Marine Turtle Monitoring Program
Leatherback (*Dermochelys coriacea*)
2014 Season Report

Caño Palma Biological Station
Canadian Organisation for Tropical Education and Rainforest Conservation
Playa Norte, Costa Rica
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Sam Campbell, Kristin Covert, Jamie Golba, Naomi Lambrikx, Kelly Lui, Luuk Luttikhold, Amanda O’Campo and Jessica Sutton.
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List of Acronyms

Acc: Accuracy (GPS).
B: Border (Vertical beach zone).
CCLmin: Curved Carapace Length (minimum).
CCWmax: Curved Carapace Width (maximum).
CC: Caretta caretta.
CM: Chelonia mydas.
CP: Caño Palma.
DC: Dermochelys coriacea.
DEC: Deceased turtle.
EI: Eretmochelys imbricata.
ENC T: Encounter time.
ERO: Eroded nest.
FLO: Flooded nest.
GPS: Global Positioning System.
HAT: Hatchlings or hatchling tracks.
HLF: Halfmoon: False emergence/attemtp, when turtle exits the sea but does not lay eggs.
HTL: High tide line.
LIF: Lifted track (Poached turtle).
NAT: Natural nest.
NST: Nest.
O: Open (Vertical beach zone).
OTH: Old Tag Hole.
OTN: Old Tag Notch.
PRE: Predated nest.
POA: Poached nest.
REC: New Record - turtle has no previous tags.
REM: Re-emerging - turtle has previous tag(s).
REN: Re-nesting - turtle has nested at least once before on Playa Norte within the current season.
TRI: Triangulated nest.
UNK: Unknown (status of nest).
V: Vegetation (Vertical beach zone).
WET: Wet nest (Below the high tide line).
Summary

The official dates of the Leatherback season are 1\textsuperscript{st} March – 31\textsuperscript{st} May. Night patrols for all species took place following the first nest encounter, by Morning Census on 26\textsuperscript{th} February, until the end of Green season on 31\textsuperscript{st} October. This report focuses only on Leatherbacks and includes any nesting events that occurred after the official end of the season. Morning Census continued beyond the end of Green season and all Leatherback nests were checked until the end of their incubation period.

Survey effort

- Night Patrol commenced on 26\textsuperscript{th} February following the discovery of the first nest during Morning Census and was carried out every night until 31\textsuperscript{st} May 2014.
- Total hours spent on Night Patrols: 943.45h (mean per night: 9.56h).
- Morning Patrol was carried out daily from 26\textsuperscript{th} February until 1\textsuperscript{st} June.
- Total hours spent on Morning Patrol: 199.47h (daily mean: 2.04h).

Nesting activity

- The first nest was recorded on 26\textsuperscript{th} February and the last on 27\textsuperscript{th} June (5 leatherbacks nested after 31\textsuperscript{st} May).
- A total of 29 nests were recorded between 26\textsuperscript{th} February and 27\textsuperscript{th} June.
- A total of 15 halfmoons recorded between 31\textsuperscript{st} March and 26\textsuperscript{th} May.
- Of the nesting Leatherbacks 72.41\% (21 out of 29) were encountered by our teams:
  - 21 nests.
  - 4 halfmoons.
  - 3 RECs.
  - 15 REMs (including 4 halfmoons).
  - 7 RENs (consisting of 6 distinct individuals).
- Teams encountered eight of the 29 nests with the turtle absent.
- The maximum number of nesting events for RENs was three.
- Of the 29 nests 48.27\% were triangulated.
- No adult Leatherback turtles were poached.

Nest success

Of the 14 triangulated nests:
  - 4 remained natural for the duration of the incubation period.
  - 1 was lost due to erosion.
  - 5 were lost due to predation by dogs.
  - 4 failed due to being located below the high tide line.
  - 0 were lost to poaching.

- Mean incubation period: 61 days (n=2).
- Mean hatching success: 28.73\% (n=14).
- Mean emerging success: 28.62\% (n=14).
- Mean number of yolked eggs: 81.66 ± 18.09 (Mean ± SD; Range: 45 – 105).
- Mean number of yolkless eggs: 29 ± 9.99 (Mean ± SD; Range: 7 – 43).
Biometrics
- Mean minimum Curved Carapace Length (CCLmin): 154.94 ± 5.16cm (Mean ± SD; Range: 148.3cm – 168.16cm) (n=14).
- Mean maximum Curved Carapace Width (CCWmax): 111.29 ± 5.29cm (Mean ± SD; Range: 102.33cm – 112.91cm) (n=14).

Non-Leatherback nesting events

Green:
- Four Green turtles nested; our teams encountered the turtle during three of these events.
- There were nine halfmoons; our teams encountered the turtle twice during these events.
- An additional nest was recorded on Long Morning Census.

Hawksbill
- Ten Hawksbill turtles nested; our teams encountered the turtle during five of these events.
- There were eight halfmoons; our teams encountered the turtle once.
- An additional three nests were recorded on Long Morning Census.
**Introduction**

This report focuses exclusively on the Leatherback turtle (*Dermochelys coriacea*), for detailed information on the nesting activity of Green, Hawksbill and Loggerhead turtles please refer to the Green Turtle Season Report 2014.

The Caño Palma Biological Research station was founded in 1990 and The Canadian Organization for Tropical Education and Rainforest Conservation (COTERC) was established shortly afterwards in 1991. Caño Palma invites volunteers, interns and researches to study different taxonomic groups. This report focuses on the results from the 2014 Marine Turtle Monitoring & Tagging Program.

Four species of marine turtle nest on the Caribbean coast of Costa Rica, Leatherback (*Dermochelys coriacea*), Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*) and in significantly lower numbers Loggerhead (*Caretta caretta*) (Ernst & Barbour, 1989). These species have all been documented on our study site Playa Norte.

The Marine Turtle Monitoring & Tagging Program at the Caño Palma Biological Station has been in operation since 2006. By conducting daily morning and night patrols the following aims are fulfilled:

1. Conduct research and collect data on nesting sea turtles on Playa Norte.
2. Assess the health status of nesting females.
3. Educate the public (local community and tourists) about sea turtle biology and conservation.
4. Deter poaching by maintaining a presence on the beach.

Data are collected following standardised protocols. In order to improve data collection and the impact of the project on nesting turtle populations on Playa Norte, the project’s focus on local community involvement and deterring poaching are constantly developing.

This report provides detailed information on the standardised methods used and the results obtained from data collection in the 2014 Leatherback nesting season. Protocols were utilised for their comparability to past year’s data and data of other projects. This enables a greater understanding though the identification of trends and places the data collected at Playa Norte in a wider context. The report includes several improvements to the project that have been developed and implemented in 2014 that is hoped will continue in the future.

**Leatherback (*Dermochelys coriacea*)**

Belonging to an ancient lineage estimated to be over 100 million years old the Leatherback turtle is the only remaining species belonging to the family Dermochelyidae (Spotila, 2004; Safina, 2007). Despite being the largest species of extant marine turtle, the Leatherback feeds almost exclusively on gelatinous plankton; jellyfish. In order to meet its energy requirements it migrates from tropical breeding grounds to high latitude feeding areas (Heaslip et al., 2012). Its
distribution therefore spans the globe and its great size and suspected heat generation ability, allow it to inhabit open and coastal areas from sub-polar to tropical waters (Eckert & Abreu Grobois, 2001; Spotila, 2004; Wallace et al., 2005). See Table 1 for characteristics of this species.

<table>
<thead>
<tr>
<th>Table 1: Species characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific name: <em>Dermochelys coriacea</em></td>
</tr>
<tr>
<td>Average length (CCL)</td>
</tr>
<tr>
<td>Nesting frequency</td>
</tr>
<tr>
<td>Nesting interval</td>
</tr>
<tr>
<td>Remigration</td>
</tr>
<tr>
<td>Average clutch size</td>
</tr>
<tr>
<td>Size of tracks</td>
</tr>
<tr>
<td>Track shape</td>
</tr>
<tr>
<td>Depth and width of nest</td>
</tr>
<tr>
<td>Nesting period on the Caribbean Coast</td>
</tr>
<tr>
<td>Nesting period on the Pacific Coast</td>
</tr>
<tr>
<td>Pivotal temperature</td>
</tr>
<tr>
<td>General characteristics</td>
</tr>
<tr>
<td>Incubation period</td>
</tr>
</tbody>
</table>

(Adapted from Chacón et al., 2007)

**Anthropogenic threats**

Aside from natural threats such as predation, tidal inundation of nests and a naturally low hatching success rate (19.8 – 54.2%) (Bell et al., 2003), Leatherbacks, like all species of marine turtle, are under threat from man in both the marine and terrestrial environment. Undertaking such large migrations increases the risk of encountering anthropogenic hazards at sea. Pelagic
long-line fisheries, entanglement in fishing gear, marine debris and propeller strikes are common causes of Leatherback mortality (Troëng, 1998; James et al., 2005). Ingestion of plastic bags, mistaken for jellyfish, is one of the leading causes of fatality in Leatherback turtles (Bugoni et al., 2001; Mrosovsky et al., 2009; Vélez-Rubio et al., 2013).

In the past nesting females were vulnerable to poaching for their meat and oil, however in many areas this is now in decline thanks to conservation efforts and tagging programmes (Eckert & Abreu Grobois, 2001; Safina, 2007). Illegal egg harvesting remains a problem and poaching rates nearing 100% have been reported outside of protected areas in Costa Rica (Eckert & Abreu Grobois, 2001). All species of marine turtle suffer from domestic dog predation of nests, including within protected areas (Choi & Eckert, 2009). Hatchlings that successfully emerge are vulnerable to disorientation caused by artificial light pollution, entanglement in marine debris and predation (Witherington & Martin, 2003; Bourgeois et al., 2009; Triessnig et al., 2012; Berry et al., 2013). While data are limited, only a 1:1000 egg to adulthood ratio is estimated (Frazer, 1986).

**Current status and conservation efforts**

Due to the rapid decline in Leatherback numbers the species has been afforded international protection. The species is listed under several international conventions including Appendix I of the Convention on International Trade in Endangered Species (CITES). This prevents all international trade in the species or its derivatives. It is also listed under Appendix I and II of the Convention on Migratory Species of Wild Animals (CMS) and the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) (Wallace et al., 2013).

Undertaking accurate population assessments of a migratory marine species that comprises seven distinct sub-populations is extremely challenging. Since 1986 it has been listed as Endangered (IUCN Monitoring Conservation Centre, 1986) then Critically Endangered (Sarti Martinez, 2000) and most recently downgraded to Vulnerable (Wallace et al., 2013) on the IUCN Red List of Threatened Species. While this may appear to be the right direction it should be understood that the assessment is for the species as a whole and certain subpopulations – the Pacific population in particular - are still considered to be Critically Endangered (Tiwari et al., 2013; Wallace et al., 2013a). Although the Atlantic population is listed as Vulnerable and in decline (Troëng et al., 2004; Wallace et al., 2013), the Northwest Atlantic Ocean subpopulation, the subject of this report, is listed as Least Concern and the population is considered be increasing (Tiwari et al., 2013a).

Ex-situ conservation efforts for marine turtles include relocating nests to hatcheries, head-starting programmes and conservation medicine & rehabilitation and are beyond the scope of this report (see: Chacón et al., 2007; Phelan & Eckert, 2006). Protecting marine turtles at sea has taken the form of introducing Turtle Excluder Devices (TEDs) to fishing nest which act as a trap-door enabling turtles caught in gill nests to escape (Safina, 2007). In-situ protection includes patrolling beaches to prevent poaching, the relocation of nests laid too close to the tide line and therefore guaranteed to fail due to inundation and undertaking tagging and monitoring programmes to assess the population density of the species. These methods have been
attributed to the increase of the nesting population in the Caribbean and are methods employed by conservation projects in Costa Rica (Dutton et al., 2005; Gordon & Harrison, 2011).

The COTERC Marine Turtle Tagging and Monitoring Programme is one of these projects and works on Playa Norte (See Study site). According to Costa Rican law N° 8586 (conservation of migratory species and wild animals) articles 1° and 3° (including endangered marine species and habitats part of the distribution of migratory species), public access to Playa Norte beach is prohibited between 18.00 and 05.00 during the sea turtle nesting season. This legally corresponds to the period from 1st March until 31st October. In addition the marine turtle monitoring and tagging programme focuses on in-situ conservation, through the protection of nests, beach cleans to remove marine debris, working to reduce artificial lights on the beach and environmental education.
Methods

Study site

Data collection was carried out along a 3\,1/8 mile (approx. 5Km) beach transect on Playa Norte (Fig. 1), stretching from the Tortuguero river mouth Laguna Tortuguero (Datum WGS84 552224.9E 1170322N) to Laguna Cuatro (Datum WGS84 550043.7E 1175989N). Playa Norte is part of the Barra del Colorado Wildlife Refuge and the south borders the Tortuguero National Park. The area is managed by the Tortuguero Conservation Area (ACTo) and is regulated by Ministerio de Ambiente y Energía (MINAE) - the Costa Rican Ministry of Environment and Energy.

![Figure 1: Research transect (adapted from Grant & Lewis, 2010).](image)

Permanent mile markers at every 1/8 of a mile facilitate orientation along the transect and allow for spatial distribution analyses. Mile markers were re-painted and replaced as required in March and maintained when necessary throughout the season. G.P.S coordinates were taken at each mile marker and saved as fixed points in the G.P.S. map function (Garmin GPSMAP 62S) for future spatial analysis.

A semi-illuminated path runs parallel to the beach. There are two hotels (Hotel Vista al Mar and Turtle Beach Lodge) and several private residencies along the transect. The public lights on the path and the private lights from hotels/houses can cause artificial light pollution in the vegetation along the beach and sometimes directly on the beach itself, which poses a threat to the orientation of nesting turtles and emerging hatchlings (Witherington & Martin, 2003; Bourgeois et al., 2009; Berry et al., 2013).
Beaches and wetlands in Costa Rica are legally protected under Resolución ACTo-Dirección-04-2013. The use of motorised vehicles is prohibited in the area anywhere within 200 meters inland of the high tide line, which includes the public path. Nonetheless vehicles including motorbikes, four-wheel quads and occasional trucks are observed.

For analysis purposes the beach is divided vertically into three sections, open, border and vegetation; defined by the amount of shade they receive (Fig. 2).

**Figure 2: Vertical beach zones** -> >50% exposure to direct sun light (Open), <50% exposure to direct sun light (Border), 0% exposure to direct sun light (Vegetation).

**Data collection**

**Night Patrol protocol**

Night Patrol was carried out nightly from 26th February – 31st May. Each Night Patrol team covered the beach in 4h-6h shifts. For safety reasons teams consisted of a minimum of three people. Teams were scheduled in overlapping shifts in an effort to maximise presence on the beach whilst covering as many hours and as much distance as possible (Fig. 3). Start times and patrol strategies were changed on a regular basis to avoid predictability of our coverage by poachers and also to adapt to nesting activity patterns. Figure 4 gives an example of patrol coverage strategies used.

<table>
<thead>
<tr>
<th>Time</th>
<th>20.00</th>
<th>21.00</th>
<th>22.00</th>
<th>23.00</th>
<th>00.00</th>
<th>01.00</th>
<th>02.00</th>
<th>03.00</th>
<th>04.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM1</td>
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<td>PM2</td>
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<tr>
<td>PM3</td>
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</tbody>
</table>

**Figure 3: Example of Night Patrol shifts with three teams**
In order to ensure the safety of our teams, minimize the impact on turtles and be as discrete as possible in the beach, Night Patrols have the following rules:

- Dark clothing must be worn.
- No alcohol before or during Night Patrol.
- No smoking during Night Patrol.
- Limit light usage and only use red light.
- Do not apply insect repellent before or during patrol.
- Stay behind or next to patrol leader (PL) at all times.
- If you see poachers tell the PL, never approach poachers.
- Walk on or below the most recent high tide line when possible.
- Keep quiet when walking the beach and when encountering a turtle.
- Never walk in front of the turtle or shine light near its head.
- Patrol is cancelled or delayed if there is a lack of appropriate personnel or during extreme lightning storms when there is a risk of injury.

Night Patrols collected data on:

1. **Tracks and nests (when the turtle is absent):** For each encounter the species and location data (northern mile marker, vertical beach zone, G.P.S. co-ordinates and G.P.S. accuracy -hereafter referred to as Location Data) were recorded. The vertical beach zone and the G.P.S. coordinates of halfmoons were taken at the furthest point from the tide line, where the turtle turned around. The encounter was recorded either as NST (nest) or (HLF) halfmoon.

2. **Nesting sea turtles:** For all turtles encountered, the species, encounter time, encounter activity (nesting stage/halfmoon) and location data were recorded. If encountered before...
oviposition it was possible to count the eggs. Providing eggs were visible the nest was triangulated. For all nesting turtles encountered the flipper tags were checked and tagged if necessary, morphological measurements were taken and an external health-check conducted. Where possible tag and morphological data were taken on turtles that were going back to sea, either post-nesting or as a halfmoon. A turtle facing the sea and located halfway between the sea and the vegetation zone was assumed to be returning to the sea. Turtles may have been stopped by the Patrol Leader to read tags in these circumstances. An overview of the different nesting stages and appropriate action to be taken by the team is provided in Table 2.

Table 2: Stages of marine turtle nesting activity and corresponding actions taken by patrol teams

<table>
<thead>
<tr>
<th>Nesting stage</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Emerging.</td>
<td>Wait.</td>
</tr>
<tr>
<td>2) Selecting nest site.</td>
<td>Wait - Patrol Leader checks on progress.</td>
</tr>
<tr>
<td>3) Cleaning.</td>
<td>Wait - Patrol Leader checks on progress.</td>
</tr>
<tr>
<td>4) Digging egg chamber.</td>
<td>Wait - Patrol Leader checks on progress.</td>
</tr>
<tr>
<td>6) Covering egg chamber.</td>
<td>Tag data, Minimum Curved Carapace Length (CCLmin) &amp; Maximum Curved Carapace Width (CCWmax), Body Check.</td>
</tr>
<tr>
<td>7) Disguising the nest.</td>
<td>Tag data, Minimum Curved Carapace Length (CCLmin) &amp; Maximum Curved Carapace Width (CCWmax), Body Check.</td>
</tr>
<tr>
<td>8)Returning to sea.</td>
<td>Tag data, Minimum Curved Carapace Length (CCLmin) &amp; Maximum Curved Carapace Width (CCWmax), Body Check (if possible).</td>
</tr>
</tbody>
</table>

A. Egg counting & nest triangulation

Eggs were counted during oviposition by placing a hand below the cloaca and counting each egg as it passed over the hand into the egg chamber. While the turtle was digging the egg chamber, the Patrol Leader created a shallow channel to the mouth of the chamber. This channel allowed the egg counter to position one hand underneath the cloaca while reducing the risk of touching it. A medical latex glove was worn when counting eggs. The Nest ID (a piece of flagging tape containing the nest identification number; Fig. 5) was dropped into the nest at the beginning of oviposition and egg counting and triangulation of the nest began at this point. The yolked eggs were counted using the counter and the number of yolkless eggs was remembered. At the end of oviposition, when the turtle began covering the egg chamber with her rear flippers, the distance from the uppermost egg to the top of the egg chamber (egg depth) was measured (cm) with a flexible 3m measuring tape.

Egg counting coincided with triangulation of the nest. The 0m end of the 50m tape measure was held directly over the egg chamber taking care to avoid contact with the turtle. The triangulation team tied the appropriately labelled (centre, north and south) flagging tape on three sturdy pieces of vegetation with at least 45 degree angles from one another (Fig. 5).
Figure 5: Triangulation (flagging) tapes and Nest ID - Flagging Tapes (top) & Nest ID (bottom).

Triangulation always started with centre and then moved to north and south, measuring the distances to the nest from the knot on the flagging tape (Fig. 6). The distance from the egg chamber to the most recent high tide line was then recorded. The knot was always tied facing the direction of the nest and the person(s) not measuring made sure that the tape was tight and not caught on anything between the turtle and triangulation point.

Figure 6: Nest triangulation

B. Tag information

Tagging enables the identification of individual turtles which in turn allows us to build up an historical record of that individual. This includes morphometric data, nesting events, health status etc. Leatherbacks are tagged in the membrane between the tail and the rear flipper (Fig. 7a). On completion of oviposition the Patrol Leader checked the rear flippers for existing tags and/or evidence of previous tags. The right rear flipper was always checked and recorded before the left. If tags were present, the numbers were recorded (numbers repeated twice by the person checking the tag and the data recorder). Old tag evidence was recorded as either an
Old Tag Hole (OTH) (Fig. 7b) or Old Tag Notch (OTN) (Fig. 7c). Illegible tags, tags causing damage (e.g. ingrown) or tags that were likely cause damage or fall out in the near future (e.g. tag placed too far in or out with a risk of becoming ingrown or snagging on something) were removed and replaced. If no tags were present, the Patrol Leader implanted new ones.

A correctly placed tag is positioned so that one third (or two numbers) of the tag is outside of the flipper and two thirds (or four numbers) are inside the flipper. The lower tag number is always placed on the right flipper and the higher on the left. Removing tags only takes place after the tag data from the other flipper are recorded. Two tags are never placed in one flipper; an old tag would always be removed before a new tag is placed in the same flipper. This prevents a turtle returning to sea with no tags, which would mean the loss of data for that individual.

![Figure 7: Leatherback tag position (a), Old Tag Hole (OTH) (b) and Old Tag Notch (OTN) (c).](image)

**C. Biometric measurements**

Once the turtle had been tagged or existing tag data recorded, the length and width of the carapace was measured with a 3m flexible measuring tape. The Curved Carapace Width maximum (CCWmax) and Curved Carapace Length minimum (CCLmin) were measured (Fig. 8a & 8b). The CCLmin starts at the point where the skin meets the carapace at the neck and ends at the tip of the caudal projection (Fig. 8c). The CCLmin is always taken on the right side of the central ridge and, for standardisation of data collection, always to the end of the caudal projection regardless of whether an injury/abnormality results in the projection being longer on the left. The CCWmax is taken at the widest point of the carapace and where the carapace meets the plastron.

For quality control purposes each measurement was taken at least three times, more if the measurements varied by more than 1cm. Anything that affected the measurements (e.g. barnacles) was recorded in the body check.
**Figure 8: Leatherback biometrics** - Maximum Curved Carapace Width (CCWmax) (a), Minimum Curved Carapace Length (CCLmin) (b) and Leatherback Dorsal Ridges and Caudal Projection (c).

**D. Body check**

A body check to establish a general health assessment was performed after the measurements were recorded. Old and new injuries (scars, holes, notches, missing parts of flippers, bite marks), barnacles, tumors, parasites and any other abnormalities were recorded. Evidence of previous tags was not recorded during the body check, as this was recorded when checking for tags.

The body check was carried out following a standardised protocol in which each predefined body zone is given a number from one to eight (Fig. 9). A diagram of the zones was available in the front page of every field book. The assessor started with zone two (right front flipper) and moved around the body in a clockwise direction. Since zone one (the neck and head) is the most sensitive part of the turtle and checking it bears the greatest risk of disturbing the turtle, it was done last and with great care. The light was shielded with one hand and moved slowly from the top of the carapace over to the neck and head while always avoiding light anywhere near the turtle’s eyes.
Barnacles can bias measurements and are an indication of ill health therefore were recorded when encountered: **Size** (small, medium and large with examples traced in the data field books for reference), **distribution pattern** (clustered or scattered) and **abundance** (1-5 = few, 6-15 = moderate, 16+ = many) were all noted. An assessment of the caudal projection (zone 5) was recorded as this may affect the CCLmin measurements, damage to the caudal projection might also indicate partial injuries sustained by the turtle. It was recorded as either complete (COM) or incomplete (INCOM).

During the body check the light was orientated away from the turtle’s head and turned off at any break in the assessment in order to minimise potential disturbance. All abnormalities were recorded per zone, with any estimated measurements and name of the surveyor noted. A circle was drawn around the zone number in order to prevent later confusion between zone numbers and measurements. If no abnormalities were found **BODY CHECK: ALL GOOD** was recorded to confirm the body check has been completed.

### E. After working the turtle

Once the data collection was completed and checked by a second person, the team waited until the turtle returned to the sea and recorded the GPS point of the nest. The Leatherback tracks were disguised by the patrol team to prevent the next team wasting time checking them when they passed the tracks on the same night. It was unnecessary to disguise Leatherback nests as historically eggs of this species are rarely poached at Playa Norte. To that end, halfmoon tracks were marked with two lines during Night Patrols to signal to other teams that the tracks had already been encountered and data recorded.
Human Impact Survey

Public access is prohibited between 18.00 and 05.00 from 1st March to 31st October. However, due to the low level of law enforcement on Playa Norte, illegal human activity is frequently observed. In collaboration with MINAE, a standardised Human Impact Survey was carried out as part of the nightly patrols throughout the season. Human Impact was divided into five categories: White light (W), Red light (R), Fire (F), Local (L) and Tourist (T). Temporal and spatial distribution was also recorded for each impact category. The results were reported to MINAE on a weekly basis.

Light Survey

In addition to the Human Impact Survey a monthly Light Survey was conducted on the night of the new moon. The survey always began at 20.00h and recorded the permanent artificial lights that were switch on along the transect at the time of the survey. Lights were only recoded if it was possible to see the bulb and were counted when the surveyors walked past to prevent double counting. Team members individually noted the number of bulbs they observed in each mile marker and the average of these counts were taken and rounded to the nearest whole number. Distinctions were made between white and yellow lights and it was also recoded if they were public lights or private.

Morning Census and Long Morning Census protocol

Morning Census was carried out daily from 26th February – 1st June 2014. Patrols began at 05:30h and the transect was surveyed from 0 – 3 1/8 six days a week. Once a week Long Morning Census surveyed from 0 –4 1/8. The aim of the Long Morning Census was to gain a better understanding of the nesting activity on Playa Norte beyond the regular transect. Data were collected on:

1. Nest and track information: Morning Census recorded any additional tracks and nests on the beach that had not been encountered by the previous night’s patrol teams (Table 3). To prevent double counting, a copy of the activity data from the previous night was recorded in the Morning Census book for reference during the survey.

<table>
<thead>
<tr>
<th>NAME: HP, LF</th>
<th>DATE: 1/5/14</th>
<th>HOUR: 05.30-07.15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Species</td>
<td>Location Data</td>
</tr>
<tr>
<td>REM DC</td>
<td>O</td>
<td>2 6/8</td>
</tr>
<tr>
<td>NST CM</td>
<td>B</td>
<td>1 7/8</td>
</tr>
<tr>
<td>HLF DC</td>
<td>O</td>
<td>1 2/8</td>
</tr>
</tbody>
</table>

2. Nest check of all triangulated nests: all triangulated nests were checked daily from the day after they were laid to the day of their excavation. The accuracy of the triangulation was checked by the Morning Census team the morning immediately after the nest was
triangulated. In the event that the lines of the triangle were over 50cm or the lines did not make a triangle, the night patrol team returned to the nest to correct the triangulation. The status of the nest itself was assessed and any signs of abnormality recorded. Condition classifications were as follows:

- **Natural (NAT):** nest is in a natural state with no disturbance.
- **Wet (WET):** nest is below most recent high tide line.
- **Flooded (FLO):** nest is filled with water from the tide.
- **Poached (POA).**
- **Predated (PRE).**
- **Unknown (UNK):** signs of poaching and/or predation, but status undetermined.
- **Eroded (ERO).**
- **Hatching evidence (HAT):** hatchling(s) or hatchling tracks from nest are present.
- **Depression (DEP):** there is a depression on the surface of the nest*
- **No Depression (No DEP):** there is no depression on the surface of the nest*

*Only recorded after the depression sticks have been erected (see below).

Leatherback incubation periods range from 50-70 days (Chacón *et al.*, 2007). On Playa Norte the 2013 mean was 63 days (±3.4) (Christen & García, 2013). On day 60 the nests were re-triangulated and depression sticks erected to ease the checking for signs of hatching (depressions or hatching tracks) (Fig. 10). These sticks facilitate the assessment of signs of hatching. Indications of hatching include a physical depression in the sand around the nest area caused by hatchlings digging their way to the surface inside the nest, very soft sand in the top 10cm of the nest area or a small cave-like hole where hatchlings have emerged. Hatching tracks leading away from the nest may also be present. Possible depressions are confirmed with the help of a pencil that is gently pushed into the depression area. If the sand underneath gives way very easily it is considered a depression. The careful distinction between a depression or cave and hole dug by a crab is important. Crab holes run diagonally into the sand and have very smooth and even walls; depressions usually run more vertically into the sand, are wider and with walls that are not as well defined.

*Figure 10: Depression sticks.*
Assessments of the nest status each day allowed for detailed conclusions of the nests’ fate, as well as temporal analyses of any disturbance. Daily assessments of the intactness of triangulation flagging tapes were essential in order to avoid data loss, as termites, ants or people regularly destroyed tapes.

3. **Nest excavations**: when the incubation period was complete (see excavation protocol), nests were excavated by the Morning Census team or addition teams during busy periods.

**Excavation protocol**

Nest excavations are conducted to determine the nest success of triangulated nests. Nest success is divided into hatching and emerging success. Hatching success is the total number of hatchlings that exited the egg. The total number of hatchlings that emerged from the nest is referred to as the emerging success. Therefore a nest can have a 100% hatching success, but 0% emerging success (e.g. 100% post-hatching mortality inside the nest). A number of abiotic and biotic variables can cause partial or complete nest failure including temperature, moisture, root invasion, flooding, erosion, predation and poaching (Kamel & Mrosovsky, 2004).

Nests were checked daily and were excavated under the following circumstances:

1. If hatchling tracks present – excavate two days later.
2. If five consecutive days of depression – excavate on the following (sixth) day.
3. If no signs of hatching were present by 75 days – excavate on 75th day.

The first stage of excavations was to locate the egg chamber by re-triangulating the nest. Sand was then carefully removed using a cupped hand until the first signs of the nest appeared (e.g. eggs, empty eggshells or hatchlings). The egg depth was taken from the top of the nest using the bottom flat part of a stick lying over the entrance (Fig. 11). The nest contents were removed and sorted into different categories (Table 4 and Fig 12). Finally, nest depth was measured from the bottom of the nest to the surface of the beach again using a horizontal stick over the egg chamber for reference.

**Figure 11: Measurement of the egg depth.**
Table 4: Nest contents

<table>
<thead>
<tr>
<th>Nest content</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipped eggs (PE)</td>
<td>Egg is intact apart from a small triangular hole caused by the hatchling’s egg tooth. The hatchling is dead and the head is near the hole.</td>
</tr>
<tr>
<td>Hatched eggs</td>
<td></td>
</tr>
<tr>
<td>Empty egg shells &gt;50%</td>
<td>Only shells &gt;50% of the whole egg were counted. Pieces of shell &lt;50% cannot be counted as it cannot be determined from how many different eggs they originated.</td>
</tr>
<tr>
<td>(EES)</td>
<td></td>
</tr>
<tr>
<td>Dead-in-nest Hatchling (DH)</td>
<td>Hatchlings that exited the egg, but died inside the nest.</td>
</tr>
<tr>
<td>Live-in-nest Hatchling (LH)</td>
<td>Hatchlings that exited the egg, but have not emerged from the nest (yet).</td>
</tr>
<tr>
<td>Unhatched eggs</td>
<td>Complete eggs, not pipped or showing evidence of predation by microorganisms or animals.</td>
</tr>
<tr>
<td>Yolkless eggs (Y)</td>
<td>Non-fertilised eggs that range from 1cm diameter to a diameter similar to yolked eggs. Leatherback nests can contain ~10-40 yolkless eggs.</td>
</tr>
<tr>
<td>No Embryo (NE)</td>
<td>Yolk present with no embryo.</td>
</tr>
<tr>
<td>Embryo Stage 1-4 (E1-4)</td>
<td>Eggs that did not develop or died during development.</td>
</tr>
<tr>
<td>Stage 1 (E1)</td>
<td>*embryo occupies ≤ 25% of the egg; can be as small as a spot of blood within the yolk.</td>
</tr>
<tr>
<td>Stage 2 (E2)</td>
<td>*embryo occupies 26-50% of the egg.</td>
</tr>
<tr>
<td>Stage 3 (E3)</td>
<td>*embryo occupies 51-75% of the egg.</td>
</tr>
<tr>
<td>Stage 4 (E4)</td>
<td>*embryo occupies &gt; 75% of the egg (Fig. 13).</td>
</tr>
<tr>
<td>Predated (P)</td>
<td>Predated eggs are categorised as follows:</td>
</tr>
<tr>
<td>Dogs (or other mammals).</td>
<td></td>
</tr>
<tr>
<td>Microorganisms (fungi or bacteria) – established by smell and colour.</td>
<td></td>
</tr>
<tr>
<td>Holes caused by crabs.</td>
<td></td>
</tr>
<tr>
<td>Other/unknown.</td>
<td></td>
</tr>
<tr>
<td>The presence/absence of ants and maggots in the nest was also recorded.</td>
<td></td>
</tr>
<tr>
<td>Deformed Embryos (DE)</td>
<td>Common deformities include abnormal numbers of scutes, no-eyes (eyes overgrown with skin), albino, twins (conjoined), injuries/tumour-like growth on head.</td>
</tr>
</tbody>
</table>
Excavations were stopped and postponed if more than five live hatchlings were present in the nest or if the eggs appeared to still be developing (white and firm). If fewer than five live hatchlings were present in the nest, the condition of the hatchlings was assessed using the plastron and the level of activity indicators. If the plastron was still open and/or the hatchling was lethargic, they were reburied next to the original nest at the same depth at which they were found. If the plastron was closed and they were very active, the hatchlings were allowed to make their way to sea naturally. Assistance was only given to the hatchlings if the air or sand temperature was dangerously hot, at which point they were given shade en route to the sea or moved to an area of wet sand Hatchlings were never put in the sea. If able to make their own way into the water, it can be assumed that the hatchlings are active enough to swim and keep their heads above water. Hatchlings always walk into the surf without assistance and from a reasonable distance, so they can prepare their muscles and lungs for swimming.

Hatching Success and Emerging Success are calculated for each excavated nest using the following formulas:

\[
\text{Hatching Success} = \left(\frac{\text{EES}}{\text{EES} + \text{NE} + \text{E1} + \text{E2} + \text{E3} + \text{E4} + \text{PE} + \text{P}}\right) \times 100
\]

\[
\text{Emerging Success} = \left(\frac{(\text{EES} - (\text{LH} + \text{DH}))}{\text{EES} + \text{NE} + \text{E1} + \text{E2} + \text{E3} + \text{E4} + \text{P}}\right) \times 100
\]
Unmarked nests were not excavated, as laying date, incubation period and original clutch size were unknown. However, if a non-triangulated nest was encountered while hatchlings were emerging, efforts were made to ensure that the hatchlings reached the sea safely and unharmed. The nest was also investigated to deduce if more hatchlings could be saved.
Results

Survey Effort

Night Patrol

The first nest of the season was identified by Morning Census on 26\textsuperscript{th} February and therefore Night Patrols began on this date. Due to the number of personnel available the number of patrols was often limited to two teams per night, however there was a slight increase from May (Fig. 14). Patrols covered the beach from 20.00h – 04.00h with each team patrolling, where possible, for 6 hours, however this was limited to the physical fitness of the team members. The weekly mean hours spent on the beach increased from 8 hours in March to a peak of 17.44h in May. Beach presence was kept at a maximum, according to the number of personnel available (Fig. 15). The total number of hours spent on Night Patrol was 943.45h (mean per night = 9.56h).

![Figure 14: Survey effort - Bars indicate the number of Night Patrol teams per night from 26\textsuperscript{th} February- 31\textsuperscript{st} May averaged for each week of a month (1-4).]
Figure 15: Beach presence - Bars indicate the number of hours the beach was covered every night from 26th February – 31st May, averaged for each week of a month (1-4). Multiple teams allowed patrols to overlap resulting in more hours of covering than the 8 hours between 20.00h and 04.00h.

Morning Census and Long Morning Census

Morning Census was carried out every morning from 26th February until 1st June. Long Morning Census was carried out every Sunday during this time period. The total time spent on Morning Census was 199.47h (mean 2.04h).

Nesting Activity

A total of 29 Leatherback nests were recorded between mile 0 and 3 1/8 on Playa Norte between 25th February and 27th June (Table 5). Teams encountered the turtle during 72.41% (n=21) of the nesting events and it was possible to triangulate 48.27% (n=14) of these nests as the turtle was encountered prior to covering the egg chamber. A total of 15 halfmoons were recorded.

Table 5: Leatherback nesting activity - Total number of nests recorded 1st March – 27th June.

<table>
<thead>
<tr>
<th>Total nests</th>
<th>Nests turtle present</th>
<th>Nests turtle absent</th>
<th>Triangulated nests</th>
<th>Halfmoons</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>21 (72.41%)</td>
<td>8 (27.58%)</td>
<td>14 (48.27%)</td>
<td>15</td>
</tr>
</tbody>
</table>

A total of 26 Leatherbacks were encountered. Three were RECs, 15 REMs (four of which were halfmoons) and seven RENs. On one occasion the turtle was encountered going back to sea having nested, this turtle had an OTH and OTN; however it was not possible to insert new tags.

The seven RENs comprised of six individuals. One individual nested three times, the remaining RENs nested twice on Playa Norte this season. The inter-nesting interval for the individual that
nested three times was 29 and 19 nights respectively. The inter-nesting interval for all RENs ranged from ten to 36 nights.

The first Leatherback nested on 25th February and the last on 27th June. The nesting activity only showed one peak in the third week of April when 5 nests were laid. For the remainder of the season a maximum of three nests per week were laid with 4 weeks experiencing no nesting events (Fig. 16).

Averaged over the season, the hours most likely to encounter a turtle were between 22:00h and 01:00h. All encounters occurred between 20:00h and 03:00h (Fig. 17).
Miles 1 and 1 6/8 received the most nests (n= 4 and 3 respectively). This season the majority of Leatherback nesting events occurred northing of mile 1 5/8 (Fig. 18).

![Graph showing nesting events]

**Figure 18: Encounter locations** - Bars represent the total number of encounters within the section of a given mile marker along the beach transect from 1st March – 27th June.

**Long Morning Census**

Nesting events occurred north of the transect beyond mile 3 1/8 amounting to 20.51% of all nests (n=8). Of these 62.5% (n=5) were in mile 3 2/8 which was the most utilised section of the beach by nesting females (Table 6).

<table>
<thead>
<tr>
<th>Mile</th>
<th>Number of Encounters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>1</td>
</tr>
<tr>
<td>2/8</td>
<td>2</td>
</tr>
<tr>
<td>3/8</td>
<td>3</td>
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<tr>
<td>4/8</td>
<td>4</td>
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<tr>
<td>5/8</td>
<td>5</td>
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<td>6/8</td>
<td>6</td>
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<tr>
<td>7/8</td>
<td>7</td>
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<tr>
<td>1 1/8</td>
<td>8</td>
</tr>
<tr>
<td>1 2/8</td>
<td>9</td>
</tr>
<tr>
<td>1 3/8</td>
<td>10</td>
</tr>
<tr>
<td>1 4/8</td>
<td>11</td>
</tr>
<tr>
<td>1 5/8</td>
<td>12</td>
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<tr>
<td>1 6/8</td>
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<td>1 7/8</td>
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<td>2 3/8</td>
<td>17</td>
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<td>2 4/8</td>
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<td>28</td>
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</tr>
<tr>
<td>7 5/8</td>
<td>54</td>
</tr>
<tr>
<td>7 6/8</td>
<td>55</td>
</tr>
<tr>
<td>7 7/8</td>
<td>56</td>
</tr>
</tbody>
</table>

**Table 6: Nesting activity outside the transect** - Total number of nests and halfmoons encountered between mile marker 3 1/8 and 4 1/8 from 4th March – 14th June

<table>
<thead>
<tr>
<th>Nests</th>
<th>Halfmoons</th>
<th>Mile with the most nests</th>
<th>Month with most nests</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 (2 south of mile 0)</td>
<td>1</td>
<td>3 2/8 (n=5)</td>
<td>May (n=5)</td>
</tr>
</tbody>
</table>

**Nest success**

**Nest fate**

July experienced a combination of heavy rainfall and an extremely high tide. On 26th July Laguna Cuatro flooded leading to the complete loss of one nest where no excavation was possible. An additional 4 nests (28.57%) were recorded as wet during the incubation period and when excavated almost all had completely failed – only two empty shells were recovered from these nests. Of the 14 nests triangulated, 35.71% (n=5) were subjected to some degree of predation by dogs; however it was not always the case that the nest was completely decimated (Table 7).
Table 7: Nest fate of triangulated nests - Number of nests destroyed by dog predation, poaching or abiotic variables (N=10).

<table>
<thead>
<tr>
<th>Fate</th>
<th>Total number</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predation by dogs (partial)</td>
<td>5</td>
<td>35.71</td>
</tr>
<tr>
<td>Poaching</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Erosion</td>
<td>1</td>
<td>7.14</td>
</tr>
<tr>
<td>Wet</td>
<td>4</td>
<td>28.57</td>
</tr>
</tbody>
</table>

Excavations

Four triangulated nests (28.57%) continued to be natural for the duration of the incubation period and the nest ID was found during the excavation. A total of 360 eggs were counted during the excavations of these four nests, of which only 50 (13.88%) were empty suggesting the hatchlings successfully left the nest. Due to this low sample size it was not possible to conduct statistical analysis on the success of these nests.

Human Impact

Human Impact Surveys were conducted every night in order to gain a better understanding of the illegal activity on the beach during turtle nesting season. White lights were the most frequent human impact representing 44.24% of the illegal activity, followed by locals (defined here as Spanish speakers) representing 39.80% (Table 8). Semana Santa fell in the third week of April resulting in an increase in human activity along the transect. Locals and fires (recorded in five minute intervals for the duration they were burning) were the greatest impacts at this time (Fig. 19). The majority of the activity took place between 20.00h and 22.00h (Fig. 20). Fewer observations were made before 20.00h however this is due to observer effort – the teams recording these impacts were on the beach unusually early and is not necessarily a reflection of the human impact in this time period.

Major areas of activity occurred in front of the hotels in miles 2/8 and 2 4/8. The Turtle Beach Lodge (TBL) security guards patrolled the beach area in front of the hotel at 2 4/8 with bright white lights every night (Fig. 20). In total 903 white light observations in front of TBL were recorded representing 31.78% of the total human impact observations; it should be noted that this number includes a small number of people using their telephones in front of the hotel. An additional area of activity was at 6/8 where a local resident hosts tourists and was where many of the fires were recorded.

Table 8: Human Impact observations

<table>
<thead>
<tr>
<th>Total number of observations</th>
<th>White lights</th>
<th>Red lights</th>
<th>Fires</th>
<th>Locals</th>
<th>Tourists</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1257</td>
<td>35</td>
<td>324</td>
<td>1131</td>
<td>94</td>
<td>2841</td>
</tr>
</tbody>
</table>
**Figure 19: Temporal distribution of (illegal) human activity (Date)** - Bars indicate the total number of impacts encountered in each week (1-4) of a given month for (a) Locals and Tourists, (b) White lights, Red lights and Fires. (Week four contains dates 29+).
Figure 20: Temporal distribution of (illegal) human activity (Time) - Bars indicate the total number of impacts encountered from minute 00-59 for each hour for (a) Locals and Tourists, (b) White lights, Red lights and Fires.
A.  

**Figure 21: Spatial distribution of (illegal) human activity** - Bars indicate the total number of impacts encountered from 1st March – 31st May within the section of a given mile marker for (a) Locals and Tourists, (b) White lights, Red lights and Fires.

**Light Survey**

In order to gain a clearer understanding of artificial light use along the transect monthly Light Surveys were undertaken. These surveys will provide data for mitigation strategies to reduce light on the beach that could negatively affect the nesting behaviour of marine turtles. The two hotels, Turtle Beach Lodge and Vista al Mar, consistently had the highest white and yellow bulb count. The public lights at 6/8 and 1 4/8 were also clearly visible from the beach (Fig. 22).
Figure 22: Light Survey - Bars indicate the total number of permanent white and yellow lights located along the transect per month.

Collaboration, outreach and public education

Working with stakeholders and the local community is crucial to the success of the programme and at the beginning of the season we made efforts to meet with as many people as possible that are connected to the project.

At the start of the season we visited the community members that live along our survey transect. Going door-to-door we offered cookies and introduced ourselves. Building this kind of rapport not only assists with creating good relations, it also opens up the potential for us to hear about events on the beach and enables us to call on them should there be an emergency.

Victor Hugo Montero from MINAE visited the station at least once a month to discuss turtle activity and poaching observations. In May Victor and Diego Cordero, also from MINAE, gave a presentation at the station on the different protected areas in Costa Rica with an emphasis on the Tortuguero Conservation Area (ACTo) and the work MINAE undertake here. The presentation was warmly received by everyone at the station.

Two networking and social afternoons took place between Caño Palma and our colleagues at the Sea Turtle Conservancy (STC), Tortuguero. These were valuable opportunities to meet and talk to other people that are doing similar work with turtles. A positive relationship with the STC not only enables a better working relationship for both our organisations and therefore contributes to the conservation of marine turtles, but also allows our volunteers and interns to meet research assistants who are facing similar challenges on the beach at night.

One of the aims of the project is to raise awareness and promote the programme to as wide an audience as possible. This season we achieved this through giving a number of presentations.
At the beginning of the season we gave a presentation to the local community, San Francisco, covering the 2013 seasons nesting activity and results.

A special education session was organised at Hotel Vista al Mar for a group of 38 American high school tourists, teachers and parents. We gave a general presentation about COTERC, the Marine Turtle Monitoring Project and the marine turtle species we work with at Playa Norte, followed by a question and answer session and a demonstration of how to work a turtle on the beach. The group then participated in a beach clean between miles 3/8 and 6/8.

In May we were visited by 25 Natural Science students (18-20 years) and two professors from the Séminaire de Sherbrooke, a CEGEP from Quebec, Canada. The group received a tour of the station before attending a presentation on the turtle project and the biology of the three species we commonly encounter. They were then given the training simulation before helping with a beach clean near mile 0.

Conservation club for the local school in San Francisco was held one afternoon each week for the duration of the season. Aimed at the children of the local community Conservation Club featured presentations, games, videos, recycled material art projects and other turtle related activities.

A colouring/activity book that began as a turtle project, developed into two activity books that covered all flora and fauna groups. The aim was to provide a fun educational resource for children to help raise awareness about conservation. The books were professionally printed and pitched at different age groups with the version for the older children drawing on their curriculum and the stages of learning they were at. The publication of the books deliberately coincided with the start of the children’s summer holidays. This project was met with great enthusiasm from the volunteers with contributions from the majority of people on base.

Two public information signs provided by Toronto Zoo in Spanish and English were placed at either end of the transect. The aim is to raise awareness and inform beach users about the conservation efforts in place.

### Beach clean

Marine debris is a major threat to marine turtles both in the marine and terrestrial environment and affects turtles at all life stages. Beach cleans are the largest volunteer activity for the marine environment globally (Trissenig *et al.*, 2012) and are undertaken by Caño Palma volunteers on Playa Norte. This seasons weekly beach cleans began in April and ran for six weeks before a lack of personnel prevented further efforts. Over these weeks a total of 208.4kg of waste was removed from the beach between mile 0 and 1 (Table 9).

<table>
<thead>
<tr>
<th></th>
<th>Non-recyclable (kg)</th>
<th>Recyclable (kg)</th>
<th>Glass (kg)</th>
<th>Total weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine debris</td>
<td>165.9</td>
<td>21.4</td>
<td>21.1</td>
<td>208.4</td>
</tr>
</tbody>
</table>

*Table 9: Waste removed from the beach between miles 0-1.*
Volunteers and interns

A total of 15 interns and 34 volunteers (including 14 students from Shawnee State University, USA) were trained in how to work a turtle using our protocols (Table 10). Eight turtle interns qualified as patrol leaders and took teams out on the beach at night.

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Country</th>
<th>Association</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intern</td>
<td>Canada</td>
<td>Vanier College</td>
<td>4</td>
</tr>
<tr>
<td>Intern</td>
<td>Canada</td>
<td>York University</td>
<td>2</td>
</tr>
<tr>
<td>Intern</td>
<td>Canada</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Intern</td>
<td>The Netherlands</td>
<td>HAS University of Applied Science</td>
<td>3</td>
</tr>
<tr>
<td>Intern</td>
<td>USA</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Volunteer</td>
<td>Canada</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>Volunteer</td>
<td>Denmark</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Volunteer</td>
<td>Egypt</td>
<td>-</td>
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</tr>
<tr>
<td>Volunteer</td>
<td>Germany</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Volunteer</td>
<td>Switzerland</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
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<td>The Netherlands</td>
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</tr>
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<td>Volunteer</td>
<td>UK</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Volunteer</td>
<td>USA</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Volunteer</td>
<td>USA</td>
<td>Shawnee State University</td>
<td>14</td>
</tr>
</tbody>
</table>

Prior to working on the beach at night all volunteers received standardised training in our protocols in the form of a Powerpoint presentation (Training 1) followed by a simulation exercise on the beach (Training 2). They were then required to sit an exam in which they needed to score 80%. Potential patrol leaders were required to achieve 95% in this exam, with the proviso that a score of 90% would lead to an oral re-sit. Passing with this grade lead to practice patrol leading with a qualified patrol leader (usually a staff member) until they were deemed sufficiently experienced to received tagging training – using cardboard “flippers”. Where possible practice patrol leaders were supervised the first time they tagged a turtle and were then able to take out their own teams at night – however due to the low number of turtle encounters this season there were occasions when patrol leaders were in such demand that competent interns were qualified and leading teams before having the opportunity to tag.

An excavation training Powerpoint was given in advance of the first nest excavation which was used as a practical demonstration. Additional safety trainings were given to all long term volunteers and interns (Table 11).

In order to give interns practical training experience, Trainings 1 and 2 and later the excavation training presentation were delivered by patrol leaders and sometimes practice patrol leaders. Assessments and tagging training were only undertaken by project co-ordinators.
### Table 11: Trainings

**Training presentation (Training 1) – Classroom.**
Training presentation on the methodology and protocols for working turtles; includes an overview of the biology of the species and the threats and the conservation actions in place.

**Simulation exercise (Training 2) – Beach.**
Simulation of working a turtle on the beach undertaken in the order of events from encountering the tracks, triangulating the nest, taking the biometric data, through to correctly completing the data book and protocols for once the turtle has returned to sea. Locating the nest by reverse triangulating (when there were sufficient people, teams attempted to find the other team’s nest – buried nest ID/coconut).

**Excavation presentation – Classroom and practical demonstration – Beach.**
Theoretical and practical training in conducting nest excavations and recoding the data.

**Tagging training – Classroom (Potential patrol leaders only).**
Practical simulation training in flipper tagging using cardboard “flippers”.

**Safety and Risk Assessment training – Classroom.**
Practical and theoretical basic first aid for possible accidents that may occur on the beach. Focus on checking respiration, recovery position, treating a major bleed and heat stroke. Overview of risk assessment and writing a Site Specific Risk Assessment.

**Emergency Action Planning – Classroom.**
Discussion session covering emergency scenarios and tricky situations that have happened in the past and ways of dealing with them.

**Lightning Safety Training – Classroom.**
Practical session on how to assess the dangers of being on the beach in a lightning storm, how to monitor the storm, when to leave the beach and where/where not to shelter.

All interns and long term volunteers who did not have their own research to undertake were required to produce a scientific poster relating to marine turtles. Posters on the following subjects were produced in April and May:

- Marine debris.
- Fibropapillomatosis
- 
- Stages of egg development.

### Improvements to the programme

A number of changes were made to the programme this season to ensure that the number of turtle encounters was as high as possible and that quality of data collection was to the highest standard.

Night patrols were increased to six hour shifts to ensure the maximum beach coverage. This is an increase of two to three hours from 2013; necessary in order to ensure that as many turtles as possible were encountered and that protection was at a maximum with the teams available.
Long morning census was conducted once a week instead of every two weeks as in 2013. This increased the accuracy of data to provide a better understanding of the activity in the extra mile on the beach. In 2013 a high percentage of the Leatherback nesting events occurred north of mile 3 1/8.

Changes have been made to some of the trainings. Non-formal education moves away from traditional teaching tools that focus on passive learning and teacher lead presentations and focuses more on group and student lead learning through active participation. Trainings encourage participants to be much more involved and build confidence in participating, often leading to higher learning outcomes and learning-by-doing. The Emergency Action Planning and Lightning Safety training (a new training for 2014) adopted these methods.

The light survey was carried out monthly this season whereas it was only undertaken once in 2013. It is hoped that this additional detail will enable focused light mitigation strategies in the future.

A student from HAS University conducted an excellent project on Leatherback nest success and following this an addition layer of detail has been added to the data collection protocol. Shelled Albumin Globs (SAGs - also known as yolkless eggs) may be hydrated, dehydrated or predated and this is now recorded during excavations. This additional detail assists in the analysis of nest success.
Discussion

Although Playa Norte never receives large numbers of nesting Leatherbacks 2014 was an exceptionally low year, receiving around half the number of nests of 2013 (51.72% decrease). Whether this is cause for concern cannot be established from the results of one season’s data and needs to be analysed over a longer time period and on a larger spatial scale to fully understand the differences in the population trend. Numerous factors may explain why females this season did not nest in great numbers on Playa Norte. Females failing to nest in a specific location is not necessarily an indication that the population is in decline. They may simply be nesting elsewhere.

Effort

In an effort to increase the number of turtle encounters and the protection of the beach, shift duration was increased to six hours this year. Despite this turtles were missed and new volunteers often found the physical demands of this arduous. While we do not suggest shortening the shift duration, we also do not recommend shifts longer than six hours. The ideal solution would be to have more teams on the beach, however as this requires additional patrol leaders it won’t necessarily be an option at the beginning of the season. Another option for increasing the patrols would be to have teams of two people, a patrol leader and an assistant. This has safety implications and also requires patrol leaders able to triangulate a nest alone, however with the right people this may be worth considering.

Long Morning Census

Five out of eight Leatherbacks that nested beyond the transect, nested in mile 3 2/8. Without data on possible variables that may have made this area desirable (i.e. the beach profile or analysis of the sea currents, etc.) it is impossible to speculate as to why this might area may have received so many turtles. While it may be tempting to suggest extending the transect to mile 3 3/8 there are safety implications in having teams patrolling so far from base. This season we did not have the personnel to encounter all the turtles inside the transect and therefore we do not suggest extending night patrols further than 3 1/8 at this stage.

Daily nest checks

Last year was the first year that every nest was checked daily and this implementation was continued in 2014. This level of detail increased the quality of data and therefore the quality of analysis of the nest success/failure. Checking the nests daily also meant that fewer nests were lost as missing flagging tapes were replaced within 24hours. We suggest continuing with the daily checking of nests.

Re-nesting events

It is estimated that Leatherbacks have a re-nesting interval of 9 days (Chacón et al., 2007). The six individuals that re-nested on Playa Norte this season had nesting intervals greater than this (the female that nested three times had intervals of 29 and 19 days respectively). The other
turtle nesting intervals ranged from ten to 36 nights. This suggests that during the interim these females either nested at different locations or that our teams did not encounter her.

**Human Impact**

Efforts were made at the beginning of the season to reduce the white light use by the Turtle Beach Lodge security guards. However as little headway was made and in an effort to maintain good relations with the hotel teams eventually stopped raising the subject with the security guards.

Another major human impact event was Semana Santa. Despite access to the beach being prohibited, activity was greatly increased during this time with many groups of people using the beach at night and lighting bonfires. Many of the people on the beach were not aware that the beach was closed and willingly turned off lights and exited the beach. A possible mitigation strategy for next Semana Santa could be a local awareness raising campaign in an attempt to prevent people entering the beach at night.

**Light Survey**

This year the Light Survey was undertaken every month. This level of detail provides a better representation of the light pollution on the beach than a one off annual survey. For example, the lights at the beach entrance to Vista al Mar are on intermittently and repeated sampling increases the likelihood that they appear in the data. It is hoped that these data can be used as part of a light mitigation strategy for the transect and we recommend that monthly surveys are continued in future years.

**Outreach**

Despite our best efforts Turtle Beach Lodge did not take us up on our offers of giving presentations to the hotel guests. We did however have better luck at Vista al Mar and on one occasion made a significant profit from T-shirt sales to the group. These presentations were for tour groups which enabled us to access a wider audience than the local community. We would like to continue this collaboration and welcome invitations to give future presentations.

**Beach clean**

Given the high volume of litter collected from six beach cleaning sessions we highly recommend continuing this activity when sufficient personnel allow. Targeting areas where there are high concentrations of nests approaching the end of the incubation period may be a strategy for ensuring that resources are allocated most efficiently.
References


