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Barra del Colorado Wildlife Refuge, Costa Rica
Leatherback Season Report 2010

Submitted to:
MINAET (Costa Rican Ministry of Environment, Energy and Telecommunications)
COTERC (Canadian Organization for Tropical Research and Rainforest Conservation)

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WITH MANY THANKS TO THE FOLLOWING ORGANIZATIONS FOR THEIR FINANCIAL AND/OR INSTITUTIONAL SUPPORT:
ACKNOWLEDGEMENTS

The 2010 season of the COTERC Marine Turtle Monitoring Project was conducted under a permit from the Ministry of Environment, Energy and Telecommunications (MINAET) of Costa Rica.

Many thanks to the Donner Canadian Foundation for the financial support enabling us to continue to monitor and protect marine turtles and their nesting habitat on Playa Norte, Costa Rica. Extended gratitude goes to Vista al Mar Lodge for allowing the project’s participants to access Playa Norte via their property as well as the Lodge’s staff for their help in calling when turtles were nesting in front of the lodge.

Data in this report was collected by many staff, students and volunteers. The success of the 2010 season would not have been possible without each individual’s devotion to sea turtle conservation expressed by their sincerity and tireless work efforts. Having volunteers and students such as those that have participated in COTERC projects reassures one that despite some unfavourable odds, conservation is possible. Thanks for the extra effort extended by the Caño Palma Biological Station Manager Mike Dunn, for getting the Leatherback season started single-handedly and indefatigable hard work into the Green season whilst keeping the station up and running. Thank-you also to the current station manager, Todd Lewis, for his continued help with the project and managing the station. Many thanks go to Turtle Beach Lodge for their participation in educational presentations and their continued support of the Turtle Project and the Biological Station.

Gratitude is also extended to the Sea Turtle Conservancy (STC) (formerly known as the Caribbean Conservation Corporation - CCC) and Dr. Emma Harrison for their continued support, friendship and assistance with training. Also a huge thank-you to the villagers of San Francisco for all of their help and continued interest in working with COTERC and Caño Palma Biological station staff and volunteers.

The continued support of the project by COTERC members and board, as well as that of Dr. Chow-Fraser and her lab members at McMaster University, is very much appreciated.
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SUMMARY

- A total of 197 surveys totalling 963.6 miles were conducted throughout the 2010 Leatherback season
- First nesting female track found on Mar. 09, 2010.
- A total of 37 tracks were recorded: 66% resulted in eggs (n=28) and 24% were HLFs (n=9) with a peak of nesting female emergences from June 3rd to June 13th.
- Highest number of nests laid (n=4) occurred between miles 2 and 2.12; 14.3 % were laid in the border (n=4) and 75.7% (n= 24) were in the open.
- A total of 11 encounters with Leatherback females occurred; 10 individual females were identified, all encounters occurred between 22:45 and 01:15.
  - Mean CCLmin was 154.9 cm (SD=8.1) and mean CCWmax was 114.9 (SD=10.9)
  - All females had complete caudal projections and no abnormalities or disfigurements.
- Of 28 nests, 16 Leatherback nest excavations were successfully completed, including all triangulated nests (n=9), ultimate nest fates for all 28 nests;
  - 10 nests natural & hatched,
  - two natural & unhatched,
  - three nests poached,
  - two predated,
  - 12 nests’ fates are UNKNOWN.
- Incubation duration ranged from 61 – 64 days (mean = 62.3 days). Hatching and emergence success both ranged from 0 - 96.2% with means of 48.2%. and 43.1% respectively.
- No poaching or lifting of adult leatherback turtles was documented at any point in the 2010 season.
INTRODUCTION

Although Caño Palma Biological Station is in its 20th year (est. 1991) and marine turtle research has a very long history within Tortuguero, it was not until 2004 that the Canadian Organization for Tropical Education and Rainforest Conservation (COTERC) became directly involved in sea turtle conservation. Initially approached, and subsequently assisted by, the Sea Turtle Conservancy (STC)\(^1\), a feasibility study was conducted in the 2004 and 2005 nesting seasons. From this initial investigation, consisting solely of morning track counts, it was determined that the four species of marine turtles: *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata*, *Caretta caretta*; that utilize Playa Norte as a rookery did indeed nest in high enough numbers to warrant long-term investigation. Thus, the COTERC Marine Turtle Monitoring and Conservation Project has been running annually by MINEAT permit since 2006.

As the majority of nesting females emerge at night, night patrols are necessary to observe behaviour and obtain biometrics on these individuals. With the exception of Leatherbacks and random injury or abnormalities, sea turtles lack external morphological differences that identify them as individuals. Leatherbacks have “pink spots” on their heads which have proven to be unique; however, documenting the spot would require photography permits which the Project currently does not have. Therefore, it is necessary to flipper tag\(^2\) all species of turtles which allows for positive identification and monitoring of individual females. Thus in 2006, a more vigorous monitoring program was initiated that included night surveys during which flipper tagging is conducted. Further additions during this year included nest excavations and nest relocations into the project. Excavations allow the project to assess habitat productivity and potentially individual reproductive success rates. Nest relocations were adopted due to the high levels of erosion and poaching on Playa Norte. Nests deemed to be threatened by either factor continue to be relocated to another area of beach immediately after observed oviposition. Since 2006, these additions have been conducted concurrently with morning censuses for the entirety of all four species’ nesting seasons.

The inclusion of all of the aforementioned monitoring projects provide critical data on individual’s health and their reproductive output, as well as population dynamics, minimum recruitment and the viability of the nesting beach habitat. These factors have made the COTERC Marine Turtle Monitoring and Conservation Program a robust and sound contributor to the management plan of the Barra del Colorado Wildlife Refuge (REBACO), as well as contributing to a better understanding of the larger meta-population dynamics of the Tortuguero area.

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\(^1\) Sea Turtle Conservancy was formerly known as the Caribbean Conservation Corporation (CCC).

\(^2\) Refer to methods for tagging procedures.
Documented within this report are the methodologies, results, and a brief discussion of the 2010 Leatherback season. Another, separate technical report, documents the 2010 Green and Hawksbill season.

**METHODS**

Protocols used throughout the 2010 season follow guidelines set out by the IUCN/SSC Marine Turtle Specialist Group as well as those used by the STC. For further details, please refer to the 2010 Marine Turtle Monitoring and Conservation Programme Night, Morning and Excavation Protocols (http://coterc.org).

**Study Site: Playa Norte**

The study site, known as Playa Norte, is located within the Barra Colorado Wildlife Refuge (BCWR) of the Tortuguero Lowlands. The BCWR is managed by the Tortuguero Conservation Area (ACTo) and is regulated by the Costa Rican Ministry of Environment, Energy and Telecommunications (MINAET). The study area is a 3.125 mile (approx. 5 Km,) stretch of beach that runs from the Tortuguero River Mouth (10°35’34.4”N - 83°31’28.6”W) to the north end of Laguna Cuatro (10°38’06.9”N - 83°32’31.7”W, see Figure 1). Laguna Cuatro is a large lagoon which occasionally floods and disconnects the last 1/8 mile of beach during the early and later months of the year. Permanent mile markers are posted at every 1/8 of a mile from mile zero to mile 3.125 to allow for spatial analyses (Figure 2). Permanent structures on Playa Norte consist of two lodges; Turtle Beach Lodge and Vista al Mar Lodge, and several small houses. However, the study area is under increasing pressure from illegal development along the coastline and the adjacent rainforest. In the year since the last report, three new private residences were illegally built and many previously existing residences drastically increased their properties by slashing and burning the native vegetation to replace it with palm plantations. Additionally, a path used by those on foot, bicycle, horseback or car, runs parallel to the beach and continues to increase in use by motorized vehicles. Monitoring of the study site and its use by people is conducted throughout all four species nesting seasons (see Table 1).

**Table 1: Approximate peak nesting seasons of the four species of sea turtles utilizing Playa Norte.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
<th>Peak Nesting Season</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Chelonia mydas</em></td>
<td>Green</td>
<td>June to October</td>
</tr>
<tr>
<td><em>Dermochelys coriacea</em></td>
<td>Leatherback</td>
<td>March to June</td>
</tr>
<tr>
<td><em>Eretmochelys imbricata</em></td>
<td>Hawksbill</td>
<td>April to September</td>
</tr>
<tr>
<td><em>Caretta caretta</em></td>
<td>Loggerhead</td>
<td>April to September</td>
</tr>
</tbody>
</table>
Figure 1: Study area for the Playa Norte Marine Turtle Monitoring and Conservation Programme, REBACO, Costa Rica. © Google Earth 2009.

Figure 2: Photo of mile marker at mile 1.5. © April Stevens 2009.
Training of Project Participants

Patrol leaders (PLs) and volunteers were trained upon their arrival at Caño Palma Biological Station. All Patrol Leaders were trained by the Project Coordinator and tested both by written and situational formats prior to becoming a full PL. Pass rates were set at 95% and upon completion, were thoroughly discussed. In the case of <95%, a secondary test was written, requiring a 100% pass rate. Training for all project participants (PLs included) was conducted first in the classroom, followed by practical in-field preparation in order to ensure proficient data collection and ethical behaviour on the beach.

Classroom training consisted of lectures on marine turtle biology and conservation, project protocols and included discussions of possible beach scenarios. Practical training included triangulation and reverse triangulation techniques and PLs received practical tagging training using dummy flippers (cardboard) and relocation techniques. Finally, all potential PLs were accompanied by the Project Coordinator on both morning and night patrols until they were considered able to lead patrols independently.

Beach Habitat Management

The 2010 Leatherback season began with a check of all beach mile markers to ensure presence and legibility. All mile markers were repainted and two markers that had fallen over between nesting seasons were replaced. Furthermore, it was prudent to place a second mile marker behind existing originals due to evidence of tidal erosion near to many mile markers. Garbage removal, or beach cleaning, was undertaken throughout the nesting season, predominantly during morning census, in order to improve the nesting habitat as well as remove potential hazards for both marine turtles and patrol members.

Morning Census and Nest Status Assessments

Track surveys were conducted daily by a PL and at least one volunteer. Surveys started at sunrise (typically between 05:00 and 06:00) and lasted for up to three hours depending on the volume of turtle nesting traffic from the previous evening. Encountered tracks were categorized as Half-moons (HLF: non-nesting emergences) Nests (NST: emergence resulting in a clutch), or a Lift (LIF: track abruptly ends due to turtle being lifted and removed from the beach by poachers). For each of these categories the following information was also collected:

- Date
- Global Positioning System (GPS) location and instrument accuracy
- Species
- Closest northern mile marker (for spatial analysis)
• **Vertical position**³
  o **Open** (O: area of beach which receives 100% sunlight)
  o **Border** (B: area where nest is partially shaded by vegetation)
  o **Vegetation** (V: area where nest is constantly shaded by vegetation).

For **HLF**s vertical position was the most westward point on the animal’s track. For **NST**s, vertical position was where the eggs were believed to be, as determined from the disturbed sand and track directions.

If the emergence event resulted in clutch deposition, the nest was further classified as one of the following:

- **Natural**: appeared undisturbed and in its original state
- **Poached**: when egg shells *and* a cavity were found
- **Eroded**: tidal/wave action of sea eroded the beach and eggs washed out or left exposed
- **Predated**: disturbed/destroyed by an animal.
- **Unknown**: signs of possible human disturbance such as stick holes, disturbed sand and human and/or dog prints; however, no conclusive evidence (egg shells *and* cavity) were present.

Once data collection was complete, all tracks and nests were disguised to prevent double counting as well as confuse any possible future poaching efforts. Furthermore, all nests were investigated for two consecutive mornings to document possible poaching activities.

All nests, beginning 10 days before their theoretical hatching date⁴, were monitored during morning census to ensure no human activities such as dumping of garbage, fires, or piling of debris had occurred above the nest. Furthermore, due to the large amounts of rain potentially erasing hatchling tracks, this process increases the likelihood of finding nests that have emerged during periods of high rainfall or those disturbed by animals or people. Observed hatchling tracks were traced back to the common volcano⁵, two sticks placed on either side of the depression for identification for later excavation (see Incubation Duration and Nest Success) and the following information recorded;

- Date
- GPS location and instrument accuracy
- Closest northern mile marker

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³ Relates to the amount of sunlight a nest will receive not actual vegetation composition.
⁴ Based on mean incubation durations found in previous years of study for all species.
⁵ Depression made by the collapse of the chamber upon hatchling emergence.
• Nest number (if believed to be a triangulated nest)
• Any dead or alive hatchlings found outside of the nest

Night Patrols
Regular daily night patrols began on the 1st of March after information was given to the station that a Leatherback had been seen by locals even though there was no track evidence seen on prior morning censuses. Each night, a minimum of one patrol team composed of at least three members, walked the beach between mile 0 and 3 1/8 for a minimum of four hours. When a turtle track was found, the patrol leader determined whether or not the turtle was still present. If the turtle was not, the patrol leader determined if the track was a HLF, NST or LIF and the team proceeded to collect the following information:

• Date
• GPS location and instrument accuracy
• Species
• Northern mile marker
• Time of encounter
• Vertical position
• If deemed a nest, further categorized as Natural, Poached, Eroded, Predated or Unknown

If the turtle was still on the beach, nesting stage was exclusively determined by the Patrol Leader and appropriate action taken relevant to the nesting stage (see Table 2).

Egg Counting and Triangulation
A team member previously designated to the role, counted eggs visually and when possible, physically also by holding a gloved hand 5-10 cm below the cloaca and feeling eggs drop past. Both yolked and yolkless eggs were enumerated. Immediately after oviposition was completed, egg depth was recorded. Once the female started to cover the eggs with sand, a small piece of numbered flagging tape was placed in the egg chamber, which facilitates proper nest identification upon its excavation.

Triangulation was achieved only if eggs were observed with a team member standing directly over the chamber with the eggs in sight to ensure accuracy (for triangulation procedures please see Night Protocols on www.coterc.org).

Tagging and Biometrics
Upon completion of oviposition, flippers were investigated to see if the animal had current tags, or tagging scars. Scarring from previous tagging efforts such as Old Tag Notches (OTNs) or Old Tag Holes (OTHs) were recorded (see Figure 3a). All Leatherbacks were double
tagged (once in each flipper), in the membrane between the rear flippers and the tail using National Band & Tag Co., Newport, USA Monel #49 tags.

Table 2. Patrol activities as they relate to nesting stage of the encountered female.

<table>
<thead>
<tr>
<th>Turtle Activities</th>
<th>Patrol Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emerging from sea</td>
<td>Discreetly wait.</td>
</tr>
<tr>
<td>Selecting nest site</td>
<td>Discreetly wait.</td>
</tr>
<tr>
<td>Digging body pit</td>
<td>Discreetly wait.</td>
</tr>
<tr>
<td>Digging egg chamber</td>
<td>PL and one other team member cautiously approach turtle from behind to prepare for egg counting.</td>
</tr>
<tr>
<td>Oviposition</td>
<td>Egg counter counts eggs visually and by hand (when possible). Other team members begin triangulation of nest to known landmarks.</td>
</tr>
<tr>
<td>Covering egg chamber</td>
<td>Check for tags and/or scaring from lost tags. Apply tags if needed. Obtain biometrics.</td>
</tr>
<tr>
<td>Disguising</td>
<td>Finish data collection and data completion check.</td>
</tr>
<tr>
<td>Returning to sea</td>
<td>Check for tags if possible. Observe.</td>
</tr>
</tbody>
</table>

Biometrics were obtained only for tagged individuals. Using a flexible measuring tape, **Curved Carapace Length (CCLmin)** and **Width (CCWmax)** were measured three times each, to the nearest millimetre. **CCLmin** was measured from where the skin meets the carapace behind the head to the end of the caudal projection on the right of the central ridge (Figure 3b). **CCWmax** was measured from where the carapace meets skin on the widest part of the carapace (Figure 3b). After obtaining biometrics, an assessment of the animal’s external condition was conducted. This included classifying the caudal projection as **complete** if no abnormalities were observed, or **incomplete** if part of it was missing. Some, but not all, incomplete abnormalities of the caudal projection prevent CCLmin measurement. Any injuries, damaged tissue, abnormalities or tumours were also documented.
Relocations
Relocations were conducted if nests were at risk of erosion or at high risk of poaching. Original nest dimensions and habitat (in vegetation or not) were documented and a new chamber was created by the Patrol Leader in similar habitat. Eggs were enumerated and transferred in clean heavy duty plastic bags to the new chamber within a one hour time frame. Relocations were triangulated for excavation purposes.

Disguising Adult Emergence Events
After data collection, all signs of an emergence event were erased or disguised by the first patrol team to discover the event. This was done to diminish the possibility of double counting and also to make it more difficult for poachers to locate the egg chamber. Disguising was accomplished by several methods including levelling out body pits, disturbing a larger area of sand than originally done by the turtle, and dusting the area with a layer of dry sand to hide tracks and nests.

Incubation Duration and Nest Success
Nests were determined hatched if hatchling tracks were observed and traced back to a common “volcano” (refer to morning census). Incubation duration (days) was thus determined from the date hatchling tracks were observed minus the date laid; however, excavation was postponed two days from track observation to prevent disturbance to individuals late to emerge. In the case of triangulated nests that failed (0% success), or evidence of emergence
was not observed, the project waited 75 days from the date the eggs were laid to prevent any potential disturbance to developmentally delayed clutches.

For each excavated nest the following information was recorded:

- **Egg Depth (cm)** – Distance between the sand surface to the first shell or egg encountered
- **Nest Depth (cm)** - Distance between the sand surface and the bottom of the egg chamber
- **Number of yolkless eggs**
- **Number of hatched eggs** – Shells ≥ 50% of original size
- **Number of hatchlings in-nest:**
  - Alive
  - Dead
- **Number of unhatched eggs:**
  - Without embryo
  - With embryo (see Figure 4):
    - **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/destroyed and impossible to determine at what stage development stopped
- **Number of pipped eggs** – Hatchling broke through but failed to fully emerge from the shell.

Figure 4: Embryonic development stages used during nest excavations (Chacón et al. 2007).

Any abnormalities, such as twins, albinos and developmental deformities were also documented as well as recording the number of eggs with the presence of larvae,
bacteria/fungi, ants, crabs or roots. Upon excavation completion, the nest was ultimately categorized as one of the following final nest statuses: **natural & - hatched** or - **un-hatched, poached, predated, or eroded**. Nests were only determined as poached if the flagging tape deposited at the time of egg counting was found in an empty chamber. Or, alternatively, only yolkless eggs were present when it had been observed during oviposition that yolked eggs had been laid. Only excavation nest status was used to determine poaching rates and unexcavated nests were excluded from hatching and emergence success analysis.

**Table 3. Definitions and formulas used to determine hatching & emergence success rates as described by Miller (1999) including the equivalent developmental stages used in the project.**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shells (S)</td>
<td>Number of empty shells</td>
</tr>
<tr>
<td>Live in Nest (L)</td>
<td>Live hatchlings remaining in nest</td>
</tr>
<tr>
<td>Dead in Nest (D)</td>
<td>Dead hatchlings outside of shells</td>
</tr>
<tr>
<td>Undeveloped (UD)</td>
<td>Unhatched eggs with no obvious embryo</td>
</tr>
<tr>
<td>Unhatched (UH)</td>
<td>Unhatched eggs with obvious embryo (S1-S3)</td>
</tr>
<tr>
<td>Unhatched Term (UHT)</td>
<td>Unhatched full term embryo (S4) or pipped</td>
</tr>
<tr>
<td>(De)predated (P)</td>
<td>Nearly complete shells containing egg residue. Includes shells predated by animals, bacteria/fungi and vegetation.</td>
</tr>
</tbody>
</table>

**Hatching Success (HS %) =** \[
\frac{\text{#shells}}{\text{#shells} + \text{#UD} + \text{#UH} + \text{#UHT} + \text{#P}} \times 100
\]

**Emergence Success (ES %) =** \[
\frac{\text{#shells} - (\text{#L} + \text{#D})}{\text{#shells} + \text{#UD} + \text{#UH} + \text{#UHT} + \text{#P}} \times 100
\]

Hatching and emergence success rates were calculated using methods from Miller (1999) (see Table 3). Hatching success is the number of hatchlings that completely hatch out of their egg shell whereas emergence success refers to the number of hatchlings that successfully exit the chamber to the sand surface (Table 3). Mean success rates were calculated by averaging the success rate of each nest rather than summing overall nest contents and assessing mean success from those values.

**Adult Turtle Poaching**

If dead turtles were encountered during surveys, the following information was recorded:

- **Date**
- **GPS location and accuracy**
• Species
• Closest northern mile marker
• CCLmin and CCWmax
• Tag numbers (if present)

Signs of wounds or missing body parts, estimated time since death and condition of the carcass when first found where documented as well. Furthermore, the carcass was photographed (the following morning if originally discovered at night).

Human Presence and Light Source Surveys

The Human Presence and Light Source Surveys, formally known as Human Impact surveys, were conducted throughout each night patrol by all patrol members. Each person was responsible for assisting in tallying the number of people utilizing the beach (in any form, i.e. tourism, commuting, etc.). Each person was also responsible for counting the following sources of non-natural light;

• Number of mobile red and white lights: Visible moving lights carried by non-patrol members or headlights of moving vehicles on the beach and parallel path.
• Number of Fires: The number of active flames directly on the beach.

Statistical Analysis

All statistical analysis was completed in JMP 6.0.

RESULTS

Surveys

Including both morning census and night patrols a total of 197 surveys totalling 963.6 miles were conducted throughout the 2010 Leatherback season. Morning surveys were initiated on a once/week basis beginning in January. Beginning Mar. 01, 2010, surveys were conducted at least once/calendar day although no tracks had been observed. Upon the first documented nesting female track, Mar. 09, 2010, both morning and night surveys were completed daily unless a patrol was cancelled due to inclement weather (n=13) or illness/injury of patrol members (n=2). The last census relating to the purpose of this Leatherback report was June 30, 2010, although monitoring continued throughout the Green sea turtle season.

Spatial and Temporal Track Distribution

The first nesting female tracks for the 2010 Playa Norte Leatherback season were two halfmoons observed during a night patrol on March 9th at miles 1.37 and 2.37. The first track to
result in a clutch being laid for Leatherbacks was on March 30th, at mile 1.25. Very low numbers of nesting female emergences continued throughout the season, which ended the 17th of June, when the last nest was recorded. Throughout the Leatherback season, a total of 37 tracks were recorded, of which 66% resulted in eggs being laid (n=28) and 24% were HLFs (n=9). A peak of nesting female emergences occurred from June 3rd to June 13th when nine tracks were observed. All nine resulted in nests (eggs laid); therefore, this 10 day period was not only the peak of activity, but also the peak of egg-laying for Leatherbacks in 2010 (Figure 5).

Nesting female tracks were documented at almost every 1/8th of a mile; however, the highest number of nests laid (n=4) occurred between miles 2 and 2.12 (see Figure 6). Due to low nesting numbers it was not possible to determine if there were significant differences between HLFs and nesting events occurring, either spatially or temporally, in the 2010 Leatherback season. As for the vertical position of eggs, 14.3 % were laid in the border (n=4) and 75.7% (n= 24) were in the open. No nests (n=0) were documented as laid in vegetation (V).

Figure 5: Temporal distribution of leatherback nesting activity during the 2010 nesting season on Playa Norte, Tortuguero, Costa Rica.

6 The first nest laid during the 2010 season was actually by Chelonia mydas on the 17th of March. Please refer to Green Report for full details.
Figure 6: Spatial distribution of leatherback nesting activity during the 2010 nesting season on Playa Norte, Tortuguero, Costa Rica.

**Encountered Turtles**

A total of 11 encounters with Leatherback females occurred, all during night patrols. Ten individual females were successfully identified, with one female being encountered twice on different nights. All individuals were encountered between 22:45 and 01:15 and all but one of the individuals laid eggs. Four females were apparently tagged for the first time, having no tags, nor visible tagging scars. Three individuals were remigrants to Playa Norte, carrying COTERC tags from the 2008 season. A total of five females carried tags from other monitoring projects; however, two of these individuals were identified as two of the three aforementioned remigrants. The remaining three individuals presenting foreign tags were missing their left rear flipper tag and thus the patrol leader replaced the absent tag on each individual (see Table 4).

**Biometrics & External Condition**

It was not possible to measure one individual that was encountered due to timing; the female was already returning to the sea. For all others (n=10), mean CCLmin was 154.9 cm (SD=8.1) and mean CCWmax was 114.9 (SD=10.9). All females had complete caudal projections and no abnormalities or disfigurements were found on any of the encountered individuals.
Table 4. Foreign tags present on five individual Leatherback females and the COTERC tag replacement when second tag was missing.

<table>
<thead>
<tr>
<th>Encounter Date</th>
<th>Right Rear Flipper Tag</th>
<th>Left Rear Flipper Tag</th>
<th>COTERC Tag Replacement</th>
</tr>
</thead>
<tbody>
<tr>
<td>02/05/2010</td>
<td>PN1763</td>
<td>PN1762</td>
<td>N/A</td>
</tr>
<tr>
<td>20/05/2010</td>
<td>80000</td>
<td>(absent)</td>
<td>VA1976</td>
</tr>
<tr>
<td>23/05/2010</td>
<td>79526</td>
<td>(absent)</td>
<td>VA4001</td>
</tr>
<tr>
<td>24/05/2010</td>
<td>VC1037</td>
<td>(absent)</td>
<td>VA8310</td>
</tr>
<tr>
<td>03/06/2010</td>
<td>BCO322</td>
<td>BCO321</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Excavations

Sixteen Leatherback nest excavations were successfully completed, including all triangulated nests (n=9). Excavations confirmed the assessment of morning census data that two nests had been poached and one predated. Furthermore, one relocated nest, previously categorized as natural during morning census, was found to be poached when the flagging tape and only yolkless eggs were found. One nest was found predated by a dog. Thus, final nest status as determined by excavation deemed three nests as poached and two predated. Furthermore, 10 nests were found to be natural & hatched and two were natural & unhatched. Therefore, out of a total of 28 nests for the entire 2010 Leatherback season, 12 nests’ fates are left as status Unknown. These nests were not triangulated and no hatching was observed, which prevents these nests from being located and excavated. Overall nest fate for the entire 2010 Leatherback season is summarized in Figure 7.

Figure 7; Final nest status and relative percentage of all nests laid for the 2010 Playa Norte Leatherback season.
**Incubation Duration, Hatching and Emergence Success**

Incubation duration was obtained for seven nests and ranged from 61 – 64 days (mean = 62.3 days). Hatching and emergence success both ranged from 0 - 96.2% with means of 48.2% and 43.1% respectively. No evidence of ants, larvae or crab activity was found in any excavated nests. Bacteria / Fungi were observed in two different nests in a total of 55 eggs. Table 6 details nest contents and depths of all excavated nests.

**Poaching of Adult Turtles**

No poaching or lifting of adult leatherback turtles was documented at any point in the 2010 season.

**Human Presence and Light Source**

Although mobile lights (both red and white) were observed on 63 separate night patrols, people were only encountered or observed on 50 of the patrols. A total of 152 people were documented as present on Playa Norte throughout the Leatherback season. Observations consisted mostly of small groups of people (≤ 10 people) or solitary individuals; however, one notably large group of tourists (n=19) being led by a guide was documented. Five people within this group were using very bright white lights and the guide was using a red light. Results of these surveys are summarized in Table 7.

**Table 6. Summary of nest contents and depths from excavated Leatherback nests on Playa Norte, 2010.**

<table>
<thead>
<tr>
<th>Category</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Mean</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yolkless</td>
<td>54</td>
<td>10</td>
<td>34.0</td>
<td>408</td>
</tr>
<tr>
<td>Hatched (shells ≥ 50%)</td>
<td>75</td>
<td>0</td>
<td>32.8</td>
<td>427</td>
</tr>
<tr>
<td>Alive Hatchlings</td>
<td>22</td>
<td>0</td>
<td>2.2</td>
<td>29</td>
</tr>
<tr>
<td>Dead Hatchlings</td>
<td>11</td>
<td>0</td>
<td>1.3</td>
<td>17</td>
</tr>
<tr>
<td>Unhatched no embryo</td>
<td>75</td>
<td>0</td>
<td>19.2</td>
<td>249</td>
</tr>
<tr>
<td>Stage 1</td>
<td>67</td>
<td>0</td>
<td>11.5</td>
<td>150</td>
</tr>
<tr>
<td>Stage 2</td>
<td>6</td>
<td>0</td>
<td>1.5</td>
<td>19</td>
</tr>
<tr>
<td>Stage 3</td>
<td>4</td>
<td>0</td>
<td>0.8</td>
<td>10</td>
</tr>
<tr>
<td>Stage 4</td>
<td>12</td>
<td>0</td>
<td>1.5</td>
<td>20</td>
</tr>
<tr>
<td>Pipped</td>
<td>1</td>
<td>0</td>
<td>0.2</td>
<td>2</td>
</tr>
<tr>
<td>Unknown</td>
<td>26</td>
<td>0</td>
<td>4.5</td>
<td>60</td>
</tr>
<tr>
<td>Bacteria/Fungi</td>
<td>50</td>
<td>0</td>
<td>27.5</td>
<td>55</td>
</tr>
<tr>
<td>Egg depth</td>
<td>95</td>
<td>30</td>
<td>56.1</td>
<td>N/A</td>
</tr>
<tr>
<td>Nest depth</td>
<td>101</td>
<td>55</td>
<td>79.3</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Table 7. Summary of human presence and light sources documented on night patrols during the 2010 Leatherback nesting season.

<table>
<thead>
<tr>
<th>Human Activity</th>
<th>Number of Incidences</th>
<th>Maximum number/patrol</th>
<th>Minimum number/patrol</th>
<th>Total for season</th>
</tr>
</thead>
<tbody>
<tr>
<td>People</td>
<td>49</td>
<td>26</td>
<td>0</td>
<td>152</td>
</tr>
<tr>
<td>Red lights</td>
<td>6</td>
<td>5</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>White lights</td>
<td>63</td>
<td>5</td>
<td>0</td>
<td>108</td>
</tr>
<tr>
<td>Fires</td>
<td>13</td>
<td>4</td>
<td>0</td>
<td>19</td>
</tr>
</tbody>
</table>

DISCUSSION

Beach Cleaning

It is highly recommended that the practice of garbage removal, or beach cleans, continue throughout the year as well as during the nesting season. Although the village of Tortuguero has an excellent waste disposal and recycling plant, users must pay a fee; thus, many people continue to dump garbage both on land and in waterways. Furthermore, waste from inland is transported by the many large waterways flowing into the area and is deposited on Playa Norte in even greater volume than what’s produced from the surrounding population(s). Garbage removal improves the nesting habitat by decreasing pollution and related toxicity issues, as well as preventing sea turtles from entanglement and/or injury from non-natural objects. Additionally, this practice decreases potential hazardous risks to night patrol members whose visibility is much reduced due to limited light usage.

Surveys

Marine turtles, including Leatherbacks, demonstrate cyclical nesting behaviour in that mature females rarely nest annually. Most females return from foraging grounds to their nesting grounds on average every 2.5 yrs. Due to this cyclical nesting behaviour, fluctuations in numbers of individuals in different years is to be expected. It was anticipated that the numbers of individuals and nests would be lower in 2010, as 2008 was a record year for Leatherbacks on Playa Norte. That said, 2010 was the lowest year for Leatherbacks for documented numbers of total emergence events, numbers of individuals, and nests laid, in the project’s history.

Although the numbers appear alarmingly low, this is not conclusive evidence that declines are occurring to the population at large. The project’s relatively young age and the Leatherback’s nesting behaviour itself complicate any possible population fluctuation determination. From titanium and satellite tagging efforts (Witt et. al, 2008), it is now known that Leatherbacks demonstrate far less nesting site fidelity than other species. Nesting female
Leatherbacks have been documented nesting on several beaches both within Costa Rica and outside of Costa Rica during one nesting season. This has also been observed over the years on Playa Norte, including the 2010 season, with individuals displaying tags from other nesting beach monitoring projects in Costa Rica as well as the greater Caribbean region. For these reasons, it is of critical importance that long-term monitoring and surveying be sustained to enable any population level assessments.

The information about movement and beach utilization that tagging programs provides are critical factors for conservation efforts and demonstrate the continued need for tagging and nightly monitoring, not simply morning track counts. Tag information can only be obtained if turtles are actually encountered, requiring a large number of human resources and labour intensive patrols. Moreover, the need for multiple, overlapping patrols is a necessity as demonstrated by the fact that emergence events continue to occur within a short time frame (22:45 to 01:15 in the 2010 season), which in this case resulted in less than half of the individuals being encountered over the season. Although Playa Norte is a relatively small study area, the time spent with each individual animal means that much of the beach is left unpatrolled. More individuals can be seen as they’re emerging at similar times if more people are physically present on the beach at the same time.

**Spatial & Temporal Distribution**

The very low numbers of emergence events for the entire 2010 season prevent true spatial and temporal analysis; however, some inferences can still be made. Although there has been continued illegal development such as; building, slashing, burning and clearing of vegetation, it can be assumed that individuals do not appear to be specifically avoiding any areas of beach when emerging from the sea due to the fact that almost every 1/8th of a mile contained an emergence event. Furthermore, similar to the 2009 Leatherback season and in contrast to the 2007 and 2008 seasons, Playa Norte experienced several erosion events. Throughout the months of February, March, April and May, several mature trees and two semi-permanent fishing shacks collapsed due to erosion. This erosion may be the reason that the highest number of nests laid (n=4) occurred between miles 2 and 2.12; a popular nesting site for Leatherbacks in previous seasons as well. This area has been observed to be relatively stable (less prone to erosion) in comparison to other areas of Playa Norte and may be one reason as to why they continue to nest more frequently on this particular stretch. Although observed trends demonstrate that the sand in eroded areas is later replenished, the return of the beach occurs post-Leatherback season. Since Leatherback’s prefer to nest in the open (areas lacking vegetation), if current erosion trends continue on Playa Norte, it may no longer be a suitable nesting beach for this species.
Encountered Turtles

As stated earlier, the actual number of individuals encountered was low in comparison to previous seasons. This is attributable to the fact that there were few emergences in total, all of the emergences occurred in a very short time frame each night, and limited numbers of project participants led to only 1 patrol per night. Recommendations would be to ensure higher numbers of patrols/night when possible, particularly during 22:00 – 01:00 when feasible.

The low numbers of individuals also prevent any analysis on consistency of measurement as only one individual was encountered more than once in the season. Unfortunately, for that individual measurements were not obtained successfully three times each encounter, thereby preventing any accuracy analysis. The three remigrant turtles that had been encountered in previous years on Playa Norte showed a small increase in both length and width of no more than 5 cm. As mature sea turtles grow continuously throughout their lifespan, albeit slowly once mature, such minor differences, especially for Leatherbacks, from year to year could be accounted to growth rather than human error. The practice of measuring both width and length three times, as well as comparison over subsequent years will determine potential human error and/or growth rates. Additionally, since only one turtle was encountered it is not possible to evaluate a re-nesting interval for the 2010 season.

Nest Status and Success

Although the mean nest success rates, 43.1% for both hatching and emergence, were lower than all previous Leatherback seasons reported for Playa Norte, they are not unusually low for this species. It is likely that the low success rates found during the 2010 season result from a genetic or environmental factor since predation, solely in the form of fungal / bacterial infection was only found in two nests. Furthermore, this infection was predominantly in one nest (50 eggs) indicating that this particular nest was likely flooded or exposed in another manner to infection rather than a change in the suitability of Playa Norte as nesting habitat.

With the exception of one nest being originally categorized as natural and later discovered as poached post-excavation, morning census was highly reliable in assessing nest status as poached on the criteria of an empty egg chamber and shell presence. This aforementioned nest is believed to have been exposed approximately one month later by a nesting Green turtle. Although this event was unobserved by patrol members, it is highly likely that poachers took the exposed eggs rather than there having been an incorrect evaluation during the morning census. It is highly recommended that these factors continue to be used for a status of poached for untriangulated nests and final nest status continue to be ultimately determined by excavations.

For both triangulated and non-triangulated nests, excavations permit an exact determination of whether nests initially categorized as UNK (either during a morning or night
survey) were poached or not. However, untriangulated nests that do not hatch cannot be located; therefore, it is indeterminable whether the nest was poached or simply was an unsuccessful nest. Oftentimes poachers disguise their activities by filling in the emptied chamber; thus, the categorization of UNK enables estimation of maximum and minimum poaching rates for the year by setting the UNK nests as 100% or 0% poached respectively, and adding these values to the known poached percentage.

**Poaching of Adult Turtles**

As has been the case in all years of monitoring on Playa Norte, no poaching or lifting of Leatherback turtles was found in 2010. This is due to several factors including their enormous size preventing an easy lift, as well as that the meat is considered oily and unpalatable. This is in stark contrast to both Green and Hawksbills turtles, who are much smaller in size and whose meat and eggs are both more easily taken and highly coveted by locals for personal consumption as well as sale.

**Human Presence and Light Sources**

The number of people on the beach was higher throughout the Leatherback season compared to previous years. This is thought to be due to the Tortuguero National Park opening its Turtle Observation program later this year than in preceding years. Since Turtle Beach Lodge began to utilize the Tortuguero Guided Sea Turtle Observation program there has been an overall decline in mobile lights observed on Playa Norte. However, the lack of enforcement by local authorities on Playa Norte is well known to both locals and guides alike, they continue to guide tours on the beach prior (as well as sometimes during) to the official park opening albeit it being illegal to do so. Enforcement, in the forms of heavy fines (to outweigh the financial benefits of illegally guiding) and/or jail terms will likely be the only way to combat trespass on Playa Norte. Although there were no documented events by patrol members of a turtle being visibly disturbed by people on the beach, several tourists and a few locals encountered during patrols said that they had personally witnessed females disturbed (stopped the nesting process and returned to sea) from people coming too close to the individual and/or touching the nesting female. This reiterates the need for either enforcement from local authorities or a proper guiding program similar to Tortuguero beach being established on Playa Norte to prevent potential disturbances to nesting females.

In several cases lights were observed and then turned off when patrol teams were seen or heard approaching, presumably by poachers as guides and tourists do not turn off their lights when approached by patrolees. This behaviour highlights the poacher’s knowledge that their activities are illegal; however, it does not prevent the activity in itself. Despite many educational efforts, the disguising and relocating of nests seem the only successful measures in preventing egg poaching, as indicated by the continued rate of poaching but observed changes
in poacher’s behaviour. Patrols are now being followed and watched by poachers in order to take nests that have already been documented and / or to determine to where nests are being relocated. Furthermore, adults have been observed teaching their children nest finding techniques, encouraging poaching efforts and instructing them to pull down the Project’s flagging tape, thereby undermining the efforts of educational programs conducted previously with school children. This is not to say that environmental educational projects should be discontinued but rather reinforced by a regulatory presence. In the absence of an authoritative presence on Playa Norte, the most successful methods for poaching prevention are: diversifying patrol schedules so as not to be predictable, having as many patrols as possible, and disguising and relocating nests.

References


