

REPORT ON THE 2009 LEATHERBACK PROGRAM AT TORTUGUERO, COSTA RICA

Submitted to
Caribbean Conservation Corporation
and
The Ministry of Environment, Energy and Telecommunications, Costa Rica
15 September, 2010

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Acknowledgements

The 2009 Leatherback Program monitoring and research activities were conducted under a research permit from the Tortuguero Conservation Area (ACTo) of the Ministry of Environment, Energy and Telecommunication of Costa Rica (MINAET), detailed in resolution number ACTo-GASP-PIN-001-09.

All data presented in this report were collected by the Field Coordinator Ricardo Sarmiento Devia (Colombia) and his hardworking team of Research Assistants: Geiner Alvarado Ramirez (Costa Rica), Miguel Cazenave (Spain), Jesús Cortes Solano (Costa Rica), Trevor Erickson (USA), Orlando Jiménez Perez (El Salvador), Marina Laborde Basto (Portugal), Tina Lee (USA), Erin Leline (USA), Ana Clara Mazzolari (Argentina), Jonathon Willans (Canada), Emily Wilson (USA) In addition, numerous program participants assisted in data collection and their help is gratefully recognized.

Jorge Ivan Ramos conducted the weekly track surveys of the entire nesting beach; his considerable efforts are very much appreciated.

The dedicated staff members of the John H. Phipps Biological Field Station were an integral part of the 2009 Leatherback Program. Station Manager Juan Carlos Cordero provided logistical support; Valerie Rojas was the administrator of the visitor center; boat captain Jorge Ivan Ramos safely transported researchers on the canals; Zelmira Williams kept the station staff well fed; Jeanette Molina was responsible for keeping the station tidy and ensuring that everyone had clean clothes; Roberto Zepeda kept the station and grounds maintained, and the station was kept secure, day and night by security personnel José Lara and Jorge Luis Vasquez.

Sr Eduardo Chamorro and the dedicated park rangers of ACTo are acknowledged for their on-going efforts to protect sea turtles in Tortuguero National Park; and thanks also to the rangers at the Jalova field station for sharing their living quarters with the research assistants.

The continued support of tour guides and the entire community of Tortuguero during the 2009 Leatherback Program is much appreciated.

Gratitude is also extended to National Director Roxana Silman and her administrative assistant Maria Laura Castro in the CCC office in San José for the provision of logistical support throughout the Program. The help of the CCC staff in Gainesville, Florida in purveying necessary equipment and providing any support requested is also acknowledged.

For financial assistance during the 2009 Leatherback Program we would like to thank the Bay and Paul Foundation, the Chase Wildlife Foundation, the Firedoll Foundation, the Lemmon Foundation, the Marisla Foundation, the Norcross Wildlife Foundation and all of the volunteer participants.

Executive Summary

Monitoring and Research Activities Conducted

- 1 A total of 27 track surveys were conducted between the Tortuguero river mouth and Jalova lagoon between 3 January and 5 July 2009
- 2 Leatherback nesting was recorded on track surveys from late February to early June; however, leatherbacks were observed by the Field Coordinator (FC) and Research Assistants (RAs) during night patrols until 15 July.
- 3 Peak nesting was recorded on 11 April when eight fresh leatherback nests were recorded from one night.
- 4 The FC and the RAs conducted a total of 28 additional track surveys between the Tortuguero and Parismina river mouths between 14 March and 3 June 2009.
- 5 725 leatherback, 59 green turtle and 19 hawksbill nests were recorded during the track surveys of the entire 22 miles of beach.
- 6 Poaching was estimated at a minimum of 17.7% of leatherback nests, 3.4% of green turtle nests and 5.3% of hawksbill nests.
- 7 Comparison of the leatherback nesting estimates obtained from track surveys conducted either by the track surveyor (274 nests) or by the FC and RAs (504 nests) between Tortuguero river mouth and Jalova lagoon between 14 March - 3 June revealed that the two methods showed quite different results.
- 8 One green turtle was taken illegally during the 2009 Leatherback Program.
- 9 A total of 78 leatherback turtle encounters were recorded during 790.3 hours of night patrols between 8 March and 3 June, 2009; 25 were newly tagged females, 38 had tags from previous years and/or other nesting beaches, and 15 were renesters. In addition, eight green turtles and three hawksbill turtles were encountered.
- 10 Of the 63 individual leatherback turtles encountered 60.3% (n = 38) bore tags from previous years or other nesting beaches. Of these previously tagged leatherback turtles, 42.1% were originally tagged in Tortuguero (n = 16); the others were tagged in Caño Palma (n = 1), Parismina (n = 4), Pacuare (n = 5), Mondonguillo (n = 6) and Gandoca/Manzanillo (n = 3). There were also three females originally tagged in Bocas del Toro province, Panama. One of the females tagged in Tortuguero was first observed in 1999, 10 years previously. One green turtle had tags from Pacuare.
- 11 A total of 17.4% (n = 4) of the newly tagged leatherback turtles (n = 25) showed evidence of old tag holes or notches when they were encountered for the first time.
- 12 A total of 70.5% of the encountered leatherback turtles nested in the open beach zone (n = 55), 10.3% nested in the border zone (n = 8) and 19.2 % did not lay eggs (n = 15).
- 13 No significant difference in carapace length (CCL_{min}) was found for newly tagged or previously tagged leatherback turtles.

- 14 Mean curved carapace length (CCL_{min}) of leatherbacks was 153.3 cm (n = 56).
- 15 Mean clutch size for leatherback females was 76 yolked and 23 yolkless eggs (n = 21).
- 16 Mean carapace length (CCL_{min}) was 103.7 cm for green turtles (n = 6), and 89.9 cm for hawksbill turtles (n = 2). Mean clutch size for green turtles was 104 eggs (n = 3) and 182 for hawksbills (n = 1).
- 17 Precision of the CCL_{min} measurement during the same encounter was relatively high in 2009, and was similar for all species; 0.5 cm for leatherback (n = 56), 0.3 cm for green (n = 6) and 0.6 cm for hawksbill turtles (n = 2).
- 18 Precision of the CCL_{min} measurement for leatherback turtles measured during more than one encounter was 1.8 cm for two encounters (n = 5) and 2.1 cm for three encounters (n = 3).
- 19 A total of 27 leatherback nests were marked for monitoring; one of these was marked during the 2009 Green Turtle Program.
- 20 Three green turtle nests and one hawksbill nest were also marked for monitoring; they will be included in the analysis of hatching success in the 2009 Green Turtle Program Report.
- 21 Overall hatching success for monitored leatherback nests (n = 21) was 58.1% and overall emerging success was 57.6%.
- 22 Mean distance between the sand surface and the top egg at the time of excavation for undisturbed nests (n = 15) varied between 45-79 cm with a mean of 61.4 cm. Mean distance from the sand surface to the bottom of the egg chamber varied between 64-89 cm, with a mean of 78.9 cm.
- 23 The incubation period for leatherback nests for which emergence was observed (n = 8) ranged from 59-64 days with a mean of 62 days.
- 24 One deformed embryos and two twin embryos were recorded during nest excavations, corresponding to 0.29% of eggs.
- 25 Rainfall was heaviest in March (384.2 mm), and May was the driest month (208.8 mm).
- 26 Air temperature ranged from 19 – 31°C. March was the coolest month (Mean air temperature = 25.4°C) and April was the warmest (Mean air temperature = 26.8°C).
- 27 Monthly mean sand temperatures in the vegetation zone ranged between 25.9 – 26.9°C.
- 28 A total of 107,261 visitors paid to enter Tortuguero National Park (TNP) in 2009, the first decrease in visitation in ten years.
- 29 The visitation at the CCC Visitor Center decreased in 2009, continuing the trend from 2007. A total of 27,565 visitors were registered for the year, an average of 76 visitors per day.
- 30 The pattern of artificial lights visible on the beach remains the same as that recorded in other years; most lights are in Tortuguero village and several lodges and cabinas north of the village.
- 31 Seven turtles were recorded as killed by jaguars during the 2009 Leatherback Program; five

green turtles, one hawksbill and one leatherback.

- 32 The FC and RAs conducted environmental education activities as part of the Junior Research Assistant Program, for students at the Tortuguero High School.
- 33 CCC staff and RAs assisted with the third spay/neuter clinic held 19-21 March. 141 animal were treated of which 42 were castrated.

Conclusions

- 1 The task of replacing and painting mile markers along the entire beach was extremely arduous due to the reduced number of RAs and the extreme weather conditions at the start of the 2009 Leatherback Program.
- 2 In 2009, leatherback nesting increased slightly from levels recorded in 2008.
- 3 Leatherback nesting in 2009 was concentrated in the southern half of the beach, from mile 12 – 22.
- 4 The two methods, track surveyor and FC/RAs track surveys, used to estimate the number of leatherback nests gave quite dissimilar results for the 2009 leatherback nesting season.
- 5 Levels of poaching increased for leatherbacks but decreased for green turtles and hawksbills in 2009.
- 6 Only one green turtle was recorded as poached during the 2009 Leatherback Program.
- 7 The number of leatherback turtles encountered during nightly patrols (n = 89) was similar to 2008, but patrol effort was considerably lower due to a reduced number of RAs.
- 8 Overall hatching and emerging success of leatherback nests was much higher in 2009 than that observed in previous years.
- 9 There was no formal program of environmental education activities conducted during the 2009 Leatherback Program.
- 10 The beach clean-up was very successful and was a well coordinated activity involving CCC, national park staff, lodges, local businesses and the community of Tortuguero.
- 11 The third spay/neuter clinic was very successful and well supported by the communities of Tortuguero and San Francisco.

Recommendations

- 1 In future years eight RAs should be contracted to conduct the monitoring, research and outreach activities of the Leatherback Program.
- 2 Preparation of the beach markers should be conducted with the use of an ATV if possible, to assist the RAs to complete this task easily and efficiently.
- 3 RA training and orientation should continue to include presentations from MINAET staff, to discuss issues related to environmental law, and members of the community, to talk about the historical development of Tortuguero.

- 4 Track surveys conducted by the FC and RAs every three days should be continued in future Leatherback Programs.
- 5 Continuing high levels of poaching south of the limit of Tortuguero National Park (between miles 18 – 22) highlights the need for extra patrols by park rangers in this section of beach during the leatherback nesting season. CCC should work in conjunction with MINAET to secure additional funding to conduct patrols and turtle protection initiatives during leatherback nesting season, specifically targeted around the Jalova river mouth.
- 6 Night patrols should be conducted in the sections of the beach with highest leatherback nesting activity (including the stretch of beach between Jalova and Parismina), to increase encounter rates and provide a more consistent presence on the beach to deter potential poachers.
- 7 The development of a regional database for leatherback information should be encouraged, to better improve knowledge about the movements of this species along the Caribbean coast of Costa Rica and Panama.
- 8 All marked nests need to be carefully monitored on a daily basis throughout the incubation period, in order to determine the precise fate of each nest and the date of hatching.
- 9 CCC should continue to monitor levels of tourism in Tortuguero, to ensure that tourist activities do not negatively affect sea turtles or other endangered species in the area.
- 10 CCC should continue monitoring physical data in Tortuguero; these data provide important data to determine any changes in environmental conditions over time, as a result of climate change.
- 11 Lost data loggers should be replaced, to continue the monitoring of sand temperatures. Care should be taken when choosing their locations to minimize the risk of them being disturbed during the nesting season.
- 12 The CCC Visitor Center needs to be modernized and updated to fulfill its role in raising awareness and improving education about sea turtle conservation issues, the history of the CCC in Tortuguero, and the flora and fauna of TNP.
- 13 CCC should work with the Costa Rica Energy Institute (ICE) and the local community to try to minimize the number of artificial lights visible on the nesting beach, to avoid deterring females from nesting and disorientating hatchlings.
- 14 A full time outreach and environmental education coordinator should be contracted to supervise the education program and act as a liaison between CCC, the National Park and the local community.
- 15 CCC should continue to be an active member of the committee organizing the spay/neuter clinics in Tortuguero and should support the clinics however possible.

1. Introduction

Research and conservation of the sea turtle populations of Tortuguero, Costa Rica was initiated by Dr Archie Carr in 1955 (Carr *et al.* 1978) and continues to this day. Caribbean Conservation Corporation (CCC) began an annual leatherback (*Dermochelys coriacea*) program in Tortuguero in 1995 (Campbell *et al.* 1996); this program is implemented in partial fulfillment of CCC's scientific mission in Tortuguero:

'CCC will provide the scientific information necessary to conserve the populations of sea turtles that nest at Tortuguero, Costa Rica, so that they fulfill their ecological roles'

CCC staff and the Scientific Advisory Committee made a major revision of the Leatherback Program monitoring protocol in 1997, and they conduct regular reviews and modifications as necessary. The 2009 Leatherback Program represents the fifteenth consecutive leatherback program and the twelfth year of implementing the new monitoring protocol.

The objectives of this report are to summarize the results of the 2009 Leatherback Program, assess the accomplishments and shortcomings of the program, and provide appropriate recommendations for future research activities and conservation efforts in Tortuguero.

2. Methods

2.1 Preparations

At the start of the 2009 Leatherback Program the RAs completed an extensive orientation and training program; they received lectures about sea turtle biology and conservation, and the Leatherback Program monitoring protocol was explained in detail. In addition to theoretical instruction they received practical training in flipper tagging, nest marking and other data collection procedures from the FC. Training patrols were conducted on several nights along sections of beach close to the field station (between the Tortuguero river mouth and mile 5); the FC demonstrated field techniques and supervised RAs collecting data and tagging turtles. Additional training patrols were also conducted at the southern end of the beach, close to the Jalova lagoon. The RAs were also introduced to key members of the community, including staff at the National Park ranger station. They learned about the history of the National Park, environmental laws relating to sea turtles, and the historical development of Tortuguero. They were also taken on a canal tour to learn about the flora and fauna of the park.

The positions of mile markers along the 22 miles (36km) of beach between the Tortuguero and Parismina river mouths were verified using a 300ft fiberglass measuring tape. Mile markers were located every 1/8 of a mile between the Tortuguero river mouth (mile -3/8) and mile 5, and every 4/8 mile between mile 5 and the Parismina river mouth (mile 21 4/8). Three markers were put up in every location from mile -3/8 - 5, and between miles 14 - 18; two markers were positioned at each location for the rest of the beach. All markers were painted white, with the mile painted in black.

2.2 Track Surveys

2.2.1 Weekly track surveys

Track surveys between the Tortuguero river mouth and Jalova lagoon (18 miles) were conducted

approximately weekly by the CCC track surveyor. Track surveys started near Tortuguero river mouth around 5:00am and were completed at Jalova lagoon at approximately 10:30am. Only fresh sea turtle tracks from the previous night were counted. Notes were also kept on the number of turtles depredated by jaguars (*Panthera onca*) or taken by poachers, and the number of poached fresh nests.

Dead turtles were considered depredated by jaguars when they were surrounded by jaguar tracks or showed characteristic jaguar injuries, such as large bite wounds to the neck.

A nest was recorded as poached if there were signs of human disturbance, including footprints around the nest, poke holes from a stick, evidence of digging, an empty egg chamber or fresh egg shells close to the nest. A turtle was considered poached when the track indicated that humans had dragged the turtle off the beach.

The total number of leatherback nests for the season was extrapolated from the track survey data by applying a GAM model and integrating resulting values using Berkeley Madonna software (For methodology see Troëng *et al.* 2004).

2.2.2 Three-day track surveys

Track surveys were conducted by the FC and RAs between the Tortuguero and Parismina river mouths, every three days during the 2009 Leatherback Program, following the completion of the RA orientation and training period. The beach was divided into four sections: Tortuguero river mouth - CCC station (mile 2 5/8); CCC station - Juana López trail (mile 15); Juana López trail - Jalova lagoon (mile 18) and Jalova lagoon - Parismina river mouth (mile 21 4/8). All tracks since the previous survey were recorded, to get a total count of all nesting activity throughout the season. Once a track had been recorded two lines were drawn through it, and sticks were placed in a cross formation over the nest, to ensure that it was not counted on future surveys. Notes were also kept on jaguar predation, and levels of illegal take of turtles and nests.

2.3 Tagging of Nesting Sea Turtles

Nightly tagging patrols were conducted, with varying frequency, on three different beach sections; Tortuguero river mouth - CCC station (mile 2 5/8), CCC station - mile 5, and Jalova lagoon (mile 18) - mile 14.

Any turtle that was encountered during the patrol was tagged after finishing oviposition or when returning to the sea. Leatherbacks were tagged in the rear flippers; green turtles (*Chelonia mydas*) and hawksbills (*Eretmochelys imbricata*) were tagged axillary, close to the first scale on the front flippers. All turtles were double-tagged to allow identification even if one tag was lost between nesting emergencies.

For each encounter the following information was recorded:

- Date
- Time when first encountered
- Mile marker (to the north of the turtle)
- Activity when first encountered
- Species
- Tag numbers and/or evidence of old tag holes or notches

The location of the nest was classified into one of three groups:

- Open – open beach with no vegetation and no shading
- Border – nest partially shaded by vines or other sparse vegetation for some part of the day
- Vegetation – dense vegetation completely shading the nest throughout the day

2.4 Biometric Data Collection

If the turtle was encountered before the start of oviposition, the eggs were counted as they were laid into the egg chamber. They were counted by a person wearing a plastic glove to avoid contamination of the nest. Normal sized and yolkless eggs (those that have just the albumen surrounded by a shell, with no yolk present) were counted separately.

Curved Carapace Length minimum (CCLmin) was recorded for each leatherback; this was measured, using a flexible fiberglass tape measure, from the nuchal notch to the end of the caudal projection, next to the central ridge. The caudal projection was classified as ‘complete’ if no irregularities occurred and ‘incomplete’ if it was irregular or part of it was missing that would effect the carapace measurement. CCLmin for green and hawksbill turtles was measured from where the skin meets the carapace at the nuchal notch, along the midline, to the posterior notch between the supracaudals. All measurements were recorded to the closest millimeter. To determine precision, all measurements were repeated three times by the same person. Precision for one encounter is defined as the difference between the shortest and the longest of the three measurements. Precision for females encountered more than once during the Program is defined as the difference between the shortest and the longest of all measurements collected from the same turtle.

2.5 Determination of Nest Survivorship and Hatching Success

If a leatherback turtle was encountered along the beach section between the Tortuguero river mouth (mile - 3/8) and the mile 5 marker, and the egg chamber was still open (prior to covering) the nest was marked for inclusion in the study of nest survivorship and hatching success. Green and hawksbill nests were also marked in this section of beach if the female had not covered the egg chamber.

The location of the egg chamber was marked using three pieces of flagging tape that were attached to vegetation behind the nest, and the distance from the centre of the egg chamber to each tape was measured so that the location of the nest could be determined at a later date using triangulation. Use of a third flagging tape ensured that nests could still be located even if one piece of flagging tape went missing.

Each morning at 6.00am the marked nests were inspected so that the fate of the nest could be determined. Evidence of depredation, poaching or beach erosion were noted and resulted in termination of monitoring for that nest; if the evidence was inconclusive, monitoring continued as normal, but the date of the observed disturbance was recorded, so that any resulting anomalous excavation data could be accounted for.

Marked nests were excavated two days after evidence of hatching (hatchlings observed or hatchling tracks originating from the nest location), or 75 days after oviposition (65 days for green or hawksbill nests) if no signs of hatching were observed.

For each nest excavated the following information was recorded to determine hatching and emerging success:

- Number of empty shells – only shells corresponding to more than 50% of the egg were counted
- Number of hatchlings – alive or dead
- Number of unhatched eggs – these were categorized as:
 - Without embryo – no visible embryo observed
 - Embryo – an embryo at any stage of development was present
 - Full embryo – a fully developed embryo was present
- Number of pipped eggs – embryo had broken the shell but did not hatch
- Number of predated eggs
- Number of deformed embryos – including albinism or multiple embryos in a single egg
- Number of yolkless eggs

In addition the depth from the surface to the top of the egg chamber (to the first egg encountered), and the bottom of the egg chamber (after the last egg was removed) was measured to the nearest centimeter.

2.6 Physical Data Collection

Throughout the 2009 Leatherback Program several environmental variables were monitored on a daily basis at the John H. Phipps Biological station in Tortuguero.

- Rainfall was collected in a gauge that was emptied each day at 9.00am and recorded to the closest 0.1mm.
- Air temperature was recorded at 9.00am; the minimum and maximum values for the previous 24 hours, and the current temperature were noted.
- Sand temperature was measured using data loggers buried at 30, 50 and 70cm depth in the open, border and vegetation zones of the beach in front of the CCC station. The data loggers were set to take a temperature reading every hour. The data were downloaded at the end of the 2009 Leatherback Program.

2.7 Collection of Human Impact Data

2.7.1 Visitors to Tortuguero

The number of tourists that paid to enter the CCC Visitors Center was recorded each day by the administrator. Staff at the Tortuguero National Park offices at Cuatro Esquinas provided information on tourist visitation to the park in 2009.

2.7.2 Artificial lights

To assess the impact of artificial lights on the Tortuguero nesting beach a light survey was conducted each month. Dates as close as possible to the new moon were selected when natural light levels on the beach were minimal. The beach was surveyed from the Tortuguero river mouth to the mile 5 marker.

For each survey the following data were recorded:

- Date
- Beach section – Boca or Park

- Name of observers
- Mile section
- Number of lights visible from the beach
- Light source (if possible to determine)
- Location of light source (beach side or river side)

To avoid duplicate recording of the same light source in more than one 1/8 mile section of beach, only those lights that could be seen while viewed perpendicular from the beach were recorded in each 1/8 mile.

2.8 Dead Turtles

Any dead turtles encountered during track surveys or other monitoring activities were recorded and an attempt was made to determine the cause of death.

2.9 Environmental Education and Outreach Activities

Presentations about sea turtle biology, conservation and environmental economics were given opportunistically to groups staying at or visiting the John H. Phipps Biological Station. In addition, researchers organized a program of environmental education activities at the Tortuguero village school and high school, involving children in grades 1 - 9.

The Castration Clinic for Pets in Tortuguero, which was initiated in 2008, continued in 2009. CCC was involved with organizing educational talks to members of the community regarding pet care and also in helping to coordinate a veterinarian spay/neuter clinic.

3. Results

3.1 Preparations

The FC arrived in Tortuguero on 27 February to prepare for the 2009 Leatherback Program. Due to financial limitations in 2009 only four RAs were contracted for the Leatherback Program; thus it was decided to divide the program into two groups. The first group of RAs arrived at the field station on 2 March, 2009. Training and orientation sessions were conducted from 3-15 March by the FC with support from the Scientific Director. The second group of RAs arrived on 15 April, 2009 and received training from 16-23 April. In addition to talks about sea turtle biology, history of the CCC and a presentation about the laws pertaining to sea turtles in Costa Rica, the RAs also had the opportunity to learn about the history and development of Tortuguero community from a member of one of the founding families of the community, Alonzo Rankin. They also visited the other biological research station, Caño Palma to talk to staff about the work being done there.

Severe bad weather at the end of 2008 and the beginning of 2009 meant that the majority of the beach mile markers had to be replaced at the start of the 2009 Leatherback Program because they had been washed away in high tides. The preparation of the mile markers was a significant task for the RAs in 2009; their work was hampered by heavy rains and it took over two weeks to complete the task of marking the entire 22 miles of beach from the Tortuguero river mouth to the Parismina river. As in 2008 an ATV was used for the section between miles 5-15.

3.2 Track Surveys

3.2.1 Weekly track surveys

A total of 27 weekly track surveys were conducted between 3 January and 5 July 2009, during which 41 leatherback nests and 29 false crawls were recorded by the track surveyor. Figure 1 displays the results of the weekly track surveys; each bar represents the number of leatherback nests and false crawls recorded during a single survey.

It can be seen that leatherback nesting occurred from late-February to early-July. However, several females were encountered after this date during night patrols conducted during the 2009 Green Turtle Program, thus it is known that leatherback nesting continued until at least 15 July.

There was one distinct peak in nesting observed during the 2009 season; eight leatherback nests were recorded during the survey on 11 April (See Figure 1). It is also interesting to note the abrupt end to nesting activity observed in June.

Using the methodology described in Troëng *et al.* (2004) extrapolations from the weekly survey data suggest that just 274 leatherback nests were laid between Tortuguero river mouth and Jalova lagoon. However, the FC and RA track surveys, conducted every three days from March - June, recorded 504 leatherback nests along the same beach section.

The annual leatherback nesting trend at Tortuguero for the last 15 seasons is shown in Figure 2. It can be seen that in 2009 there was a slight increase in leatherback nesting, although there has been an overall decline since 1995 of 73%. Using the nesting estimates calculated from the weekly track surveys, in the last five years an average of 397 leatherback nests have been laid per season.

3.2.2 Three-day track surveys

The FC and RAs conducted 28 track surveys of the entire 22 miles of nesting beach between 14 March and 3 June, 2009. They recorded a total of 725 leatherback, 59 green turtle and 19 hawksbill nests during those surveys; in addition 275 leatherback, 54 green turtle and eight hawksbill false crawls were also counted.

Peak leatherback nesting, as determined from the from the 3-day surveys, was recorded on 22 April; 49 leatherback nests had been laid during the previous three nights. This is close to the peak nesting date (11 April) recorded by the weekly track surveyor (See Figure 1).

The spatial distribution of leatherback nesting during the 2009 Leatherback Program is shown in Figure 3. The spatial distribution of leatherback nesting in 2009 was more typical of that observed in previous years, and different to the distribution reported in 2008; the majority of leatherback nests were recorded in the southern half of the beach (beyond mile 12) and between Jalova and Parismina (See Figure 3). Mile 19 had the highest nesting density; 98 leatherback nests were recorded in that mile which accounted for 13.5% of the total (See Figure 3).

Figure 1. Temporal distribution of leatherback nesting activity during 2009, as determined during weekly track surveys

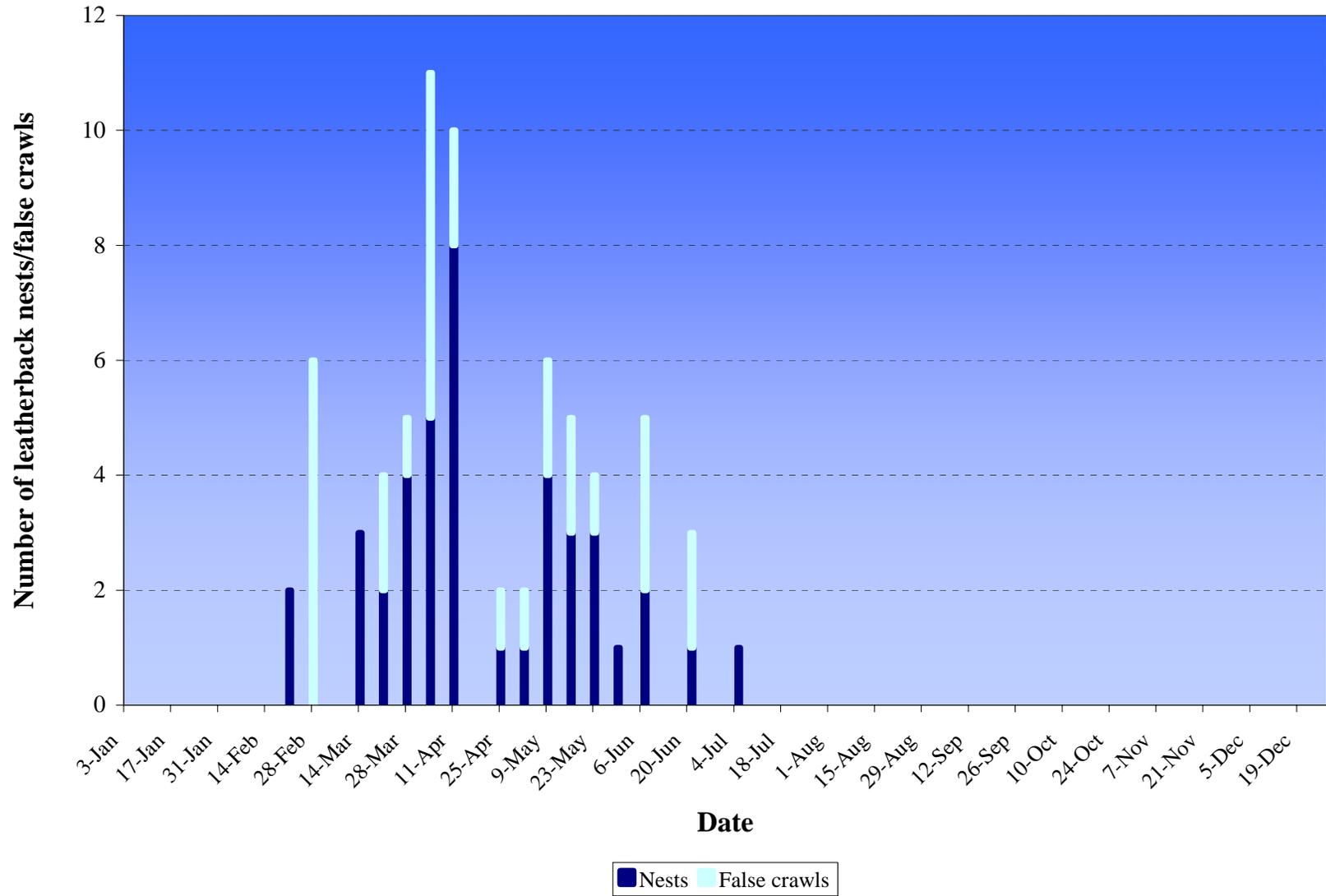


Figure 2. Annual leatherback nesting trend at Tortuguero from 1995 - 2009, as determined from weekly track surveys

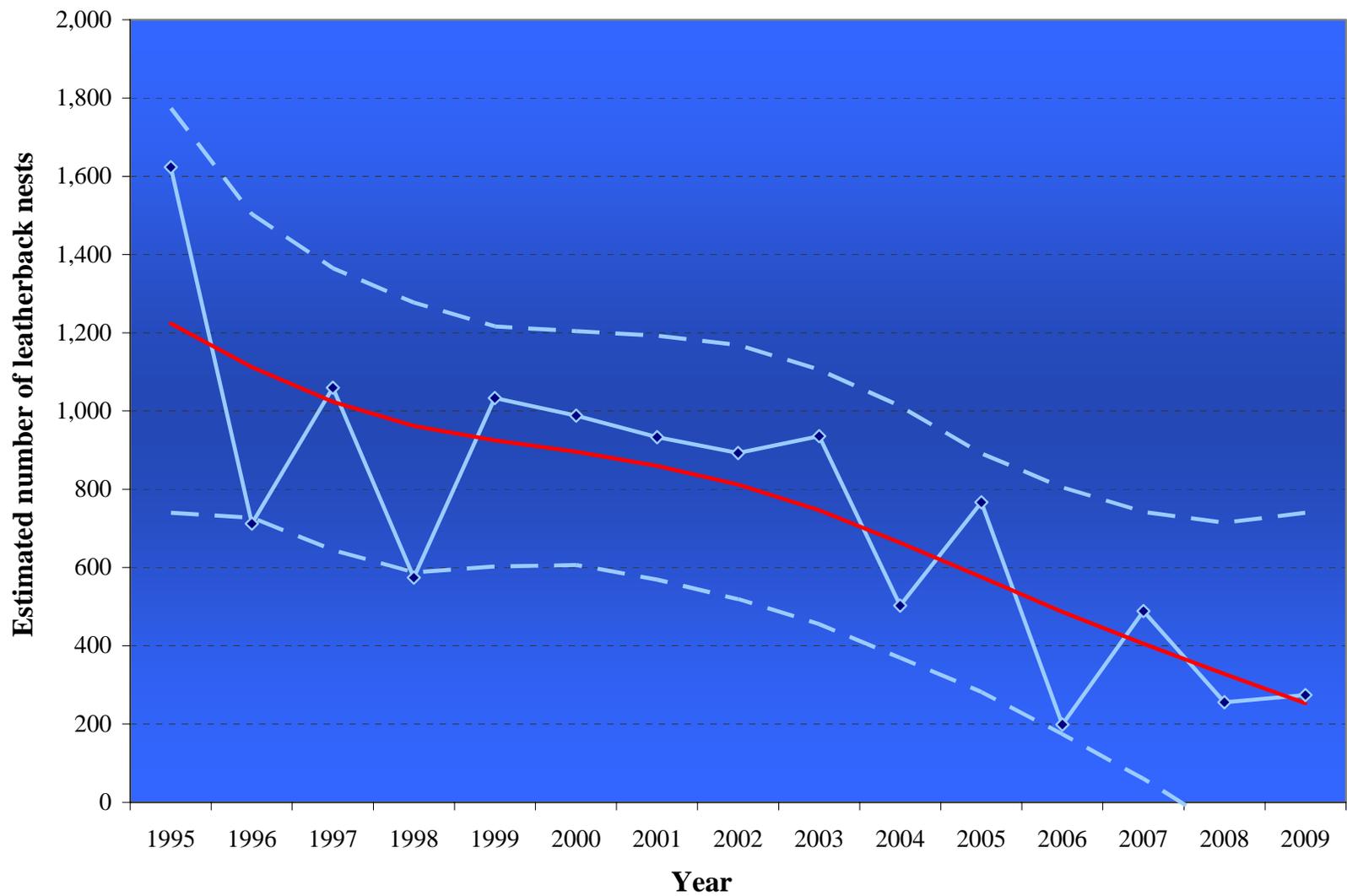
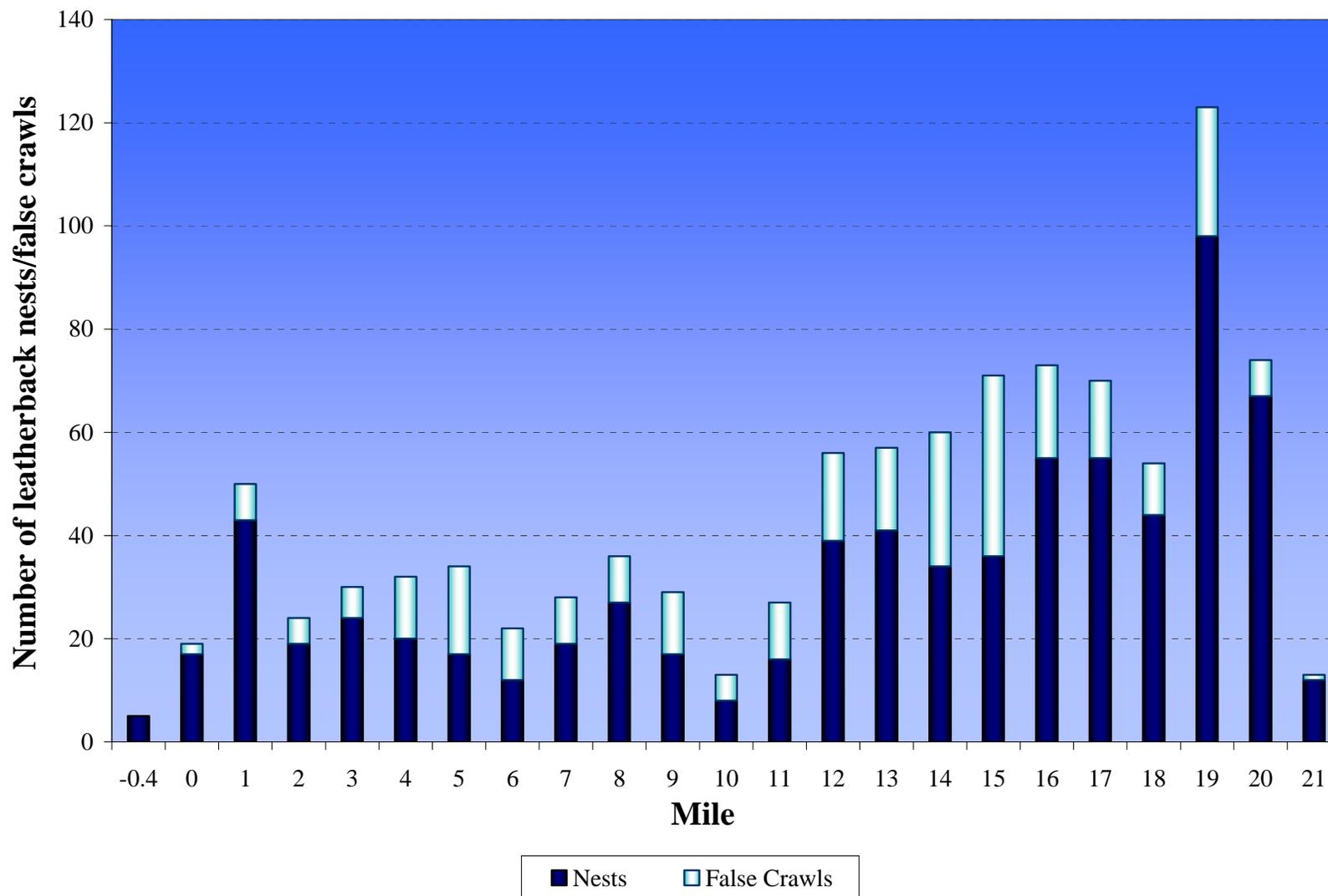


Figure 3. Spatial distribution of leatherback nests during the 2009 Leatherback Program, as determined by track surveys conducted by FC and RAs every three days



3.2.3 Illegal Take of Turtles and Nests

Illegal poaching of nests was observed throughout the 2009 Leatherback Program (See Table 1).

Table 1. Number of turtle nests and level of illegal poaching, as determined from track surveys conducted by FC and RAs during the 2009 Leatherback Program

Date	Leatherback			Green turtle			Hawksbill		
	Nests	Min no. poached	Min % poached	Nests	Min no. poached	Min % poached	Nests	Min no. poached	Min % poached
14-Mar	16	8	50.0	0	0	N/A	0	0	N/A
17-Mar	21	10	47.6	2	0	0	0	0	N/A
20-Mar	19	8	42.1	0	0	N/A	0	0	N/A
23-Mar	19	4	21.1	2	0	0	0	0	N/A
26-Mar	29	10	34.5	0	0	N/A	0	0	N/A
29-Mar	26	3	11.5	1	0	0	0	0	N/A
1-Apr	22	4	18.2	2	0	0	0	0	N/A
4-Apr	40	1	2.5	4	0	0	0	0	N/A
7-Apr	46	2	4.3	1	0	0	0	0	N/A
10-Apr	37	2	5.4	5	0	0	0	0	N/A
13-Apr	39	9	23.1	2	0	0	0	0	N/A
16-Apr	26	2	7.7	3	0	0	0	0	N/A
19-Apr	37	3	8.1	1	0	0	0	0	N/A
22-Apr	49	8	16.3	5	0	0	0	0	N/A
25-Apr	14	2	14.3	2	0	0	0	0	N/A
28-Apr	26	4	15.4	1	0	0	0	0	N/A
1-May	33	3	9.1	2	0	0	0	0	N/A
4-May	25	0	0.0	3	0	0	2	0	0
7-May	39	11	28.2	4	0	0	1	0	0
10-May	46	13	28.3	3	0	0	0	0	N/A
13-May	17	2	11.8	4	0	0	1	0	0
16-May	19	8	42.1	2	0	0	2	1	50
19-May	15	0	0.0	1	0	0	6	0	0
22-May	16	4	25.0	1	0	0	0	0	N/A
25-May	10	2	20.0	2	0	0	3	0	0
28-May	13	3	23.1	2	0	0	2	0	0
31-May	13	1	7.7	2	2	100	0	0	N/A
3-Jun	13	1	7.7	2	0	0	2	0	0
Total	725	128	17.7	59	2	3.4	19	1	5.3

N/A = No nests for that species were recorded during that survey

A total of 131 (16.3%) nests were reported as poached during track surveys conducted by the FC and RAs; 128 leatherback, two green turtle and one hawksbill. The minimum poaching level of leatherbacks was higher in 2009 than that recorded in 2008 (17.7% compared to 11.0%, respectively); however, poaching of green turtle and hawksbill nests was very low in 2009 (See Table 1).

The spatial distribution of illegal take of nests is shown in Figure 4. Poaching was concentrated in the four-mile section of beach from Jalova to Parismina; which lies outside the limits of Tortuguero National Park. There were 103 nests poached from this section of beach, which accounts for 78.6% of all nests taken. Very few nests were taken within Tortuguero National Park, or close to the village of Tortuguero (See Figure 4).

Only one nesting female turtle was recorded as poached during track surveys conducted from March-June 2009. It was recorded on 26 March at mile 20, outside the southern limit to TNP; there was an obvious drag mark, suggesting the turtle had been flipped onto its carapace and removed from the beach.

3.3 Tagging of Nesting Sea Turtles

Tags used during the 2008 Leatherback Program were National Band & Tag Company (NBTC) Monel #49 tags VA4150, VA4908-VA4991 (except VA4926-VA4932, VA4945-VA4950 and VA4983-VA4989); VC1106-VC1120 (except VC1113-VC1117) and Inconel #681 tags 113491-113541 (except 113498-113510, 113514-113519, 113526-113528 and 113532-113537).

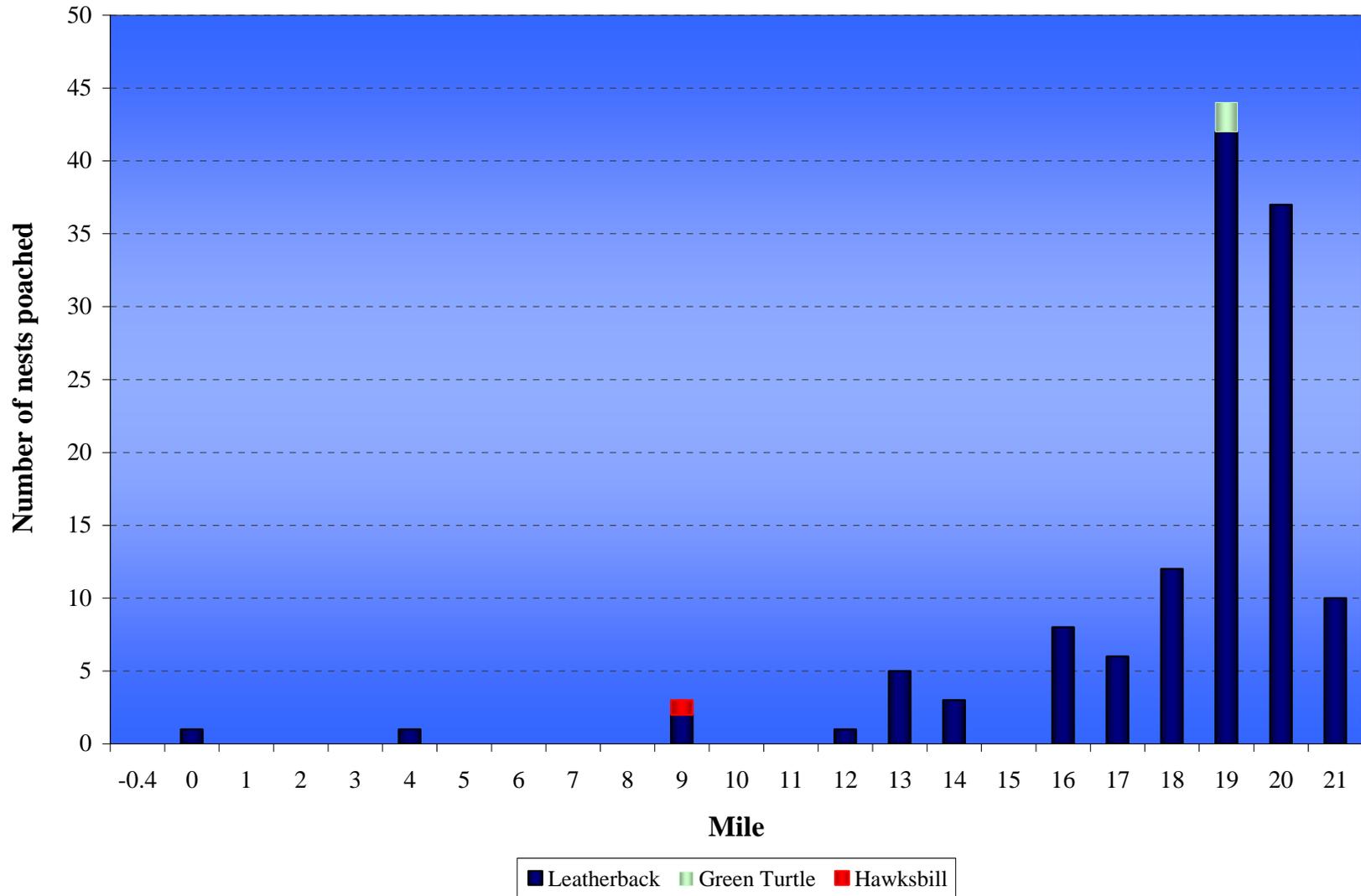
Nightly patrols were conducted between 8 March - 3 June 2009 (with the exception of 10, 11, 13, 16, 19 and 28 March, 4, 8, 12, 23 and 26 April, and 6 May); in total, 790.3 team patrol hours were logged. During these patrols a total of 89 turtles encounters were recorded; 78 leatherbacks, eight green turtles, and three hawksbills (See Appendix 1). This is equal to an average of 0.10 leatherback, 0.01 green and 0.004 hawksbill turtles encountered per patrol hour.

The turtles encountered correspond to 63 individual female leatherbacks, seven green turtles and three hawksbills. Although the majority (60.3%) of leatherback females were already tagged when first encountered ($n = 38$), there were 25 individuals newly tagged during the 2009 season, which was a slightly higher percentage than in recent years (See Appendix 1).

Of the previously tagged leatherback turtles encountered in 2009, 42.1% had originally been tagged in Tortuguero ($n = 16$). The remainder were tagged by researchers at Caño Palma (north of the river mouth in Tortuguero; $n = 1$) and other nesting beaches on the southern Caribbean coast of Costa Rica, including Parismina ($n = 4$), Pacuare ($n = 5$), Mondonguillo ($n = 6$) and Gandoca/Manzanillo ($n = 3$). There were three leatherbacks originally tagged in Panama; one at Chiriquí Beach in 2007, and two others at unknown nesting beaches within Bocas del Toro province. Of the turtles tagged in Tortuguero, one was originally tagged 10 years ago in 1999. One green turtle was encountered with tags that were applied in Pacuare Nature Reserve in 2006 and one hawksbill had tags from Tortuguero in 2003.

Evidence of holes or notches were found on 17.4% ($n = 4$) of the newly tagged leatherback turtles checked for previous tagging ($n = 23$) when they were encountered for the first time during the 2009 Leatherback Program. The majority of leatherbacks nested in the open beach zone (70.5%, $n = 55$); 10.3% nested in the border zone ($n = 8$) and 19.2% did not lay eggs ($n = 15$).

Figure 4. Spatial distribution of illegally poached nests during the 2009 Leatherback Program, as determined by track surveys conducted by FC and RAs every three days



3.4. Biometric Data Collection

CCLmin measurements were taken for 56 of the 63 individual leatherback turtles encountered. Only two females had their caudal projection classified as incomplete, so data for all females irrespective of caudal projection category were pooled. An initial analysis was conducted to compare the carapace length of newly tagged and previously tagged females; the results showed no significant difference in CCLmin between these two groups (Wilcoxon test: $Z = -1.36$, $p = 0.17$), thus data from all females were used to calculate the overall mean CCLmin (See Table 2). To ensure independency of the data only measurements taken on the first encounter with each female were used for this calculation.

Table 2 summarizes the biometric data collected from leatherback females. Mean carapace length was 152.3cm ($n = 56$) and mean clutch size was 76 yolked eggs (range = 33 - 108) and 23 yolckless eggs (range = 0 - 44). If, however, the one small clutch (33 eggs) was removed from this analysis the mean clutch size was 78 yolcked eggs and 25 yolckless eggs.

Table 2. Mean carapace length and clutch size of leatherback turtles encountered in 2009

Carapace length / cm			Clutch size / no. eggs		
n	\bar{x} CCLmin ± S.D.	Range	n	\bar{x} yolcked ± S.D	\bar{x} yolckless ± S.D
56	152.3 ± 7.8	132.4 – 170.0	21	76 ± 19	23 ± 11

Mean carapace length (CCLmin) for green turtles encountered during the 2009 Leatherback Program was 103.7 cm ($n = 6$). Three clutches were counted and the average size was 104 eggs (See Table 3). The two hawksbill turtles that were measured had a mean carapace length (CCLmin) of 89.9 cm. Only one hawksbill clutch was counted; the female laid 182 eggs.

Table 3. Mean carapace length and clutch size of green and hawksbill turtles

Species	Carapace length / cm			Clutch size / no. eggs	
	n	\bar{x} CCLmin ± S.D.	Range	n	\bar{x} ± S.D.
Green	6	103.7 ± 5.2	97.4 – 111.6	3	104 ± 19.7
Hawksbill	2	89.9 ± 0.8	89.3 – 90.5	1	182

The precision of the CCLmin measurements taken during 2009 was relatively high, and was very similar for all three species encountered during the Leatherback Program (See Table 4).

Table 4. Precision of carapace measurements for the different species of turtle

Species	n	\bar{x} precision for CCLmin (cm) ± S.D.	Range / cm
Leatherback	56	0.5 ± 0.3	0 – 1.1
Green	6	0.3 ± 0.2	0.1 – 0.6
Hawksbill	2	0.6 ± 0.0	0.6 – 0.6

The precision of the CCLmin carapace measurements for leatherback turtles measured during

more than one encounter was 1.8 cm for two encounters and 2.1 cm for three encounters (See Table 5). There was one turtle that was encountered twice and on the second occasion her caudal projection was recorded as having a recent injury; the difference in CCLmin for the two encounters was 4.4cm; if this value is removed, the mean precision for females encountered twice becomes 1.1cm.

Table 5. Precision of carapace measurements for individual leatherbacks encountered more than once during the 2009 Leatherback Program

No. of encounters	n	\bar{x} precision for CCLmin (cm) \pm SD	Range / cm
2	5	1.8 \pm 1.6	0.7 – 4.4
3	3	2.1 \pm 0.5	1.7 – 2.6

3.5 Determination of Nest Survivorship and Hatching Success

A total of 27 leatherback nests were marked between 18 March and 15 July 2009; one of these were marked during the 2009 Green Turtle Program. Of these nests six were removed from the analysis of survivorship and hatching success as the fate could not be determined for five nests that were not found during excavation and there was no record during the incubation period that they had been washed out or poached. For one other nest some of the data from the excavation were not recorded. This left a total of 21 nests included in the subsequent analyses. The fate, hatching and emerging successes of 21 marked and monitored leatherback nests are summarized in Table 6. The data from the nest excavations are summarized in Table 7.

Three green turtle nests and one hawksbill nest were also marked; these will be included in the analysis of nest survivorship and hatching success in the 2009 Green Turtle Program Report.

Table 6. Fate, hatching and emerging success of marked leatherback nests

Fate	n	% of total	% Hatching success	% Emerging success
Undisturbed	13	61.9	91.1	90.5
Unhatched	3	14.3	0.0	0.0
Washed out	3	14.3	0.0	0.0
Partly hatched	2	9.5	17.6	16.7
Total	21	100	¹58.1	¹57.6

Not included in analysis	n
<i>Unknown</i>	5
<i>Data not recorded</i>	1

¹ Calculated as the mean of all 21 nests

From Table 6 it can be seen that undisturbed nests had a very good hatching and emerging success; 91.1% and 90.5%, respectively. Those that were only partly hatched had very low hatching or emerging success; 17.6% 16.7%, respectively.

Table 7. Summary of data from nest excavations of marked leatherback nests during the 2009 Leatherback Program

Fate	n	Hatchlings		Empty shells	Pipped	Unhatched eggs			Predated	Deformed / Twin embryo	Yolkless eggs	Total number of eggs
		Live	Dead			No Embryo	Embryo	Full Embryo				
Undisturbed	13	1	3	616	3	118	28	14	16	2	487	677
Unhatched	3	0	0	0	0	147	30	62	2	1	64	241
Washed out	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Partly hatched	2	2	0	9	0	101	9	0	4	0	24	123
Total	21	3	3	625	3	366	67	76	22	3	575	1,041

N/A = No eggs were found at excavation

Overall mean hatching success of leatherback nests was calculated as 58.1% (n = 21). Emerging success was 57.6% (n = 21). These values were calculated as the mean of the 21 nests that were marked and the fate of the nest was determined (See Table 6). If unhatched and washed out nests are excluded, hatching and emerging success are 81.3% and 80.6%, respectively.

The incubation period for undisturbed leatherback nests for which emerging was observed (n = 8) varied between 59 - 64 days, with a mean of 62 days.

The distance from the sand surface to the top egg for undisturbed nest at excavation varied between 45 - 79 cm with a mean of 61.4 cm (n = 15). The distance from the sand surface to the bottom of the egg chamber for the same nests varied from 64 - 89 cm, with a mean of 78.9 cm.

One deformed embryo and two twin embryos were recorded, corresponding to 0.29% of eggs encountered during nest excavations.

3.6. Physical Data Collection

Table 8 summarizes the rainfall and air temperature data collected during the 2009 Leatherback Program. Rainfall between March and June varied less than in previous years (208.8mm – 384.2mm per month); with May being the driest month, and March the wettest (See Table 8). Average daily rainfall, over a 24-hour period, ranged from 6.7mm in May to 12.4 mm, in March.

Daily air temperature at the CCC field station in Tortuguero from March to June 2009 ranged between 19.0 – 31.0°C (See Table 8). Average daily temperatures did not vary greatly during the season; March was the coolest month (25.4°C) and April was the warmest month (26.8°C).

Table 8. Rainfall and air temperature recorded during the 2009 Leatherback Program

Month	Total rainfall mm/month	\bar{x} rainfall mm/24hrs	\bar{x} temperature/°C	Temperature range / °C
March	384.2	12.4	25.4	19.0 – 31.0
April	331.3	11.0	26.8 ¹	21.0 – 31.0
May	208.8	6.7	26.6	21.0 – 31.0
June	234.0	7.8	26.3	22.5 – 29.0

¹ Data for 48 hours 12-14 March

Unfortunately there were some problems encountered when downloading the information from the data loggers during the 2009 Leatherback Program, and data from March – May were lost. However, mean monthly sand temperatures for June – September are shown in Table 9; these months are included as marked leatherback nests were still incubating those months. The last leatherback nest was excavated on 21 September. No data are shown for the border and open zones as these data loggers were lost during the 2009 Green Turtle Program; those in the border were possibly disturbed by another nesting turtle and then taken by people. Those in the open zone were either eroded by high tides or removed deliberately by people. In the vegetation zone, two data loggers were present; at 50cm and 70cm depth.

Sand temperatures in the vegetation zone remained relatively constant from June – September; at 50cm depth temperatures ranged from 25.9 – 26.5°C, and at 70cm depth from 26.4 – 26.9°C.

Table 9. Mean monthly sand temperatures recorded June - September 2009

Zone	Vegetation			Border			Open		
	\bar{x} temperature / °C								
Depth	30	50	70	30	50	70	30	50	70
June	N/A	26.4	26.7	N/A	N/A	N/A	N/A	N/A	N/A
July	N/A	25.9	26.4	N/A	N/A	N/A	N/A	N/A	N/A
August	N/A	26.0	26.4	N/A	N/A	N/A	N/A	N/A	N/A
September	N/A	26.5	26.9	N/A	N/A	N/A	N/A	N/A	N/A
Overall mean	N/A	26.2	26.5	N/A	N/A	N/A	N/A	N/A	N/A

N/A = No data logger at that depth during that month

3.7 Collection of Human Impact Data

3.7.1 Visitors to Tortuguero

The number of people visiting Tortuguero National Park decreased in 2009, for the first time in nine years (See Table 10); although it should be noted that the figure for 2009 only includes data from January to November. For the first 11 months of 2009, data from Tortuguero Conservation Area (ACTo) show that 107,261 tourists were registered as paying the entrance fee to the park; this is over 25,000 fewer visitors than in 2008. This decline was observed for both foreign and Costa Rican visitors (See Table 10).

Table 10. Number of paying visitors to Tortuguero National Park, 2005 - 2009

Year	Costa Rican visitors	Foreign visitors	Total no. of visitors
2000	5,543	36,354	41,897
2001	6,175	39,057	45,232
2002	5,745	44,594	50,339
2003	8,643	59,026	67,669
2004	9,545	71,912	81,457
2005	9,292	77,291	87,083
2006	21,257	80,087	101,344
2007	23,898	92,853	116,751
2008	26,727	107,963	134,690
2009 ¹	23,652	83,609	107,261

Data from Tortuguero Conservation Area (ACTo)

¹Data for January – November only

During 2009 it was brought to the attention of CCC that there had been a change to the way in ACTo staff were recording tourist visitation to TNP. Since 2006, guides and boat captains who enter the national park during canal tours have also been included in the value for national visitors. Thus, the apparent dramatic increase in Costa Rican nationals that was observed from

2005 to 2006 (See Table 10), does not represent an actual increase in the number of national tourists, but rather is an artifact of this change to the way in which data have been recorded. Thus, the values for Costa Rican tourists from 2006 – 2009 should be viewed with caution as they are undoubtedly exaggerated.

The number of visitors registered at the CCC Visitor’s Center decreased in 2009 from that in 2008, to 27,565 visitors (See Table 11). The overall daily visitation rate to the center was 76 visitors, slightly less than the number calculated for 2008. In 2009 daily visitation was lower in all months except January.

The pattern of visitation was similar to that observed previously; most visitors came in January – March, with a significant decline in May and June. There was a slight increase in visitation observed during July and August; this coincides with increased green turtle nesting, which is the major tourist attraction in the area. September had the lowest daily visitation with an average of just 27 people per day.

Table 11. Visitors to the CCC Visitors Center, January 2007 - December 2009

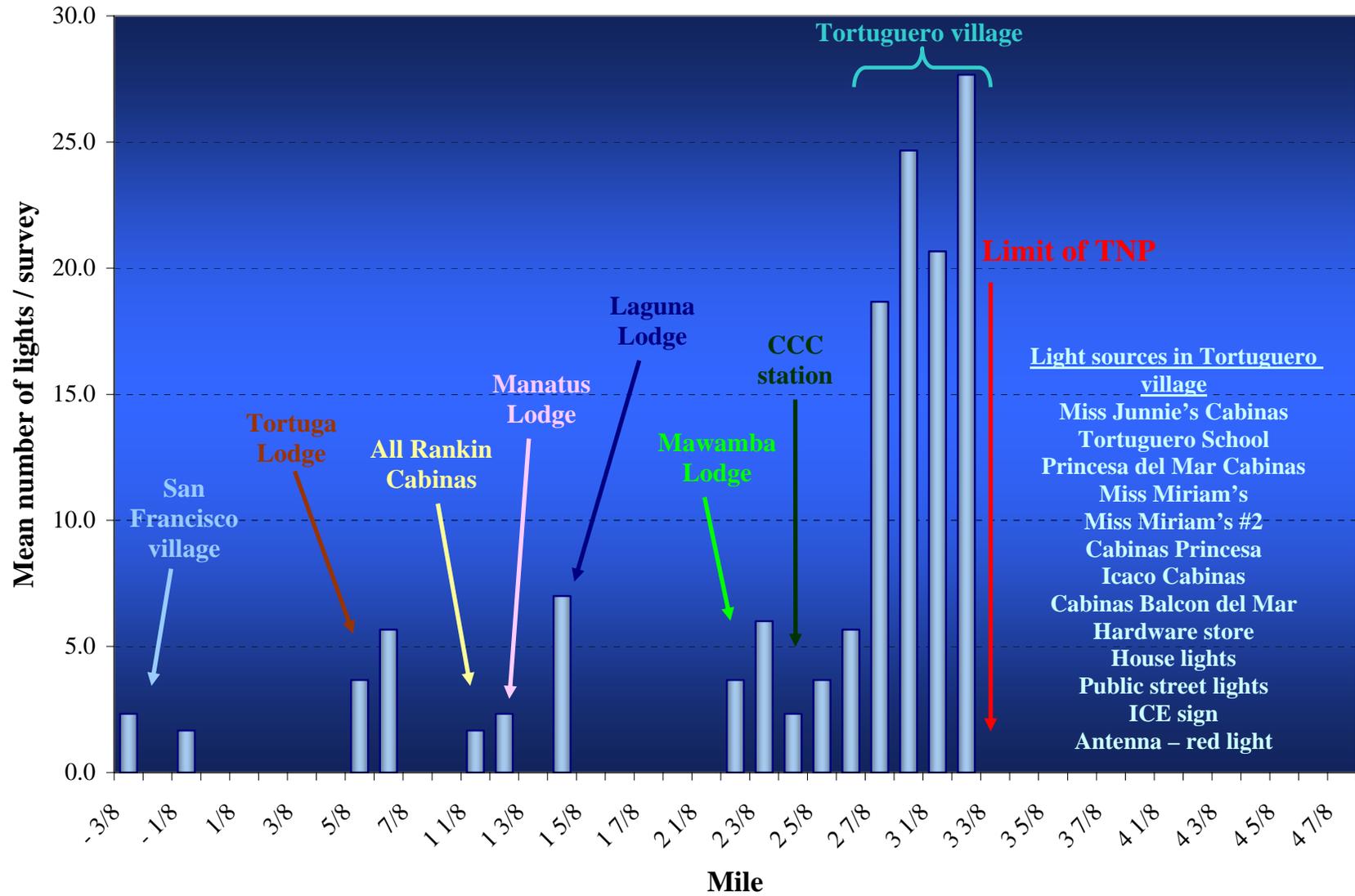
Month	2007		2008		2009	
	Total	\bar{x} / day	Total	\bar{x} / day	Total	\bar{x} / day
January	3,842	124	3,398	110	4,001	129
February	3,812	136	4,105	142	3,617	129
March	3,455	111	4,421	143	4,100	132
April	2,904	97	2,515	84	2,382	79
May	1,238	40	1,311	42	963	31
June	1,705	57	1,562	52	1,492	50
July	3,007	97	2,420	78	2,385	77
August	2,951	95	2,265	73	2,024	65
September	1,149	38	1,250	42	815	27
October	1,298	42	1,310	42	1,328	43
November	2,055	69	2,025,	68	1,879	63
December	2,603	84	2,954	95	2,579	83
Total	30,019	82	29,536	81	27,565	76

3.7.2 Artificial lights

Light surveys were conducted in March, April and June of the 2009 Leatherback Program. The spatial distribution of the artificial lights visible on the beach is shown in Figure 5; the bars represent the average number of lights counted in each 1/8 mile section during the three surveys.

It is very obvious that the majority of lights visible on the beach are found between miles 2 3/8 and 3 3/8; which corresponds to the section of beach in front of the village of Tortuguero. The limit of Tortuguero National Park is at mile 3 3/8; no light sources exist within the national park (See Figure 5).

Figure 5. Spatial distribution of artificial lights visible on the beach at Tortuguero, as determined by monthly light surveys



Lights visible to the north of the village (between miles $-3/8$ and $2\ 5/8$) are coming from San Francisco village (close to the river mouth) and several of the lodges and cabinas that are located close to the beach or on the opposite side of the river. The pattern of lights visible on the beach remains the same as that observed in previous years.

3.8 Dead Turtles

In addition to the green turtle that was taken illegally by poachers, nine dead turtles were encountered during the 2009 Leatherback Program; three leatherbacks, five green turtles and one hawksbill (See Table 12).

Five green turtles, one hawksbill and one leatherback had been killed by a jaguar; cause of death could not be determined for the other two leatherbacks. Jaguar predation occurred from March – June, and was only reported within TNP (See Table 12).

Table 12. Dead turtles encountered during the 2009 Leatherback Program

Date	Species	Sex	Mile	Comments
18 March	Cm	Female	15 4/8	Killed by jaguar – Body found without flippers in vegetation
1 April	Dc	Unknown	13	Decomposing carapace – Cause of death unknown
16 April	Cm	Female	20 4/8	Killed by jaguar – Body found in vegetation
24 April	Dc	Unknown	15 4/8	Body without head found on beach – Cause of death unknown
7-May-09	Cm	Female	8 4/8	Killed by jaguar – Body parts found in the vegetation
8-May-09	Cm	Female	17	Killed by jaguar
21-May-09	Ei	Female	16 4/8	Killed by jaguar – Tag numbers 95033 and 107128
3-Jun-09	Cm	Female	12	Killed by jaguar – Carapace found in vegetation
3-Jun-09	Dc	Female	15	Presumed killed by jaguar – Body found on beach with head wound Tag numbers VA4944 and VA4951

Cm = Green turtle; Dc = Leatherback; Ei = Hawksbill

3.9 Environmental Education and Outreach Activities

3.9.1 Environmental Education Program

Due to the reduced number of RAs and only one FC during the 2009 Leatherback Program, environmental education activities were focused on the Junior Research Assistant Program (JRAP) when time and personnel permitted. The FC and RAs gave talks and presentations about sea turtles, their biology, threats and conservation initiatives to students from Tortuguero High School who were interested in participating in the JRAP; they also supervised groups of students

during night patrols so that they could gain practical experience working with leatherback turtles.

3.9.2 Outreach Activities

3.9.2.1 Beach Clean

The FC worked with TNP staff to organize a community beach clean event on 20 April, 2009. Prior to the event lodges, cabinas, local businesses and Tortuguero High school were approached to confirm their support, and posters were displayed throughout the village inviting members of the public to participate.

Around 150 people supported the event; including CCC staff, RAs and participants, TNP staff, students from the high school, staff from the Costa Rica Energy Institute (ICE), personnel from Laguna Lodge, Mawamba Lodge, Anhinga Lodge, Tortuga Lodge and B&B Tortuguero, as well as members of the community.

The beach clean took place between the Tortuguero river mouth (mile -2/8) and the mile 5 marker within TNP; approximately four miles of beach were cleaned. A total of 100 bags of rubbish were removed from the beach, including plastic bottles, shoes, bulbs, glass containers, amongst other items. In addition to the removal of rubbish, all large logs were moved into the vegetation behind the beach; this was to facilitate the movement of turtles and hatchlings on the beach. Photographs of the event are shown in Appendix 2.

3.9.2.1 Veterinary Clinic

CCC continued to be a key member of the organizing committee for the veterinary clinic program; prior to the start of the 2009 Leatherback Program the committee met in San Jose to coordinate the veterinary clinic and educational program. As in 2008 the committee includes representatives from CCC, MINAET, and ProParques (an environmental NGO based in San Jose) with support from local residents in Tortuguero and San Francisco. Veterinarian support is provided by the Humane Association for Animal Protection in Costa Rica (AHPPA) and the School of Veterinary Medicine at the National University of Costa Rica.

The veterinary clinic took place the 19-21 March, 2009. Simultaneous clinics were held in Tortuguero and San Francisco with the vets split between the two locations; the information kiosk built by CCC in the center of the village was the location for the clinic in Tortuguero and in San Francisco they used the school. The clinic was very well supported by local residents who brought their animals to be spayed or neutered. Over the course of the two days of clinics a total of 141 animals were treated; of these 42 animals were castrated. The majority were dogs, although several cats were also brought in by their owners. Fifteen dogs were vaccinated and numerous other animals, whose owners preferred not to have them castrated, or that were already castrated, were treated for external parasites such as fleas and ticks. CCC Scientific Director Emma Harrison assisted with the logistics of the Tortuguero clinic; Leatherback Program RAs helped during the clinic as needed, and CCC provided four of the eight vets with lodging and food during their stay in Tortuguero. Photographs from the clinic are shown in Appendix 3.

4. Discussion

4.1 Preparations

In 2009 the Leatherback Program could only support a maximum of four RAs at one time, half

of the typical number selected to conduct the monitoring, research and education activities. Because it was felt that the work load would be very great on these four people it was decided to divide the program into two groups, with a changeover occurring in April. This reduction in research personnel definitely impacted the monitoring activities, and the focus was placed on conducting the three-day track surveys to ensure an accurate determination of nesting density, temporal and spatial distribution and the level of illegal take. It is recommended that in future Leatherback Programs the full complement of eight RAs be maintained.

The reduced number of RAs for the 2009 Leatherback Program made the task of replacing and painting the mile markers extremely difficult; it took over two weeks to complete the entire 22 miles of beach. The work was further hampered by extreme weather conditions at the beginning of March. The support of the ATV for the section between miles 5 – 15 assisted greatly the FC and RAs.

The two-week training and orientation program was again implemented in 2009; providing the RAs with theoretical and practical sessions regarding the monitoring protocol, in addition to informative talks about Tortuguero National Park and environmental laws in Costa Rica, and an introduction to the development of Tortuguero community. In addition, the RAs were introduced to researchers from the other biological field station, Caño Palma, to meet those responsible for conducting sea turtle monitoring activities on the beach north of the Tortuguero river mouth. This extensive program should be continued in future as it provides the newly arrived RAs with a more thorough understanding not only of the work that they will be conducting, but also about the area in which they will be living and working.

4.2 Track Surveys

As in previous years leatherback nesting was observed during weekly track surveys from mid-February to early July, and RAs encountered leatherbacks during night patrols until 15 July. There was a peak in nesting observed in mid-April (See Figure 1) and then a sharp decline in nesting at the end of the that month; nesting increased again in May. The three-day track surveys conducted by the FC and RAs covered the main nesting period for leatherbacks.

There was a slight increase in the estimated number of leatherback nests laid in 2009 compared to 2008 (See Figure 2), but current nesting is still well below levels observed in Tortuguero when the Leatherback Program began in 1995. However, it is interesting to note that there is a large discrepancy between the estimated number of nests (as determined from data collected during the weekly surveys) and the number of nests counted by the FC and RAs during the three-day surveys (274 compared to 504, respectively). It would be interesting to do a comparative analysis of the two data sets over the last 14 years to obtain a clearer understanding of the status of the Tortuguero leatherback population. It is valuable, therefore, to continue to conduct the three-day surveys in future Leatherback Programs, to compare with results from the weekly surveys.

The spatial distribution of leatherback nests in 2009 was more typical of nesting patterns observed in previous years; with the highest concentration of nesting occurring in the southern half of the beach, from mile 12 to 20 (See Figure 3). The peak at mile 1 is also interesting, however. As in previous seasons, nesting density was highest outside of Tortuguero National Park, in miles 19 and 20; these two miles accounted for 22.8% of all leatherback nesting in 2009. An interesting study would be to review nesting distribution since the start of the Leatherback

Program in 1995 to see if there are cyclic shifts in distribution that might be correlated to environmental factors such as El Niño; if such an analysis could include data for the entire coast then the findings would be significantly more informative.

Unfortunately illegal poaching of turtle nests occurred throughout the 2009 Leatherback Program. The percentage of poached nests for leatherbacks was higher than that recorded in 2008 (14.8% compared to 11.0%, respectively). Poaching of green turtle and hawksbill nests was lower in 2009 than in 2008 (See Table 1). The spatial distribution of poaching was very similar to that observed in the last few years, with the majority of poaching occurring in the four miles between Jalova and Parismina (outside the southern limit to Tortuguero National Park); over 50% of all leatherback nests laid in that section were poached (See Figure 4). Poaching is definitely concentrated around the Jalova river mouth; there was very little poaching recorded close to Tortuguero village, or in the middle of the park. This could be due to the ease of access to the beach close to Jalova and the lack of enforcement of turtle laws by Tortuguero National Park rangers due to limited resources and insufficient personnel. It was disappointing to observe that no patrols seemed to have been conducted in this section of the beach, despite CCC raising concerns with MINAET about the high levels of poaching in this area over the last few years. More concerted efforts need to be made in future years to work with researchers from Parismina to conduct regular monitoring patrols in that stretch of beach; to help deter potential poachers by providing a more consistent presence on the beach. Also to work with MINAET to secure additional funding to improve protection measures during the leatherback nesting season.

4.3 Tagging of Nesting Sea Turtles

The period of tagging patrols from March to early June coincides with the period of heaviest leatherback nesting (See Figure 1) and it is suggested that night patrols be conducted during the same period in future years.

Unfortunately the number of leatherback turtle encounters during nightly patrols in 2009 ($n = 78$) was considerably lower than the number of encounters recorded in previous years. However, this could in part have been due to the limited number of RAs during the 2009 Leatherback Program (five compared to the usual eight). This reduction in personnel was reflected in the number of patrol hours (790.3) and definitely contributed to the low number of turtle encounters recorded. Patrols close to the Jalova river mouth (at the southern end of the nesting beach) were conducted as frequently as possible, in an effort to increase the number of leatherback encounters. The number of hawksbills ($n = 3$) encountered during night patrols was similar to that observed during previous leatherback nesting seasons; however, the number of green turtles ($n = 8$) was much lower than has been recorded in other years. This might imply that the green turtle nesting season was more contracted in 2009, with fewer females arriving earlier in the season.

The proportion of new leatherback turtles (individuals that did not have tags when first encountered) observed during the 2009 season was lower than observed in 2008 (39.7% compared to 43.6%, respectively); although it should be noted that 2008 had an exceptionally high percentage of 'new' females, and that the value for 2009 is comparable to other years.

Over 60% of female leatherbacks encountered during 2009 had already been tagged when first observed, either at Tortuguero or at other nesting beaches in the region. There were two females encountered who were originally tagged at Mondonguillo beach (south of Tortuguero, on the

Caribbean coast of Costa Rica) in 1995; 14 years previously. There were also two other females who were first tagged 10 years ago in 1999; one in Tortuguero, the other in Bocas del Toro Province, Panama. It is always encouraging to encounter turtles that have a long nesting history, as it implies that there are some individuals that are able to complete their lengthy migrations season after season avoiding the numerous survival threats that they face while traveling between nesting and foraging sites.

The frequent movement of leatherbacks between the different nesting sites in Costa Rica and Panama is well documented, and has shown that these beaches share a common population. Discussions continued in 2009 regarding the regional database for leatherback tagging information; it is hoped that this initiative will be fully functional for next year, so that the full history of those females who move between different nesting beaches can be readily available for all affiliated projects.

A green turtle was encountered with tags that had been applied in Pacuare Nature Reserve in 2006; it is not very common to find green turtles with tags from other nesting beaches, so this was an interesting encounter. It will be interesting to get the original tagging data from researchers in Pacuare, to see whether this female was encountered early in the nesting season when first tagged in 2006. This again highlights the need for cooperation between turtle nesting beach projects, to allow for an effective exchange of data regarding turtles (of whichever species) that are utilizing more than one nesting site in Costa Rica or Panama.

4.4 Biometric Data Collection

No significant difference was detected in the mean carapace length (CCL_{min}) of female leatherback turtles with complete or incomplete caudal projections; the overall mean was 152.3 cm (See Table 2), which is within the range observed in previous years. There was also a similar size diversity in the size of leatherback females encountered in 2009 to that seen during other nesting seasons; ranging from very small (132.4 cm) to very large individuals (170.0 cm). This would suggest therefore, that there is a mixture of young and old females within the Tortuguero nesting population; a healthy nesting population should consist of individuals from different age classes.

Only one female that was observed on more than one occasion had her caudal projection inconsistently identified; on the first occasion it was classified as complete and on the second it was classified as incomplete. All the other females observed more than once during the season (up to four times in some cases) had their caudal projection consistently identified by different researchers. Obviously there will still be some observer differences as it is a somewhat subjective distinction, and it would be good to have a range of photographs depicting complete and incomplete caudal projections, to use during RA training.

The precision of leatherback, green turtle and hawksbill carapace measurements was lower in 2009 than in 2008 (0.3 - 0.6cm); only two hawksbills were encountered however. For leatherbacks care must be taken during the RA training sessions to ensure that all researchers are taking the measurements in the same manner, and using the same defining carapace characteristics. For females that were seen on more than one occasion during the season measurements between the different encounters varied by up to 4.4 cm; again, reflecting considerable observer variability.

4.5 Determination of Nest Survivorship and Hatching Success

Only 27 leatherback nests were marked during the 2009 Leatherback Program, and of these five were excluded from the analysis of hatching success as they could not be found during excavation; this was even with the implementation of insertion of a small piece of flagging tape with the nest code written on it into the open nest chamber. It is important that the FC conducts a series of practice sessions in nest marking during the training period at the start of each season. One idea of the FC in 2009 was to conduct one of these sessions in the dark, to better simulate the conditions under which RAs will be marking nests during night patrols. This was a useful exercise and is one that is recommended for future Leatherback and Green Turtle Programs.

It was encouraging to observe that over 60% of leatherback nests for which the fate could be determined remained undisturbed during the incubation period. For these nests, hatching and emerging success were very high (91.1% and 90.5%, respectively); these values are exceptionally high for leatherback nests which typically have a much lower success rate. Overall hatching and emerging success (including disturbed nests) was 58.1% and 57.6%, respectively; this is, however, still relatively high for this species. None of the marked nests were lost to anthropogenic factors such as poaching or depredation by feral dogs; all losses were presumably due to natural causes. With the low nesting density of leatherbacks at Tortuguero, it is important to try and obtain as much information as possible about the survivorship and success of their nests, so each nest that can be marked and monitored is incredibly valuable; therefore, RAs should be encouraged to try and mark every nest that they can during night patrols.

4.6 Physical Data Collection

The precipitation pattern observed during the Leatherback Program has shown some variation over the last few years although often March is the driest month and April the wettest; in 2009 March had the highest recorded rainfall (384.2 mm in total) and it was May that had the lowest amount of rain (208.8 mm). Overall, the 2009 Leatherback Program was drier than in 2008 (1158.3 mm compared to 1254.0 mm, respectively); although rainfall each month of the program except June was lower in 2008 than in 2009. June 2008 was an exceptionally rain month, whereas rainfall during the 2009 leatherback nesting season was more consistent, ranging between 208.8 mm to 384.2 mm a month (See Table 8). Not surprisingly March had the coolest mean temperature (25.4°C). Higher temperatures were also recorded during the 2009 Leatherback Program than in 2008; temperatures throughout the program reached up to 31°C.

There were difficulties encountered during the downloading of information from the data loggers, which meant that the data for March thru May could not be retrieved. And during the 2009 Green Turtle Program six of the data loggers were lost; meaning that very little information about sand temperatures was collected during 2009. Lost data loggers should definitely be replaced, to allow for a more complete monitoring of the different beach zones; especially the open zone where the majority of leatherback nests are deposited.

It is very important to continue to monitor air temperature, sand temperature and precipitation levels at Tortuguero, as these variables can have potentially serious impacts on the survivorship and subsequent hatching success of nests laid at this important nesting beach. Data collected over the last decade should be analyzed to determine if there have been any significant changes in any of the environmental variables monitored.

4.7 Collection of Human Impact Data

2009 was the first time in 10 years that there was a decrease in the number of tourists that paid the entrance fee to Tortuguero National Park; however, it should be noted that the visitation data available from Tortuguero Conservation Area (ACTo) only covered the period of January to November, 2009. The greatest reduction in visitation was in the number of foreign tourists, which fell from 107,963 in 2008 to 83,609 in 2009; a decline of over 24,000 people. This could be a reflection of the global economic crisis which is limiting overseas travel; it will be interesting to observe the trend in tourism over the next few years to see if this decline continues, or if the situation improves once the global economy is more stable.

The discovery in 2009 that there had been a change made to the way in which visitation to the park was recorded in 2006, without informing CCC or other institutions that might have subsequently used the data, prompted CCC to write an official letter of complaint to ACTo. In the opinion of CCC, tourist visitation data have been recorded erroneously by park staff since 2006 since tour guides and boat captains have been included in the figures for national visitors, when obviously these individuals are leading tour groups and so are not, technically speaking, tourists. Considering the number of tours that are conducted within TNP each year, including the canals, trails and the beach, and the number of guides that repeatedly enter the Park over the course of the season, the potential for error in the number of national tourists could reach into the thousands. For example; if one tour guide enters the National Park to give a turtle tour five days a week during the peak turtle tourism months of July – October, that one person would be counted as 80 individuals. Given that there are over 100 registered turtle tour guides, then there could be over 8,000 ‘tourists’ counted as having entered the park. From Table 10 it is possible to see the dramatic increase in national tourists recorded between 2005 and 2006, when the change in the data collection method occurred; from 9,292 to 21,257, respectively. Furthermore, the value for the number of national tourists is further compounded by the fact that tourists from Central American countries are also included as national tourists; due to the fact that they pay the same reduced park entrance fee. When these errors were made known to CCC they requested the true national tourist values from ACTo staff; however, it appears that the data are not readily available in digital format to recalculate the value, and so to date no new data have been received.

There was definitely a genuine decline in the number of tourists visiting Tortuguero in 2009; this was reflected in a second consecutive year in which fewer tourists entered the CCC Visitor Centre. Annual visitation fell from 29,536 in 2008 to 27,565 in 2009 (See Table 11). The pattern of visitation, however, followed that observed in previous years, with January - March having the highest number of tourists, followed by a sharp decline in May. Although there was a subsequent increase in July and August, which are typically months with high numbers of tourists due to the corresponding peak in green turtle nesting, which is one of the main tourist attractions to Tortuguero, it was disappointing that the daily visitation rate stayed below levels recorded in the last two years. Tourist visitation was lowest in September; with just 27 visitors per day recorded on average during the month. This decrease in tourism in September was observed throughout the village.

Revenue to TNP was undoubtedly much reduced in 2009, and there was an evident lack of patrols during the Leatherback Program. No park rangers were observed during monitoring activities (either during the day or night), although it is possible that the limited resources were focused on more problematic areas within the Park (ie. where poaching pressures on turtles and

nests are higher), and so these initiatives would not have been witnessed by researchers. CCC will continue to work with MINAET personnel to provide relevant information about illegal take of turtles and/or nests, to assist in the focused protection efforts.

One of the priorities for next year will be to upgrade the facilities of the CCC Visitor Center; to utilize available space more effectively and so improve the layout of displays; provide a separate area for viewing the video; produce a new video with up to date information about the research and conservation efforts being conducted by CCC; review the merchandise for sale in the shop and make appropriate changes to the items on offer. Such an extensive overhaul will require substantial funding; CCC should focus fund-raising efforts to raise the necessary money to make these changes, so that the centre can fulfill its potential, not only to educate visitors to Tortuguero about the history and work of CCC in the area, but also to generate funds for program activities through the sale of merchandise and turtle adoptions.

Artificial lights visible on the nesting beach remained a concern in 2009, especially close to the villages of San Francisco (around mile -2/8, close to the Tortuguero river mouth) and Tortuguero (between miles 2 7/8 and 3 3/8). However, the FC worked hard to establish contact with ICE (the Costa Rican electricity company responsible for the public lights in the village); through this contact CCC was able to work with ICE to place covers on problematic lights closest to the beach. Much still needs to be done to decrease the negative impact of artificial lights on the beach; for example, to cover more public lights that are set further back from the beach, and to target householders about covering or switching off lights that are visible on the beach. However, it was encouraging to see the willingness with which ICE was ready to work with CCC in an effort to solve this issue; ICE staff members also participated in the community beach clean-up activity in April. This collaborative relationship should be continued in the future, with the objective of completing eliminating the problem of lights on the nesting beach. In future years it might be worthwhile also addressing the problem caused by public lighting in San Francisco, and conducting an awareness campaign for community members about the potential negative impacts of artificial lights for adult females and hatchlings in Tortuguero.

4.8 Dead Turtles

It was encouraging to observe a significant decline in the level of illegal take of female turtles during the 2009 Leatherback Program in comparison to recent years; only one green turtle was reported as having been taken off the nesting beach by poachers. Furthermore, very few turtles were recorded as having been killed by jaguars in 2009 (See Section 3.8). What was surprising that of the seven turtles killed by jaguars, one was a leatherback; this is very unusual, and only two other records exist from recent years. There were also two other dead leatherback turtles encountered on the beach during track surveys; although the cause of death could not be accurately determined for these turtles, it is possible that they were also killed by jaguars. This apparent change in the habits of jaguars, to kill much larger prey species, should be followed in future years to see if it was just a one-off in 2009, or if the jaguars in TNP have altered their behavior in any way. Jaguar predation was concentrated within TNP, with no dead turtles found north of mile 8 4/8. As in previous years, however, jaguar footprints were observed during the majority of track surveys and these animals were active along the entire beach from close to the village to beyond the Jalova lagoon.

3.9 Environmental Education and Outreach Activities

During the 2009 Leatherback Program the reduced number of RAs and only one FC meant that the focus of the program was on continuing the monitoring activities. This meant that the environmental education program was not fully developed for the first half of 2009, due to lack of personnel. However, a minimal number of activities were conducted, and the FC implemented the JRAP with students from Tortuguero High School, although very few students participated. For CCC's work in Tortuguero to be effective, it is important that there is interaction with the local community; one of the main ways in which this is achieved is through the contact with the education centers through the environmental education program. In future years, therefore, it is recommended that a dedicated coordinator be contracted to focus on developing a comprehensive education program. This person can also act as a liaison between CCC, National Park personnel and community leaders; to ensure that there is adequate dissemination of information about the work that CCC is doing in Tortuguero. It will also be beneficial to establish links with other NGO's working in the area, and with local businesses such as ICE who have expressed an interest in supporting turtle conservation initiatives. Another key group that should be approached is the local hoteliers; their support is vital to ensure that visitors to Tortuguero are made aware of the existence of the CCC, and that tour groups patronize the Visitor Centre.

The community beach clean-up event was very well organized by the FC and was successful in bringing together various groups within the community for a common cause. Not only did the activity help improve the nesting beach habitat for turtles; it was also an example of a collaborative effort in support of turtle conservation. It would be a good type of event to conduct on an annual basis; preferably at the start of the nesting seasons.

In 2009 CCC continued to play a central role in the organizing committee for the veterinary clinic in Tortuguero; working together with representatives from MINAET, ProParques (an NGO based in Costa Rica focused on aiding the national parks around the country) and interested local community members. The third clinic, conducted in March 2009, was again well supported by local residents; 141 animals were treated, of which 42 animals were castrated. The committee members continue to be pleased with the support shown by the community for these regular clinics; however, a significant number of dogs are still encountered on the beach, with the potential to cause considerable damage to turtle nests. Future educational campaigns should focus on raising public awareness of the need to keep domestic animals off the beach during the nesting and hatching periods. The clinics should definitely be continued in future years, with support from CCC; as they provide a long-term solution to control the increasing dog population.

5. References

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6. Appendices

Appendix 1. Nightly sea turtle encounters for the 2009 Leatherback Program

Date	Leatherback				Green				Hawksbill			
	New	REM	REN	Total	New	REM	REN	Total	New	REM	REN	Total
2-Mar				0				0				0
3-Mar				0				0				0
4-Mar				0				0				0
5-Mar				0				0				0
6-Mar				0				0				0
7-Mar				0				0				0
8-Mar				0				0				0
9-Mar				0				0				0
10-Mar				0				0				0
11-Mar				0				0				0
12-Mar				0				0				0
13-Mar				0				0				0
14-Mar				0				0				0
15-Mar				0				0				0
16-Mar				0				0				0
17-Mar	1			1				0				0
18-Mar		1		2				0				0
19-Mar				2				0				0
20-Mar				2				0				0
21-Mar				2				0				0
22-Mar				2				0				0
23-Mar	1	4		7				0				0
24-Mar		1		8				0				0
25-Mar	1			9				0				0
26-Mar				9				0				0
27-Mar	1			10				0				0
28-Mar				10				0				0
29-Mar	1	3		14				0				0
30-Mar	2	1		17				0				0
31-Mar	1			18				0				0
1-Apr		1		19				0				0
2-Apr				19				0				0
3-Apr				19				0				0
4-Apr				19				0				0
5-Apr				19				0				0
6-Apr				19				0				0
7-Apr	1			20				0				0
8-Apr				20				0				0
9-Apr		2		22				0				0

Appendix 1. Continued

Date	Leatherback				Green				Hawksbill			
	New	REM	REN	Total	New	REM	REN	Total	New	REM	REN	Total
10-Apr	1	1		24				0				0
11-Apr		1		25	1			1				0
12-Apr				25				1				0
13-Apr	1			26				1				0
14-Apr	1			27				1				0
15-Apr				27				1				0
16-Apr	2	2		31				1				0
17-Apr	3	3		37				1				0
18-Apr	1	1		39				1				0
19-Apr	2		1	42	1		1	3				0
20-Apr		2		44				3				0
21-Apr	1			45				3				0
22-Apr				45				3				0
23-Apr				45				3				0
24-Apr				45				3				0
25-Apr		1		46	1			4				0
26-Apr		1	1	48				4				0
27-Apr				48				4				0
28-Apr	1	2	1	52				4				0
29-Apr				52				4				0
30-Apr				52	1			5				0
1-May				52				5				0
2-May		1	1	54				5				0
3-May		1		55				5				0
4-May		1		56				5				0
5-May		1		57				5				0
6-May				57				5				0
7-May				57				5				0
8-May	2	2	2	63				5				0
9-May			1	64	1			6				0
10-May				64	1	1		8				0
11-May		1		65				8				0
12-May				65				8				0
13-May		1		66				8				0
14-May			1	67				8				0
15-May		1		68				8				0
16-May		1		69				8	1			1
17-May		2		71				8				1
18-May				71				8		1		2
19-May				71				8				2
20-May		1	1	73				8				2

Appendix 1. Continued

Date	Leatherback				Green				Hawksbill			
	New	REM	REN	Total	New	REM	REN	Total	New	REM	REN	Total
21-May			1	74				8				2
22-May			1	75				8				2
23-May			1	76				8	1			3
24-May				76				8				3
25-May				76				8				3
26-May				76				8				3
27-May			1	77				8				3
28-May				77				8				3
29-May				77				8				3
30-May				77				8				3
31-May				77				8				3
1-Jun				77				8				3
2-Jun				77				8				3
3-Jun			1	78				8				3
4-Jun				78				8				3
5-Jun				78				8				3
6-Jun				78				8				3
7-Jun				78				8				3
Total	24	40	14	78	6	1	1	8	2	1	0	3
%	30.8	51.3	17.9		75	12.5	12.5		66.7	33.3	0.0	

New = Turtles that had no tags on first encounter in 2009

REM = Remigrant; turtles that had tags from previous years/other projects on first encounter in 2009

REN = Renester; turtles that were encountered more than once during 2009

Appendix 2. Photographs of the beach clean-up event organized during the 2009 Leatherback Program



Members of the public help collect garbage and move logs



ICE staff participated in the beach clean-up

Appendix 2. Continued



Students from Tortuguero High School assist with the beach clean-up



Students remove garbage from the beach



Members of the public help with the beach clean-up by moving logs

Appendix 3. Photographs of the veterinarian spay/neuter clinic conducted during the 2009 Leatherback Program



Vets from AHPPA and the National University of Costa Rica conduct a health check



Vets from the National University of Costa Rica perform a spay operation



CCC staff assist with the veterinary clinic