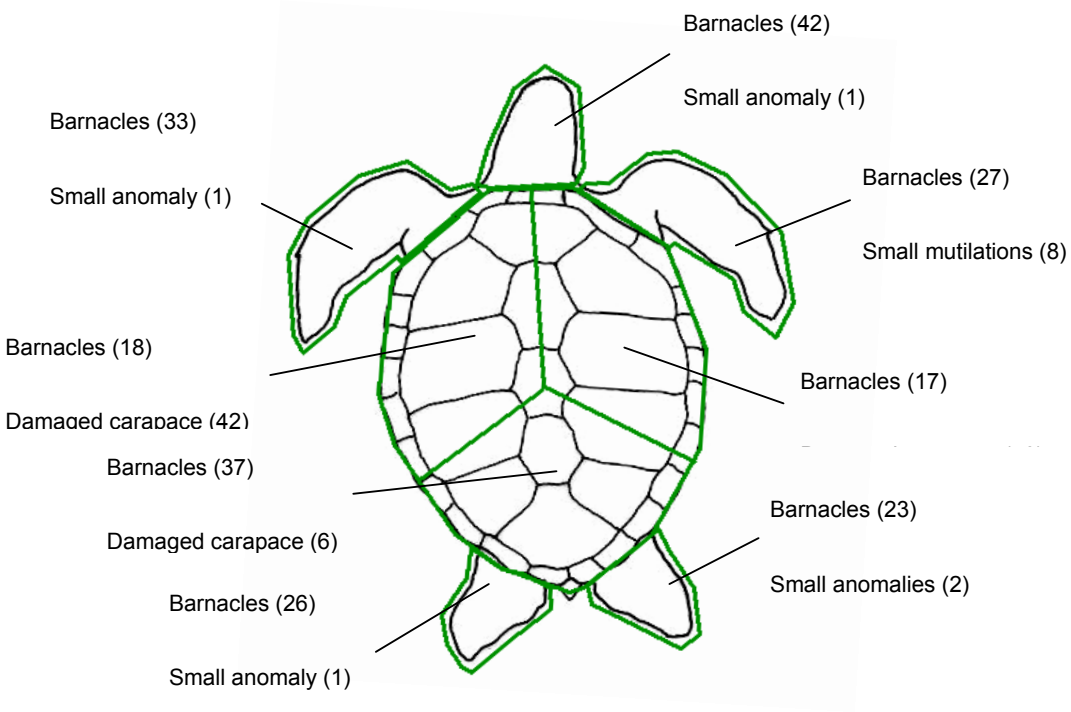

Figure 14. Detected abnormalities in nesting female green turtles from Playa Norte, Costa Rica 2008.

6.4. Human impact data

The total numbers of mobile red lights and mobile white lights seen by night patrol teams were 327 and 801 respectively. Of a total of 328 night surveys, mobile red lights were seen on 42.4% of patrols; and mobile white lights were seen on 86% of patrols. The average numbers of mobile red and white lights seen on those patrols were two and three respectively. Monthly variations of mobile red and white lights are shown in Figure 15a.

The total numbers of locals and tourists seen by night patrol teams were 687 and 1482 respectively. Of a total of 328 night surveys, locals were seen on 58.5% of patrols; and tourists were seen on 38.1% of patrols. The average number of locals and tourists seen on those patrols were four and 12 respectively. Monthly variations of locals and tourists are shown in Figure 15b.

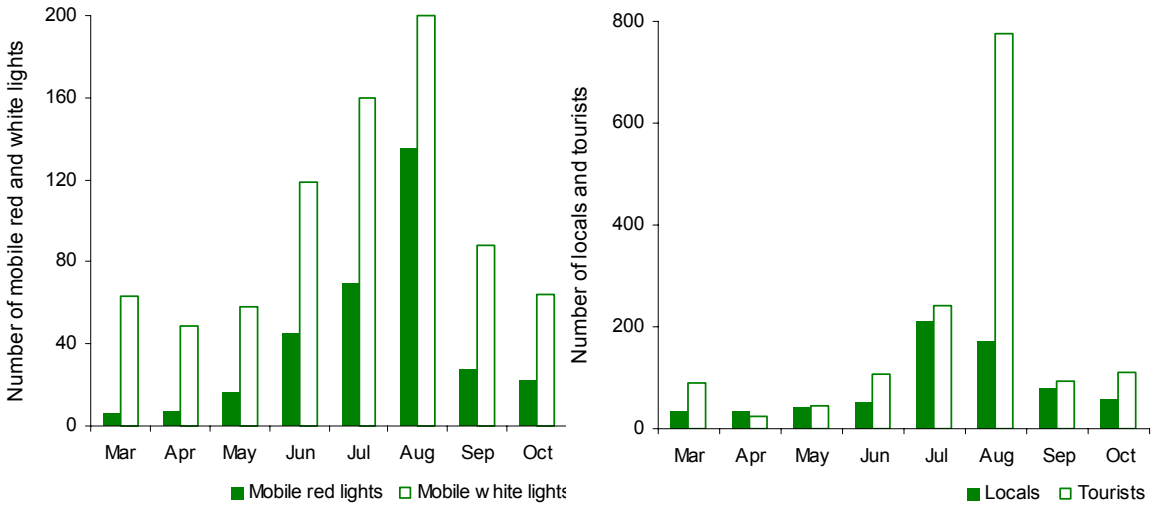

Figure 15. Monthly variations of the total number of (a) mobile red lights and white lights; (b) locals and tourists, on Playa Norte, Tortuguero, 2008.

The number of stationary red lights increased steadily until July, and decreased towards the beginning of August. The number of stationary white lights followed the same upward pattern as stationary red lights but it decreased only towards the end of August (Table 4).

Table 4. Total number of stationary red lights and white lights on new moon surveys.

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
01/08/2008	5	72
30/08/2008	4	52

6.5. Hatchling orientation

Out of all the green nests laid on the beach, 61 were seen hatched with hatchlings and/or hatchling tracks; 52 nests were determined hatched with other signs of hatching. Hatchling orientation was conducted in 33 nests with clear defined tracks. The results obtained for hatchling orientation revealed a diverse range of deviation from the optimum route to sea. The average extra distance travelled by hatchlings was 150cm. The result is displayed in Table 5.

Table 5. Hatchling orientation angles and extra distance travelled by green turtle hatchlings; n=33. Playa Norte, Costa Rica, 2008.

Number of hatchling tracks	*Angle 1*	*Angle 2*	*Angle 3*	*Angle 4*	*Average extra distance travelled by hatchings (cm)*
14	60	70	80	85	25
22	50	80	120	130	532
24	40	40	60	80	85
28	40	60	80	90	109
30	50	65	80	90	64
36	60	70	80	90	40
39	40	70	100	120	355
42	35	55	110	135	793
43	50	60	80	90	64
45	45	75	85	90	84
45	40	55	80	90	109
45	40	60	70	80	85
46	45	45	80	80	59
46	40	60	100	110	230
47	45	45	75	75	54
50	45	70	95	105	162
60	70	70	80	80	8
63	30	70	80	100	230
64	55	70	90	90	50
64	50	80	95	100	109
64	40	50	70	80	85
65	45	65	100	110	204
68	40	55	80	95	129
68	30	50	70	90	185
70	40	50	75	80	85
71	50	60	85	100	109
72	45	60	75	90	84
79	45	60	80	95	103
80	20	25	45	80	286
87	45	60	90	100	129
88	55	65	90	95	69
98	50	60	80	90	64
98	40	50	95	100	155

6.6. Nest fate and hatchling success

Table 6. Breakdown of identified green nests on Playa Norte, Costa Rica, 2008.

Total laid	*Triangulated by night team*	*Marked by day team from signs of hatching*	*Total Marked for excavation*	*Not found*	*Successfully excavated*
446	*91*	*87*	*178*	*13*	*165*

Of the successfully excavated nests, 113 were excavated two days after signs of hatching were recorded; 52 nests that were triangulated by night teams but with no signs of hatching before due date were excavated 70 days after being laid.

The incubation time of green nests was determined by referring to hatched nests with original nest date and were seen with hatchling tracks (n=57). It ranged from 47 to 70 days, with an average of 56 days.

6.6.1. Nest fate of all triangulated nests

Throughout the season, 91 nests were triangulated of which, 13 could not be located. Of the remaining 78 triangulated-and-excavated nests, 26 were excavated due to signs of hatching; while the rest were excavated by reverse triangulation 70 days after being laid.

Nest fate of all triangulated-and-excavated nests is presented in Figure 16. Thirty-six nests were natural; 11 were poached; 21 were partially-poached nests; seven were eroded, two were predated and the fate of one nests could not be determined with certainty and thus it was excluded from subsequent analysis, leaving a sample of 77 green nests.

Fifty-two percent of nest status determined at excavations was found to match with those recorded by morning census in the first two days after laying; and of all the animal/human-disturbed nests (n=34), 23.5% of disturbance was recorded within the first two days after laying.

Of all natural triangulated-and-excavated nests, 33 were hatched and three were unhatched. The mean clutch size was 102, with a mean egg depth and nest depth of 48.5cm and 62.9cm respectively.

The overall hatching success rate of all triangulated-and-excavated nests was 76.2%. A summary of hatching success and emerging success rates of triangulated-and-excavated nests of different nest fate is illustrated in Table 7; a breakdown of the excavation results for natural, poached, partially-poached, eroded and predated triangulated-and-excavated nests is

presented in Tables 8 and 9. Signs of internal predation were found in 79.6% of nests with eggs present, with bacteria/fungi as the main predation of eggs.

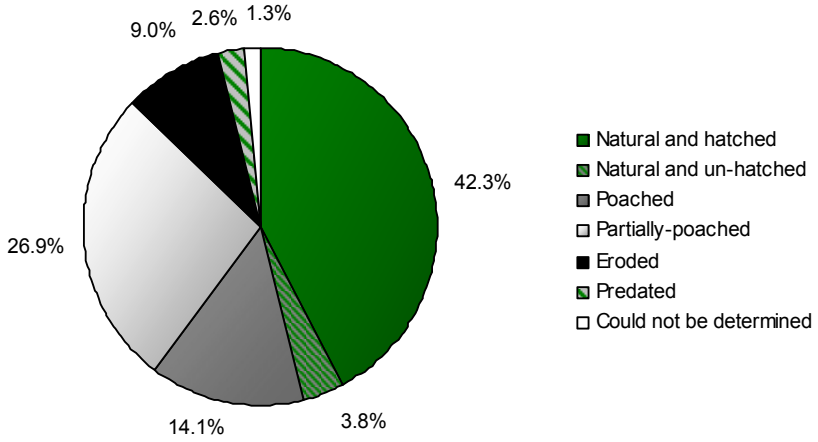

Figure 16. Nest fate of triangulated-and-excavated nests of green turtles on Playa Norte, Tortuguero, 2008; n=78.

Table 7. Summary of hatching success and emerging success of all triangulated-and-excavated nests of green turtles on Playa Norte, Tortuguero, 2008; n=77.

	n	*% of total*	*Hatching success %*	*Emerging success %*
Natural	36	46.8	77.1	73.9
Poached	11	14.3	–	–
Partially-Poached	21	27.3	73.1	72.0
Eroded	7	9.1	–	–
Predated	2	2.6	94.2	92.2
Total	77	100.0	76.2	73.8

Table 8. Summary of triangulated-and-excavated nests of green turtles on Playa Norte, Tortuguero, 2008; n=77.

	n	*Total yolked eggs*	*Total yolkless eggs*	*Mean clutch size*	*Hatched (Shells>50%)*	*Alive hatchlings*	*Dead hatchlings*	*Unhatched without embryo*	*Stage one*	*Stage two*	*Stage three*	*Stage four*	*Pipped*	*Unknown stage*
Natural	36	3657	25	102	2906	27	120	194	213	65	153	10	12	104
Poached	11	0	0	–	0	0	0	0	0	0	0	0	0	0
Partially-poached	21	899	1	43	707	0	14	87	17	6	4	3	10	65
Eroded	7	0	0	–	0	0	0	0	0	0	0	0	0	0
Predated	2	119	1	60	110	0	3	4	3	1	1	0	0	0
Total	77	4675	27	68	3723	27	137	285	233	72	158	13	22	169

Table 9. Summary of predation in triangulated-and-excavated nests of green turtles on Playa Norte, Tortuguero, 2008; n=77.

	n	*Ants*	*Larvae*	*Bacteria/Fungi*	*Crabs*	*Unknown*
Natural	36	32	11	211	25	294
Poached	11	0	0	0	0	0
Partially-poached	21	37	0	122	0	18
Eroded	7	0	0	0	0	0
Predated	2	0	0	0	0	0
Total	77	69	11	333	25	312

6.6.2. *Nest fate of all non-triangulated hatched nests*

Of the 87 non-triangulated hatched nests, 82 were natural; three were predated and the fate of two nests could not be determined with certainty. These two nests were excluded from subsequent analysis, leaving a sample of 85 green nests. Nest fate of all non-triangulated hatched nests is presented in Figure 17.

Of all natural non-triangulated hatched nests, the mean clutch size found during excavation was 110, with a mean egg depth and nest depth of 50.3cm and 62.9cm respectively.

The overall hatching success rate of all non-triangulated hatched nests was 86%. A summary of hatching success and emerging success rates of natural and predated non-triangulated hatched nests is illustrated in Table 5-8; A breakdown of the excavation result for natural and predated non-triangulated hatched nests is presented in Tables 5-9 and 5-10. Internal predation was found in 94.1% of nests, with bacteria/fungi as the main predation of eggs.

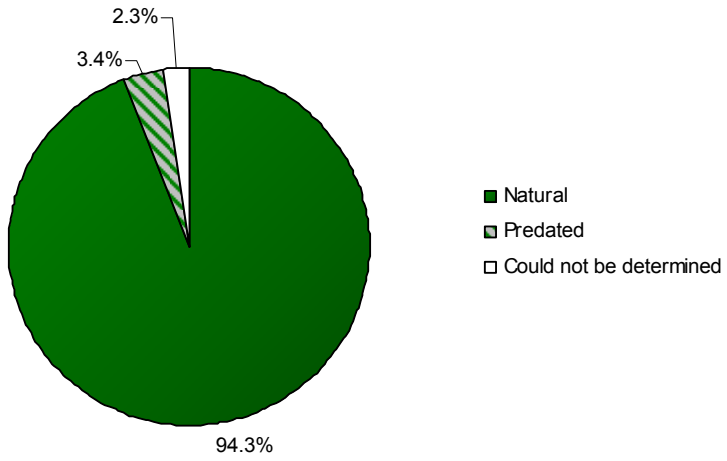

Figure 17. Nest fate of non-triangulated hatched nests of green turtles on Playa Norte, Tortuguero, 2008; n=87.

Table 10. Summary of hatching success and emerging success of natural and predated non-triangulated hatched nests of green turtles on Playa Norte, Tortuguero, 2008; n=85.

	n	*% of total*	*Hatching success %*	*Emerging success %*
Natural	82	96.5	85.8	81.6
Predated	3	3.5	92.5	91.1
Total	85	100.0	86.0	81.9

Table 11. Summary of non-triangulated hatched nests of green turtles on Playa Norte, Tortuguero, 2008; n=85.

	n	*Total yolked eggs*	*Total yolkless eggs*	*Mean clutch size*	*Hatched (Shells> 50%)*	*Alive hatchlings*	*Dead hatchlings*	*Unhatched without embryo*	*Stage one*	*Stage two*	*Stage three*	*Stage four*	*Pipped*	*Unknown stage*
Natural	82	9018	25	110	7844	29	360	453	63	54	59	42	102	401
Predated	3	141	0	47	136	2	0	0	2	0	1	0	0	2
Total	85	9159	25	108	7980	31	360	453	65	54	60	42	102	403

Table 12. Summary of predation in non-triangulated nests of green turtles on Playa Norte, Tortuguero, 2008; n=85.

	n	*Ants*	*Larvae*	*Bacteria/Fungi*	*Crabs*	*Unknown*
Natural	82	40	136	626	29	140
Predated	3	0	0	2	0	1
Total	85	40	136	628	29	141

6.7. Dead turtles

Six carcasses of green turtles were found throughout the season, five of which were found by project patrols and one was found due to information received from a local. All the dead turtles presented signs of poaching with only the carapace, plastron and sometimes the head present. The findings were reported to MINAET.

In addition, night patrol teams had encountered eight lifted records, where only no down-track was seen and/or there were other evidence of turtles being lifted, but with no turtles found. One turtle recorded as lifted by night team was found alive by morning census team the next day.

6.8. Beach habitat management

Throughout Green Season 2008, over 800 person-hours of habitat management work, with an average of approximately four times a week, were conducted as to improve the habitat for nesting turtles and emerging hatchlings.

6.9. Environmental education

Throughout the season, staff and volunteers maintained regular classes with the community of San Francisco for both English language and environmental education. Several events were also organised and attended in the local area. These consisted of conducting environmentally themed, educational community events in San Francisco and attending events both locally and nationally.

Seven community events were organised and conducted by staff and volunteers during Green Season; themes included recycling, rainforest, composting, water cycles and pollution. Presentations about the programme were given to visiting researchers and tourists as well to MINAET Park Rangers and staff.

An educational leaflet was also designed, and distributed in both Spanish and English at the two local lodges. The objectives of the monitoring programme and the importance of marine turtle conservation were described, together with best practises employed when observing marine turtles.

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, local residents living along the study site and at the first annual *Tortufest*, in Tortuguero village. More than 1000 leaflets were distributed during the Green Season 2008.

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 total number of nests this season (n=446) was a lot smaller than 2007 (n=803), but larger than 2006 (n=347), showing the fluctuations of green turtle nesting populations throughout years. However, given the remigration interval of the species it is still too soon to extrapolate any trends for the Playa Norte nesting populations (Chacón & Araúz 2001).

The green season started one month earlier than the 2007 Season and ended two weeks earlier, with a similar pattern of September being the peak season for both nests and half moons.

7.2.2. Spatial distribution

Nesting activities were recorded at every mile marker on the beach and there seemed to be no obvious preference for green turtles in selecting nest sites despite the fact that there were more nests towards the north end of the beach, at mile markers 2 5/8, 2 6/8 and 2 7/8. On the other hand, nests were lowest at mile markers 1/8, 2 4/8 and 3 1/8 due to the lack of beach on the way to San Francisco village (mile 1/8) and heavy human traffic around the lodge area (mile 2 4/8) and very open area at mile 3 1/8.

Green nests were laid mainly at the border and this matched with the general of greens of previous years in the region. Nonetheless, a high proportion of nests were also laid at the open area, showing the possibility/danger of nest swamping or erosion from high tides.

7.2.3. Nest status based on morning census

The status assigned in morning census reveals an improvement in the survival of nests. Poaching was found to be highest in areas where the trail was more open to the beach and

where human settlements were nearby, as they are expected to provide an easier and safer access route for people poaching.

The security presence in front of Turtle Beach Lodge and the regular presence of tourist groups may have contributed to the 100% natural rates of nests at mile marker 2 4/8.

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

Thirty-nine percent of nesting turtles were encountered by patrol teams, most of them were encountered disguising. The peak encounter time was 23:00 to 23:59 and 01:00 to 01:59 which coincides with the times the highest numbers of personnel were on patrol; however the wide encounter time range from 20:45 to 06:00 reinforces the necessity to maintain a high level of personnel to patrol the study site as regularly as possible.

7.3.1. Direction nesting

Turtles were found to nest mainly facing towards the vegetation, while the least facing towards the sea. This could indicate a preference for the darker vegetation line over the brighter ocean (Chacón-Chaverri, 2007 pers comm) or may be explained by other not yet recognised factors.

7.3.2. Tagging

This season 80 green turtles were newly tagged, a decrease compared to 106 from last season. The previously tagged turtles were mainly tagged by CCC, Tortuguero, indicating the sharing of green nesting population between Playa Norte and Playa Tortuguero. This also showed the importance of joint effort of turtle conservation projects along the Caribbean coast.

The three returned turtles tagged in Playa Norte 2006 hinted the nesting/remigration pattern of our green nesting population could be of a two-year interval, however more years of data are needed in order to accurately estimate the nesting interval. Following the trend from the leatherback season, there was continued evidence of old tag holes and told tag notches.

The registered re-nesting intervals, between 10 and 64 days. Given that the most common estimates for re-nesting interval are from 11 to 28 days (Lutz *et al.,* 1996) it is likely that the

turtles either returned to nest in another beach or they were simply not found while nesting on Playa Norte.

7.3.3. Biometrics

The mean CCLmin and CCWmax measured this season were 104.2cm and 96.6cm respectively. Both measurements were similar to those obtained from Green Season 2007.

Results from re-measuring the same individuals showed that there was a higher accuracy in measuring CCLmin than CCWmax probably due to the subjectivity in finding the widest part of the turtle while she is disguising. Improvement in training and field assistance are believed to help minimizing discrepancies. Nonetheless, measurements are believed to be of a replicable standard compared to other turtle projects.

7.3.4. External condition of nesting females

The most common abnormalities detected in green turtles were barnacles. Fibropapilloma tumors were detected in 2.3% of the total nesting individuals (n=2), which was higher in percentage than Playa Tortuguero Green Season 2007. 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

Hatchling orientation was done to examine the relationship between the extra distance travelled by hatchlings and external light sources or potential human disturbance. Results showed that angles of hatchling tracks varied a lot on Playa Norte. Nonetheless, nests with hatchlings having to travel the largest extra distance to the sea were situated at Mile Marker 1, which was a part of the beach that was persistently lit by the bright lights of a house.

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 or 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

Triangulation accuracy of 86% showed an improvement of triangulation skill compared to 76% of Season 2007; despite some nests were not located because of the loss of flagging tapes mainly due to the clearing of vegetation.

This season the overall poaching rate of triangulated nests, including poaching and partial poaching rate, was 41%. It was very similar to the overall poaching rate in Season 2007 (40.4%) but lower than Season 2006 (64.2%). This may indicate a plateau in the reduction of poaching through direct action. It is suggested that further meaningful and long-term reductions to the poaching rates requires continuous conservation education in the local community.

However, it should be noted that the total number of nests in 2007 was nearly double that of 2008, meaning the actual number of nests poached this season was in fact a lot lower. Another point of note is that the majority of poaching activity registered this season, unlike past seasons, were “partial–poaching” or incomplete harvesting of nests. This may indicate a better understanding of the implications of poaching or of the work and presence of patrol teams on the beach causing poaching activity to be rushed. It will be interesting to continue to monitor this phenomenon in coming seasons. The high hatching success rate of partially-poached nests has given interesting research opportunity for investigating the relationship between clutch size and hatching success.

Eroded nests were all found towards the end of season due to high tide lines and levels of beach erosion due to torrential rain in the area.

Regarding disturbed nests, only a quarter of nest disturbance were recorded on morning census in the first two days after laying, potentially indicating an increased time between laying and poaching of nests, or that more effort is being put into the disguising of poaching activity.

The recorded predation rate was 3.4% this season. It is important to note that predated nests refer to nests that were dug up by natural predators, however due to the limitations of our methodology, we could not distinguish whether the nest was predated before or after it has hatched. Therefore, the percentage here included both possibilities.

The overall hatching success rate of triangulated nests was 76.2%, which was an encouraging result compared to the 41.98% from Green Season 2007. The close number of hatching success and emerging success rates indicated most hatchlings could successfully get out of the nest chamber after hatching.

Majority of unhatched eggs terminated development during the early stages which could be indicative of a range of unfavourable conditions during early development which may merit further investigation.

7.5.2. Summary of all non-triangulated hatched nest excavations

Overall hatching success rate of non-triangulated hatched nests was similar to last season. Majority of unhatched eggs were found without embryo; however, the high number of pipped eggs may indicate unfavourable events or conditions in nests at the time of hatching.

7.6. Dead turtles

The minimum estimate of poached turtles this season was six, five were encountered by patrol team; one reported by a local. They were mostly found in either vegetation or near trail, showing where poaching normally happens and how trail provides an easy way for poachers to gain access to and from the nesting beach.

It was encouraging that one turtle was found alive on morning census, after being recorded as lifted the night before. This showed the importance of thorough investigations of track records during morning census to increase the accuracy of data and potentially the survival of adult turtles.

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.

7.8. Human impact data

Mobile white lights were generally higher in number than red lights in every month and they were more frequently seen during patrols. Both red and white lights reached their peak number

in August, which could be explained by the highest number of people present on the beach due to high turtle nesting activities in that month.

In comparison to 2007, the monthly total amount of red and white lights on the beach was of a similar pattern, although there were more red lights in the 2007 Season. This may have been a reflection on the fact that at least one of the local lodges began taking groups of tourists to the spotting scheme in Tortuguero during green season this year.

The number of tourists was mostly higher than locals in every month and the number of tourists reached a sharp peak in August while number of locals reached its peak in July. The higher tourist presence can easily explained by the higher number of tourist groups organized by Vista al Mar Lodge and Turtle Beach Lodge during the busy turtle and summer holiday season.

Compared to Season 2007, the overall number of tourist was lower this season, explaining why the number of red lights was lower this season as well, because tourist groups tend to follow the night walk guide provided by lodges that only red lights were allowed on the beach.

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

Throughout the season the project tried to be as active as possible and this provided a valuable window for communication between the community and the Biological Station. These consisted of regular environmentally themed community fun day events, together with environmental education classes and English language classes as often as possible and the setting up of community garden at the local school.

Leaflets (see Appendix) and talks were also given locally with information about the turtles nesting along Playa Norte, the threats they face and ways of aiding in their conservation.

Through regular communications with the community and locals living along the beach there were a number of denounces of illegal harvesting and other behaviours that were reported to the project and subsequently to MINAET officials.

8. References

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Appendix – 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

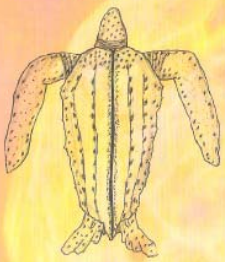
GVI (Global Vision International)
http://www.gvi.co.uk

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

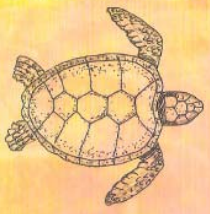


- Critically Endangered
- Nests between March and July
- Eats mainly jellyfish
- Main threats are sea pollution and drowning in drift nets.

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

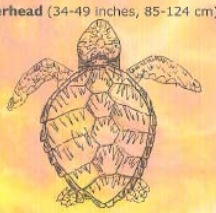
- Critically Endangered
- Nests between April and November
- Eats mainly sponges
- Main threat is poaching for its shell

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.