Canadian Organization for Tropical Education & Rainforest Conservation

Marine Turtle Conservation & Monitoring Project:


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Barra del Colorado Wildlife Refuge, Costa Rica
Leatherback Season Report 2012

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

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SUMMARY

- A total of 196 surveys amounting to 982.4 miles were conducted throughout the 2012 Leatherback season.
- First nesting female track was found on March 14th, 2012.
- A total of 90 tracks were recorded: 73.3% resulted in eggs being laid (n=66) and 26.7% were halfmoons (n=24).
- Along the 3 1/8th mile transect the highest frequency of nests laid (n=6) occurred between miles 0 and 0.13 and between miles 0.38 and 0.5.
- 92.4% were laid in the open (n=61), 6.1% (n=4) were in the border, and 1.5% (n=1) were not recorded.
- A total of 25 encounters with Leatherback females occurred; 19 individual females were identified, all encounters occurred between 21:31 and 03:00 with the majority (n=5) encountered between 22:01 and 22:30.
- Mean minimum curved carapace length (CCLmin) was 154.7 cm (SD=6.7) and mean maximum curved carapace width was 113.3 (SD=5.67).
- Two females had incomplete caudal projections and all others had complete caudal projections.
- 19 Leatherback nest excavations were successfully completed.
  - 12 nests natural & hatched,
  - 2 eroded
  - 2 partially poached
  - 3 predated
- 4 of the 15 triangulated nests were excavated to determine ultimate nest fate. 10 triangulated nests were unable to be excavated due to likely erosion and 1 was unable to be excavated due to missing markers.
- The fate of 49 nests was unknown.
- Incubation duration ranged from 59 – 69 days (mean = 62 days). Hatching and emergence success both ranged from 0 - 100% with means of 56.9% and 55.3% respectively.
- No poaching or lifting of adult leatherback turtles was documented at any point in the 2012 season.

INTRODUCTION

Although Caño Palma Biological Station is in its 21st year (est. 1991) and marine turtle research has a very long history in the Tortuguero area, 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), 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 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 was conducted along with nest excavations and nest relocations. Excavations allow the project to assess habitat productivity and potentially individual reproductive success rates.

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

2 Refer to methods for tagging procedures.
The combined aspects of the monitoring project 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 (Stevens 2010; Arroyo Arce and Jones 2009; Verissimo, et al 2008; Jackson et al. 2007; Chapparro et al. 2006). 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. Documented within this report are the methodologies, results, and a brief discussion of the 2012 Leatherback season. Another, separate technical report, documents the 2012 Green, Hawksbill, and Loggerhead seasons.

METHODS

Protocols used throughout the 2012 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 Program Night, Morning and Excavation Protocols (http://www.coterc.org/?page_id=194).

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 1/8th mile of the transect 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 1/8th to allow for spatial analyses. Final determination for spatial analysis was determined by northern GPS to ensure accuracy. 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 development along the coastline and the adjacent rainforest. Additionally, a path used by those on foot, bicycle, horseback or car, runs parallel to the beach. Monitoring of the study site and its use by people is conducted throughout all four species nesting seasons (see Table 1).
<table>
<thead>
<tr>
<th>Species Name</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 (0 marker represented by A, 3 1/8th mile marker represented by B) for the Playa Norte Marine Turtle Monitoring and Conservation Program, REBACO, Costa Rica. © Google Earth 2012.
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 Head Intern, with help from long term interns, 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. 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). 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.

Morning Census and Nest Status Assessments

Track surveys were conducted daily. Surveys started at sunrise (typically between 05:00 and 06:00) and lasted an average of two and a half hours. 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\(^3\)
  - Open (O: area of beach which receives 100% sunlight)
  - Border (B: area where nest is partially shaded by vegetation)
  - Vegetation (V: area where nest is constantly shaded by vegetation).

\(^3\) Relates to the amount of sunlight a nest will receive not actual vegetation composition
Figure 2: Vertical position of nests: V=Vegetation, B=Border, O=Open

For HLFs vertical position was the most westward point on the animal’s track (Figure 3). For NSTs, 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 of poaching (egg shells *and* cavity) were present.

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

All nests, beginning 60 days after being laid, were monitored during morning census for signs of hatching. Observed hatchling tracks were traced back to the common volcano⁴,

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⁴ Depression made by collapse of chamber when hatchlings emerge
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
- Nest number (if believed to be a triangulated nest)
- Any dead or alive hatchlings found outside of the nest
- Any egg shells found outside the nest

**Night Patrols**

Each night, a minimum of one patrol team composed of at least three members, walked the beach between mile 0 and 31/8 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).
Table 2. Patrol activities as they relate to nesting stage of the encountered female on Playa Norte, Costa Rica

<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 scarring 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>

**Egg Counting and Triangulation**

A team member previously designated to the role, counted eggs visually and when possible, physically also by holding a latex gloved hand 5-10 cm below the cloaca and feeling eggs drop past. Both yolked and yolkless eggs were counted. 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 conducted for all nests encountered during oviposition when possible. One team member stood directly over the chamber to ensure accurate measurements were taken (for triangulation procedures please see Night Protocols on [http://www.coterc.org/?page_id=194](http://www.coterc.org/?page_id=194)). When a turtle was encountered covering, triangulation was also conducted under the patrol leader’s discretion and further noted in data.
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 3). 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.

Biometric data was obtained 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

Figure 3: Diagram of Old Tag Holes and Old Tag Notches (modified from Barragán 1998).
ridge (Figure 4a). CCWmax was measured from where the carapace meets skin on the widest part of the carapace (Figure 4b). 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 tumors were also documented.

Figure 4: Proper position of the minimum curved carapace length (CCLmin) and the maximum curved carapace width (CCWmax) measurements (modified from Bolten 1999).

**Relocations**

In previous years, 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 counted and transferred in clean heavy duty plastic bags to the new chamber within a one hour time frame. Relocations were triangulated for excavation purposes. Unfortunately, lack of MINEAT permits for this activity prevented relocations in the 2012
Leatherback season

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 leveling 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 in days was thus determined by taking the date when hatchling tracks were first recorded and counting back to 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 (5 days after the average hatching date) 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 un-hatched eggs:**
  - Without embryo

Following Sea Turtle Conservancy established protocols.
With embryo (see Figure 5):

- **Stage 1** (embryo occupies less than 25% of the egg)
- **Stage 2** (embryo occupies between 25% and 50% of the egg)
- **Stage 3** (embryo occupies between 50% and 75% of the egg)
- **Stage 4** (embryo occupies between 75% and 100% of the egg)

- **Unknown** – Embryo has been predated/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 5: Embryonic development stages used during nest excavations (Chacon et al 2007).](image)

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 Natural and un-hatched, poached, partially 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.

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.
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 (&gt;50%)</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%) = \( \frac{\#\text{Shells}}{\#\text{UD} + \#\text{UH} + \#\text{UHT} + \#\text{P}} \times 100 \)

Emergence Success (EM%) = \( \frac{\#\text{Shells} - \#\text{L} - \#\text{D}}{\#\text{UD} + \#\text{UH} + \#\text{UHT} + \#\text{P}} \times 100 \)

**Adult Turtle Poaching**

Upon encounter of dead turtles, the following information is 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 is 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.

**RESULTS**

**Surveys**

A total of 196 surveys totaling 982.4 miles were conducted throughout the 2012 Leatherback season. Morning patrols began on March 14th and night patrols began on March 21st, but both surveys were inconsistent until April 12th when a turtle project head intern was hired. At this time, night patrols occurred every night unless cancelled because of lack of participants (n=2), or illness of patrol leaders (n=1). From May 9th to May 16th and from June 19th to June 24th and June 26th to June 29th there were enough participants to conduct two night patrols. In addition, on June 30th there was a third night patrol team on the beach. Figure 6 shows the percentage of days of each month covered by morning patrol, one night patrol team (PM1), two night patrol teams (PM2), and three night patrol teams (PM3) for each month of the Leatherback season. Monitoring of other marine turtle species continued past June 30th, but this was the last day leatherback tracks were found.
Figure 6: Percentage of days covered by a morning patrol team (Morning), one night patrol team (PM1), two night patrol teams (PM2), and three night patrol teams (PM3) for the four months of the Leatherback season in 2012 on Playa Norte, Costa Rica.

**Total tracks**

Overall 90 leatherback tracks were recorded in the 2012 season. Figure 7 shows the percentage of each record types recorded. 73% (n=66) of all emergences resulted in clutch laying (REC, REM and NST). Tag info was gathered for 29% (n=23) of all emergences were laying occurred (REC and REM). 48% (n=43) of nests were recorded without getting tag info on nesting females (NST). 27% (n=24) of all emergences did not result in egg laying.
**Vertical Nest Position**

The majority of Leatherback nests were found in the open area with 94% (n=61). In addition, 6% (n=4) of nests were laid in the border area. No leatherback nests were laid in the vegetation area.

**Figure 7**: Percentage of Record Types recorded in the 2012 Leatherback season on Playa Norte, Costa Rica.

**Figure 8**: Vertical position of Leatherback Nests in the 2012 Season on Playa Norte, Costa Rica.
Temporal Track Distribution

The first leatherback tracks were recorded on March 14th. Patrols were inconsistent from March 14th until April 12th due to lack of available marine turtle staff. Therefore peaks that appear to have occurred on March 24th and April 8th are due to the recording of tracks from multiple, unsurveyed, days rather from one night. There is no apparent temporal peak in nest laying throughout the season, with only slight peaks on April 15th (n=4) and May 12th (n=4). Figure 9 shows the temporal distribution nesting activity for the 2012 leatherback season.

![Figure 9: Temporal distribution of nesting activity for the 2012 leatherback season on Playa Norte, Costa Rica.](image)

Spatial Track Distribution

Figure 10 shows spatial distribution for the 2012 Leatherback season. Nests were documented at every 0.12 miles except between 0.63 and 0.75 miles. The highest number of nests laid (n=6) occurred between miles 0 and 0.13 and 0.38 and 0.5
Encountered Turtles

Nineteen individual turtles were encountered, all during night patrol. Two turtles were encountered twice and two were encountered three times. Figure 11 shows the time period all turtles were encountered. All encounters occurred between 21:31 and 03:00, with 20% (n=5) being encountered between 22:01 and 22:30. 89.5% (n=17) of individuals encountered already had tags, while only 10.5% (n=2) were turtles that received new tags. The two turtles receiving tags may have been tagged for the first time, showing no signs of old tag holes or notches.
Biometrics and External Conditions

For the nineteen measured turtles mean $CCl_{min}$ was 154.7 cm (SD 6.70) with a maximum of 171.0 and minimum of 142.5. Mean $CCW_{max}$ was 113.3 cm (SD 5.67) with a maximum of 128.7 and minimum of 104.1. Two individuals had broken or injured caudal projections and several had small injuries and tears to the flippers.

Excavations

Nineteen excavations were performed on leatherback nests in the 2012 season. Four of these were on triangulated nests, thirteen on un-triangulated nests that showed signs of hatching, and two more on originally undocumented nests. Of the nineteen excavated nests 63% (n=12) were natural and hatched, 15.8% (n=3) were predated, 10.5% (n=2) eroded and inundated with water, and 10.5% (n=2) partially poached. Nest contents are listed in table 4.

Fifteen nests were originally triangulated during oviposition but only four of these were eventually excavated. This was a result of an inability to find the nests, likely due to erosion, or an inability to excavate the nests because they were underwater. Because of the lack of relocation permits, all leatherback nests were left in situ, and many were laid very close, and sometimes on or below the high tide line. In total, ten nests that were triangulated were unable to be excavated because of erosion. In addition, one triangulated nests was unable to be excavated because all flagging tape markers had been removed.

Figure 12 shows overall percentages for all leatherback nests laid in 2012. Overall 18% (n=12) were eroded or likely eroded, 18% (n=12) were natural and hatched, 5% (n=3) were predated, 3% (n=3) were partially poached and 56% (n=37) were left unknown because they did not show signs of hatching and were not triangulated.
Figure 12: Final nest status and overall relative percentage of all leatherback nests laid during the 2012 season on Playa Norte, Costa Rica.

Table 4: Nest contents for the 19 excavated leatherback nests during the 2012 season on Playa Norte, Costa Rica.

<table>
<thead>
<tr>
<th>Status</th>
<th>HS</th>
<th>ES</th>
<th>Yolked</th>
<th>Yolkless</th>
<th>Shells</th>
<th>Embryo Status</th>
<th>Pipped</th>
<th>Live</th>
<th>Dead</th>
<th>Pre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Und</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Eroded</td>
<td>0.0</td>
<td>0.0</td>
<td>89</td>
<td>50</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Eroded</td>
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<td>30.6</td>
<td>59</td>
<td>47</td>
<td>19</td>
<td>16</td>
<td>13</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Nat/Hat</td>
<td>100.0</td>
<td>100.0</td>
<td>49</td>
<td>15</td>
<td>49</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nat/Hat</td>
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<td>60.3</td>
<td>72</td>
<td>27</td>
<td>46</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Nat/Hat</td>
<td>72.3</td>
<td>72.3</td>
<td>13</td>
<td>47</td>
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<td>2</td>
<td>4</td>
<td>3</td>
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<tr>
<td>Nat/Hat</td>
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<td>30.3</td>
<td>78</td>
<td>31</td>
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<td>39</td>
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<td>0</td>
<td>2</td>
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<tr>
<td>Nat/Hat</td>
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<td>78.4</td>
<td>64</td>
<td>43</td>
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<tr>
<td>Nat/Hat</td>
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<td>66.1</td>
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<td>5</td>
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</tr>
<tr>
<td>Nat/Hat</td>
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<td>23.8</td>
<td>79</td>
<td>23</td>
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<td>34</td>
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<tr>
<td>Nat/Hat</td>
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<td>29.3</td>
<td>86</td>
<td>27</td>
<td>27</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>9</td>
<td>30</td>
</tr>
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<td>Nat/Hat</td>
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<td>45.9</td>
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<td>2</td>
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<td>Nat/Hat</td>
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<td>75.4</td>
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</tr>
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<td>Nat/Hat</td>
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<td>76.9</td>
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<td>0</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Partially Poached</td>
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<td>80.2</td>
<td>0</td>
<td>19</td>
<td>69</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Partially Poached</td>
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<td>61.9</td>
<td>0</td>
<td>0</td>
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<td>9</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>Predated</td>
<td>86.3</td>
<td>83.6</td>
<td>73</td>
<td>6</td>
<td>63</td>
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<tr>
<td>Predated</td>
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<td>42.2</td>
<td>84</td>
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<td>38</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>10</td>
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</table>
Incubation Duration, Hatching and Emergence Success

Incubation duration was obtained for fourteen nests and ranged from 59 to 69 days with an average of 62 days. Hatching and emergence success ranged from 0-100% and was calculated from 19 nests with means of 56.9% and 59.3% respectively. Individual hatching and emergence success numbers can be found in Table 4.

Poaching of Adult turtles

There was no poaching or lifting of adult Leatherback turtles documented during the 2012 season.

Human Presence and Light Source

Figure 13 shows the percentage of days each human activity was encountered for the four months of the leatherback turtle season. Mobile lights were encountered during every month during the turtle season. Mobile red lights were seen on 16% (n= 13) and mobile white lights were seen on 86.4% (n=70) of all nights surveyed throughout the four months. Locals were encountered during all four months while tourists were only encountered April through June. Locals were encountered on 35.8% (n=29) of all nights and increased from April to June. Tourists were encountered on 13.6% (n=11) of all nights over the four months. In total 365 people were documented on Playa Norte over the leatherback season. An average of 2.6 white lights were seen each night over the leatherback turtle season.

Included in the number of mobile white lights is the security guard at Turtle Beach Lodge, who periodically shines a very bright white light throughout the night.
Discussion:

Survey Effort:

After April 12th, when a project coordinator began full time, survey efforts were consistent and there was considerable more coverage than last year (see Figure 6 and Figure 14 for comparison). Nonetheless, efforts should be made to ensure staff are available for the turtle project by March 1st, since the first leatherback tracks are consistently seen around this time (Stevens 2010; Arroyo Arce and Jones 2009; Verissimo, et al 2008; Jackson et al. 2007; Chapparro et al. 2006). In addition, although beach coverage was good, numerous nesting females were still missed. The main two factors contributing to missed turtles are the length of the transect and the necessity to stay with a nesting turtle even after data collection is complete. This protocol has been enacted in order to prevent poaching of adult turtles, but there has been no poaching of adult turtles in the history of the project (Stevens 2010; Arroyo Arce and Jones 2009; Verissimo, et al 2008; Jackson et al. 2007; Chapparro et al. 2006). In addition, leatherback meat is oily and not favoured in Costa Rica, making the harvest of eggs common but the harvest of adult females very uncommon (Eckert 2001). Because of this, a change in protocol is suggest, where patrol teams collect all biometric data with the turtle and then move on, letting the turtle finish the nesting process and return to
the sea. This will allow more Leatherbacks to be encountered and should not endanger the females as they are not normally butchered for meat.

**Figure 14**: Percentage of days covered by a morning patrol team (Morning), one night patrol team (PM1), two night patrol teams (PM2), and three night patrol teams (PM3) for the four months of the Leatherback season in 2011 on Playa Norte, Costa Rica.

**Nesting Numbers:**

Due to the cyclic nesting behavior of marine turtles it is expected to have variation in nesting numbers from year to year (Spotila 2004; Alvarado, J. and Murphy, T in Eckert et al. 1999). With 90 tracks and 66 nests in the 2012 season, numbers appear to be relatively stable compared to previous years (Table 5) (Stevens 2010; Arroyo Arce and Jones 2009; Verissimo, et al 2008; Jackson et al. 2007; Chapparro et al. 2006). With this in mind, the projects young age, having been initiated in 2006, leads to difficulty in examining trends. In order to estimate a population of sea turtles the remigration interval of nesting females must be known (Alvarado, J. and Murphy, T. in Eckert et al. 1999). This requires many more years of data than is currently available. Consistent efforts in following years are necessary to determine if population levels are changing.
Table 5: Number of tracks and nests of leatherback turtles (Dermochelys coriacea) for the past seven years of data collection on Playa Norte, Costa Rica.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Tracks</th>
<th>Number of Nests</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>90</td>
<td>66</td>
</tr>
<tr>
<td>2011</td>
<td>109</td>
<td>71</td>
</tr>
<tr>
<td>2010</td>
<td>37</td>
<td>28</td>
</tr>
<tr>
<td>2009</td>
<td>155</td>
<td>70</td>
</tr>
<tr>
<td>2008</td>
<td>112</td>
<td>90</td>
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<td>2007</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>2006</td>
<td>76</td>
<td>52</td>
</tr>
</tbody>
</table>

Nest Status and Success

Nest success rates for 2012 were detrimentally affected by lack of MINAET permits to relocate. Leatherback turtles tend to nest in the open, sandy area of the beach before the vegetation (Whitmore and Dutton 1985; Godfrey et al. 1996). This nest site selection arises from a need to balance two pressures; nesting two low on the beach may lead to nests becoming eroded or inundated with water, whereas nesting two high can reduce hatchlings ability to orientate to the sea (Kamel and Mrosovy 2004). The majority of leatherbacks in the 2012 season, as has been seen in previous years, nested in the open area of the beach (Table 6) (Stevens 2010; Arroyo Arce and Jones 2009; Verissimo, et al 2008; Jackson et al. 2007; Chapparro et al. 2006). Playa Norte is constantly changing and erosion is considerable. Because of this, and the project’s inability to relocate higher up the beach, many leatherback nests were eroded. Exact numbers of eroded nests are difficult to calculate, but ten out of fourteen triangulated nests were either so far in the water they were unable to be excavated. Taking this number with the already known eroded nests, a minimum of 17.6% (n=12) of all 2012 leatherback nest were lost to erosion. Leatherback sea turtles are classified as critically endangered and thus each loss in the population is significant. In “Research and Management Techniques for the Conservation of Sea Turtles,” Boulon (1999) states that the first and best management technique should always be to protect eggs in-situ, but translocation/relocations can be a viable solution when there is substantial nest loss or hatching success is reduced (Boulon in Eckert et al. 1999). Relocations have both benefits and disadvantages requiring conservation programs to seriously consider whether it is necessary to move the nest. Mrosovy 2006 argues that relocations may detrimentally affect the future gene pool (Mrosovy 2006). Some eggs may survive being washed over by the hide tide and may not be entirely doomed (Whitmore and
Dutton 1985; Hilterman 2001). But many others consider relocations a simple and effective conservation strategy used in order to improve hatching success (Dutton et al. 2005; Nordmoe et al. 2004). Relocations do generally result in a lower hatching success than in-situ nests in good areas, but when done with care the method is successful at improving overall hatching success to those nests at risk (Boulon in Eckert et al. 1999). Therefore, steps should be taken in 2013 to ensure permits are acquired for relocations in order to reduce this loss. In addition, monitoring of beach profile can be used to determine to what extent the beach is eroded and whether more serious measures, such as the creation of a hatchery, are necessary. Records of beach profile at standardized points (every 1/8\textsuperscript{th} of a mile at markers is suggested) will allow the project to see how the beach is changing and to identify more stable areas for relocation.

\section*{Table 6: Percentage of leatherback turtles (Dermochelys coriacea) nests laid in the open area for the past seven years of data collection on Playa Norte, Costa Rica.}

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage of Nests Laid in Open Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>94</td>
</tr>
<tr>
<td>2011</td>
<td>97.2</td>
</tr>
<tr>
<td>2010</td>
<td>75.7</td>
</tr>
<tr>
<td>2009</td>
<td>97.1</td>
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<tr>
<td>2008</td>
<td>100</td>
</tr>
<tr>
<td>2007</td>
<td>86</td>
</tr>
<tr>
<td>2006</td>
<td>90</td>
</tr>
</tbody>
</table>

\section*{Human Presence and Light Source:}

Despite the illegality of being on the beach at night, both tourists and locals are consistently seen on Playa Norte during night patrols. Tourists may inadvertently interfere with leatherback turtles’ natural nesting behavior when patrol teams are not present to prevent such interactions. Although it is difficult to keep tourists off the beach, educational presentations may provide them with the knowledge necessary to avoid disturbing a nesting turtle. Educational presentations at local hotels, lodges and school should be increased to help prevent negative interactions with turtles.
References


