



REPORT ON THE 2008 LEATHERBACK PROGRAM AT TORTUGUERO, COSTA RICA

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**By
Xavier Debade, Field Coordinator
Dagnia Nolasco Del Aguila, Field Coordinator
and
Dr Emma Harrison, Scientific Director**

**With the assistance of
Jeffrey Arana Espinoza, Research Assistant
Laura Berrondo Ramos, Research Assistant
Jesús Cortes Solano, Research Assistant
Isabel Díaz Reviriego, Research Assistant
Lucia Galean Gordon, Research Assistant
Rafael Marrón Fiol, Research Assistant
Mario Martinetti, Research Assistant
Noga Neeman Horowitz, Research Assistant
Ruddy Gonzalez, Track Surveyor
César Gamboa Ruiz, Track Surveyor
Enrique Vargas, Track Surveyor**

With the Financial Support of:



CARIBBEAN CONSERVATION CORPORATION

Address:	Apartado Postal 246-2050 San Pedro COSTA RICA	4424 NW 13th St. Suite B-11 Gainesville, FL 32609 USA
Tel:	Int + 506 2297 5510	001 352 373 6441
Fax:	Int + 506 2297 6576	001 235 375 2449
E-mail:	emma@cccturtle.org	ccc@cccturtle.org
Webpage:	http://www.cccturtle.org	http://www.cccturtle.org

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Executive Summary

Monitoring and Research Activities Conducted

- 1 A total of 23 track surveys were conducted between the Tortuguero river mouth and Jalova lagoon between 6 January and 28 June 2008
- 2 Leatherback nesting was recorded on track surveys from late February to early June; however, leatherbacks were observed by the FCs and RAs during night patrols until 12 July.
- 3 Peak nesting was recorded on 17 May when six fresh leatherback nests were recorded from one night.
- 4 The Field Coordinators (FCs) and the Research Assistants (RAs) conducted a total of 29 additional track surveys between the Tortuguero and Parismina river mouths between 13 March and 5 June 2008.
- 5 544 leatherback, 369 green turtle and 22 hawksbill nests were recorded during the track surveys of the entire 22 miles of beach.
- 6 Poaching was estimated at a minimum of 11.0% of leatherback nests, 8.1% of green turtle nests and 31.8% of hawksbill nests.
- 7 Comparison of the leatherback nesting estimates obtained from track surveys conducted either by the track surveyor (256 nests) or by the FCs and RAs (448 nests) between Tortuguero river mouth and Jalova lagoon between 13 March - 5 June revealed that the two methods showed quite different results.
- 8 A total of 88 leatherback turtle encounters were recorded during 877.3 hours of night patrols between 4 March and 3 June, 2008; 24 were newly tagged females, 31 had tags from previous years and/or other nesting beaches, and 33 were renesters. In addition, 24 green turtles and five hawksbill turtles were encountered.
- 9 Of the 55 individual leatherback turtles encountered 56.4% (n = 31) bore tags from previous years or other nesting beaches. Of these previously tagged leatherback turtles, 35.5% were originally tagged in Tortuguero (n = 11); the others were tagged in Caño Palma (n = 5), Parismina (n = 7), Pacuare (n = 2) and Gandoca/Manzanillo (n = 6). Two of those originally tagged in Tortuguero was first observed in 1998, 10 years previously. One green turtle was first tagged in Tortuguero in 2004.
- 10 A total of 20.8% (n = 5) of the newly tagged leatherback turtles (n = 24) showed evidence of old tag holes or notches when they were encountered for the first time.
- 11 A total of 87.5% of the encountered leatherback turtles nested in the open beach zone (n = 77), 4.5% nested in the border zone (n = 4) and 8.0 % did not lay eggs (n = 7).
- 12 No significant difference in carapace length (CCL_{min}) was found for leatherback turtles with complete or incomplete caudal projections.
- 13 Mean curved carapace length of leatherbacks was 150.3 cm (n = 53).

- 14 Mean clutch size for leatherback females was 77 yolked and 24 yolkless eggs (n = 33).
- 15 Mean carapace length (CCLmin) was 104.6 cm for green turtles (n = 18), and 87.5 cm for hawksbill turtles (n = 4). Mean clutch size for green turtles was 96 eggs (n = 1); no hawksbill clutches were counted.
- 16 Precision of the CCLmin measurement during the same encounter was high in 2008, and was similar for all species; 0.3 cm for leatherback (n = 53), 0.4 cm for green (n = 18) and 0.3 cm for hawksbill turtles (n = 4).
- 17 Precision of the CCLmin measurement for leatherback turtles measured during more than one encounter was 1.1 cm for two encounters (n = 11), 1.8 cm for three encounters (n = 6), 1.8 cm for four encounters (n = 2) and 1.0 for five encounters (n=1).
- 18 A total of 45 leatherback nests were marked for monitoring; three of these were marked during the 2008 Green Turtle Program.
- 19 Three green turtle nests were also marked for monitoring; they will be included in the analysis of hatching success in the 2008 Green Turtle Program Report.
- 20 Overall hatching success for monitored leatherback nests (n = 42) was 34.7% and overall emerging success was 32.8%.
- 21 Mean distance between the sand surface and the top egg at the time of excavation for undisturbed nests (n = 19) varied between 44-78 cm with a mean of 61.2 cm. The mean distance from the sand surface to the bottom of the egg chamber varied between 65-88 cm, with a mean of 77.4 cm.
- 22 The incubation period for undisturbed leatherback nests for which emergence was observed (n = 14) ranged from 57-65 days with a mean of 62 days.
- 23 Twenty deformed embryos, corresponding to 0.7% of eggs, were encountered during nest excavations.
- 24 Rainfall was heaviest in June (661.6 mm), and March was the driest month (151.8 mm).
- 25 Mean air temperature ranged from 23 - 29°C. June was the coolest month (25.8°C) and April was the warmest (27.1°C).
- 26 Monthly mean sand temperatures ranged between 24.4 – 32.4°C. Sand temperatures were higher in the open zone than in the border and vegetation zones. In the open zone mean temperature was above 30°C except for in June and July; in the vegetation and border zones the mean temperature never went above 30°C.
- 27 A total of 134,690 visitors paid to enter Tortuguero National Park (TNP) in 2008, continuing the increasing trend observed in previous years.
- 28 The visitation at the CCC Natural History and Visitor Center decreased in 2008, continuing the trend from 2007. A total of 29,536 visitors were registered for the year, an average of 81 visitors per day.
- 29 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. There was an increase in the number of lights from the village of San Francisco and several of the larger lodges north of the village.

- 30 Eighteen turtles were taken illegally during the 2008 Leatherback Program; 15 green turtles and three hawksbills. All were taken from within Tortuguero National Park.
- 31 54 dead green turtles were recorded as killed by jaguars during the 2008 Leatherback Program. It was observed that the meat from one turtle was taken by poachers after she had been killed by a jaguar, and another dead turtle was found tied up and ready to be taken from the beach.
- 32 The FCs and RAs developed a comprehensive program of environmental education activities focused on pollution and its impact on the environment. Activities were conducted with students at the Tortuguero and San Francisco schools, and the Tortuguero high school.
- 33 CCC staff and RAs assisted with the first veterinarian spay/neuter clinic held 19-21 March. 93 animals were castrated and many others were treated for parasites.
- 34 One independent research project was conducted during the 2008 Leatherback Program; a study on the effects of relocation on the survivorship and hatching success of leatherback nests. Unfortunately no turtles were observed laying nests within the designated beach zone and so no nests were relocated.

Conclusions

- 1 The necessary task of replacing and painting mile markers along the entire beach was greatly facilitated by the use of an ATV and GPS.
- 2 Leatherback nesting decreased in 2008, continuing the overall trend witnessed since the start of the Leatherback Program; a 76.1% decline in the nesting has been documented since 1995.
- 3 Spatial distribution of leatherback nesting in 2008 was very different to that observed in previous years; increased nesting was recorded at the northern end of the beach.
- 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 2008 leatherback nesting season.
- 5 Levels of poaching increased for all species of turtle in 2008.
- 6 Poaching of nests and turtles increased within Tortuguero National Park.
- 7 The number of leatherback turtles encountered during nightly patrols (n = 88) was much lower than that recorded in 2007, and patrol effort was almost 100 hours lower.
- 8 Overall hatching and emerging success of leatherback nests was similar to that observed in previous years.
- 9 The program of environmental education activities was well developed and helped develop stronger links with the community.
- 10 The first veterinarian spay/neuter clinic was very successful and well supported by the communities of Tortuguero and San Francisco.

Recommendations

- 1 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.
- 2 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.
- 3 Track surveys conducted by the FCs and RAs every three days should be continued in future Leatherback Programs.
- 4 Continuing high levels of poaching south of the limit of the National Park at Jalova and the increase in the levels of illegal take witnessed within the National Park highlight the need for extra patrols by park rangers during the leatherback nesting season.
- 5 Night patrols should be conducted in the sections of the beach with highest leatherback nesting activity, to increase encounter rates.
- 6 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.
- 7 It should be stressed to RAs the importance of marking as many leatherback nests as possible, to increase the information about nest survivorship and hatching success.
- 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 It is important that CCC remains conscientious of the increasing levels of tourism in Tortuguero, and expresses any concerns about negative impacts to appropriate authorities.
- 10 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.
- 11 CCC should work with the local community to try and minimize the number of artificial lights visible on the nesting beach, to avoid deterring females from nesting and disorientating hatchlings.
- 12 Environmental education activities should be planned at the start of each season, with supervision from the FCs and involvement of all RAS throughout the entire process of planning, developing and conducting the activities.
- 13 CCC should continue to be an active member of the committee organizing the veterinary spay/neuter clinics in Tortuguero and should support the clinics however possible.
- 14 Independent research projects should be actively encouraged in Tortuguero, with consideration for their appropriateness with regard to the research mission and conservation objectives of the organization.

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 2008 Leatherback Program represents the fourteenth consecutive leatherback program and the eleventh year of implementing the new monitoring protocol.

The objectives of this report are to summarize the results of the 2008 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 2008 Leatherback Program the RAs received an intensive program of training and orientation; they had lectures about sea turtle biology and conservation, and the Leatherback Program monitoring protocol was explained in detail. In addition to theoretical instruction they also received practical training in flipper tagging, nest marking and other data collection procedures from the FCs. 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 FCs 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, on 13 and 14 March, 2008.

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 and a GPS unit. 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 at 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 FCs and RAs between the Tortuguero and Parismina river mouths, every three days during the 2008 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 during 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.

Following the findings of an independent research project conducted at Tortuguero in 2006, in which it was found that the amplitude of the high tide had a significant influence on the arrival time of leatherback turtles at the nesting beach, it was decided to vary the time and duration of research patrols, in an effort to maximize the encounter rate with females. At the start of the 2008 nesting season information about the timing and amplitude of high tides in Tortuguero was obtained from the National Meteorological Institute of Costa Rica, and a patrol schedule was devised to ensure that research groups were present on the beach during the optimum hours around the high tide. Patrols commenced between 8.00pm and midnight, and varied in duration from three to five hours (seven in Jalova), depending on the number of RAs and volunteer participants available.

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 (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles 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 emergences.

For each encounter the following information was recorded:

- Date
- Time
- 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 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 or hatchling tracks 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 – the 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 2008 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 after the end of the 2008 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 2008.

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.

In response to concerns in 2007 from CCC, local guides and National Park staff about the level of dog predation of turtle nests and the increase in the number of dogs in the village, a committee was organized comprising representatives from interested groups and individuals to coordinate a veterinarian spay/neuter clinic and educational program in 2008 with the aim of reducing the dog population and also providing advice to local residents on how to care for their pets.

2.10 Independent Research Projects

2.10.1 Effect of relocation on survivorship and hatching success of leatherback nests

An investigation conducted during the 2006 Leatherback Program into possible factors affecting leatherback hatching success concluded that nests laid below the high tide line had a significantly lower hatching success than those laid higher up the beach (Runemark, 2006). A follow up study was initiated in 2007 to determine the effect of relocation on survivorship and hatching success of leatherback nests; this study continued in 2008. The study hoped to assess if relocation could be a potential conservation management strategy for the Tortuguero leatherback population.

Prior to the start of the 2008 Leatherback Program, the Masters student conducting the research (Noga Neeman Horowitz) spoke to the RAs about her project, and gave a demonstration of correct nest relocation techniques, in case they had to help with the relocation of a nest.

All nests laid below or within 1m of the high tide line were relocated; the 1m allowed for any variability in the location of the high tide line along the beach or possible observer error in determining its location at night. If a turtle was encountered nesting within this zone of the beach Noga Neeman was radioed to come and conduct the relocation. Ideally, a plastic bag was placed inside the egg chamber just prior to oviposition, to collect all the eggs deposited; this was

removed just before the female started covering. However, if the turtle had already started laying, the precise location of the nest was marked and the eggs were removed once the turtle had returned to the sea. Nests were relocated within the same 1/8 mile section, as close as possible to the original nest site, but well above the high tide line, and not close to the vegetation. They were marked using the same method described in section 2.5, and were checked on a daily basis during the incubation period.

3. Results

3.1 Preparations

The Field Coordinators (FCs) arrived in Tortuguero on 27 February to prepare for the 2008 Leatherback Program. The Research Assistants (RAs) arrived at the field station on 1 March, 2008. Training and orientation sessions were conducted from 2-15 March by the two FCs with support from the Scientific Director. Following a recommendation from 2007 the training program was expanded to include a talk from National Park staff about the creation of the park and environmental laws in Costa Rica, with specific reference to sea turtles. In addition RAs had a guided tour of the canals to learn more about the flora and fauna of the park. A member of one of the founding families of the community, Eddy Rankin, spoke to RAs about the history and development of Tortuguero. They also had an opportunity to visit the other biological research station, Caño Palma, and to talk to staff about the work being done there.

Many of the beach mile markers had to be replaced at the start of the 2008 Leatherback Program because they had either been washed away or destroyed by termites since the end of the 2007 Green Turtle Program. The preparation of the mile markers was a significant task for the RAs during the first week of the Program, but it was made much more efficient by the use of a GPS to locate the position of missing markers, and an ATV to conduct the section between miles 5-15.

3.2 Track Surveys

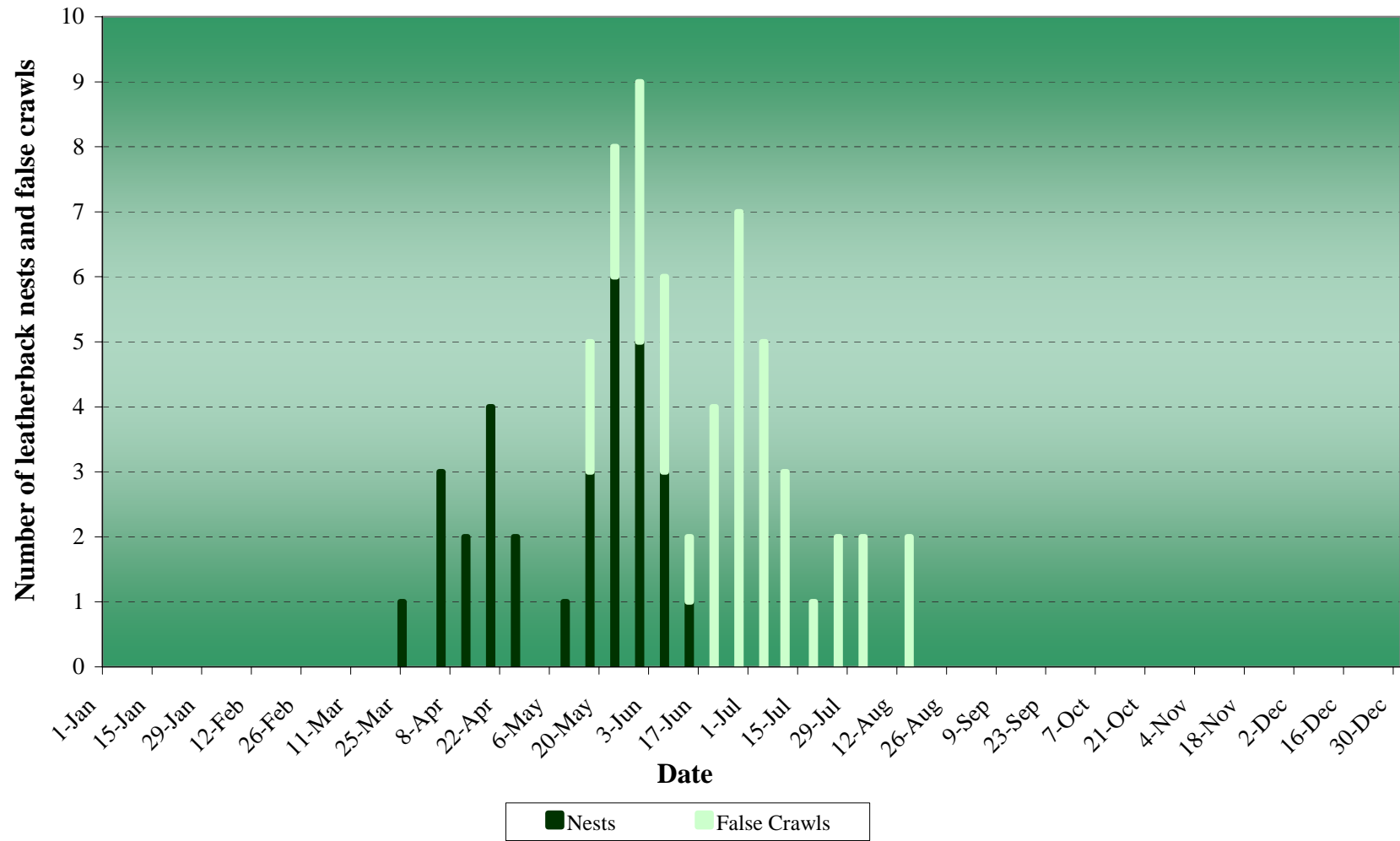
3.2.1 Weekly track surveys

A total of 23 weekly track surveys were conducted between 6 January and 28 June 2008, during which 33 leatherback nests and 38 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-June. However, several females were encountered after this date during night patrols conducted during the 2008 Green Turtle Program, thus it is known that leatherback nesting continued until at least 12 July. There appeared to be two distinct peaks in nesting during the 2008 season; the first around the 12 April when four leatherback nests were observed, and the second around the 17 May, when six leatherback nests were recorded in a single survey (See Figure 1). It is also interesting to note the number of false crawls recorded through August, past the typical nesting period for this species.

Using the methodology described in Troëng *et al.* (2004) extrapolations from the weekly survey data suggest that just 256 leatherback nests were laid between Tortuguero river mouth and Jalova lagoon. The FC and RA track surveys, conducted every three days from March - June, recorded 448 leatherback nests along the same beach section.

Figure 1. Temporal distribution of leatherback nesting activity during 2008, as determined during weekly track surveys



The annual leatherback nesting trend at Tortuguero for the last 14 seasons is shown in Figure 2. It can be seen that the overall decline in nesting continues, with 76% fewer nests laid in 2008 than in 1995; unfortunately the increase in the number of nests observed from 2006 to 2007 was not continued in 2008. Using the nesting estimates calculated from the weekly track surveys, in the last five years an average of 443 leatherback nests have been laid per season.

3.2.2 Three-day track surveys

The FCs and RAs conducted 29 track surveys between 13 March and 5 June, 2008. They recorded a total of 544 leatherback, 369 green turtle and 22 hawksbill nests during those surveys; in addition 173 leatherback, 416 green turtle and 15 hawksbill false crawls were also counted.

Peak leatherback nesting, as determined from the from the 3-day surveys, was recorded on 24 April; 28 leatherback nests had been laid during the previous three nights. This is close to the first of the two peak nesting dates recorded by the weekly track surveyor (See Figure 1).

The spatial distribution of leatherback nesting during the 2008 Leatherback Program is shown in Figure 3. The spatial distribution of leatherback nesting in 2008 was unlike that observed in previous years, when the majority of nests were recorded at the southern end of the nesting beach, and between Jalova and Parismina. In 2008 more nests were observed in the middle of the park (around mile 7) and also in the two miles north of the CCC station, towards the Tortuguero river mouth. The same number of nests was laid north of the village of Tortuguero as in the section of beach from Jalova to Parismina which typically has a much higher nesting density. Mile 16 had the highest nesting density; 44 leatherback nests were recorded in that mile which accounted for 8.1% of the total (See Figure 3).

Illegal poaching of nests was observed throughout the 2008 Leatherback Program (See Table 1). A total of 97 nests were reported as poached during track surveys conducted by the FCs and RAs; 60 leatherback, 30 green turtle and seven hawksbill nests. The minimum poaching levels observed were slightly higher than those recorded in 2007; with poaching of green turtle and hawksbill nests showing the greatest increases. In 2008, poached nests represented at least 11.0% of all leatherback nests recorded, 8.1% of green turtles nests and 31.8% of hawksbill nests (See Table 1).

The spatial distribution of illegal take of nests is shown in Figure 4. Poaching was much more widespread along the entire beach in 2008 than in previous years when it was concentrated in the four-mile section of beach from Jalova to Parismina. While this section continued to show the greatest levels of poaching in 2008 (over 50% of the total number of poached leatherback nests were taken from that stretch of beach) there was an increase in poaching levels in the centre of the park, and also a peak of activity close to the Tortuguero river mouth (See Figure 4).

Figure 2. Annual leatherback nesting trend at Tortuguero from 1995 - 2008, as determined from weekly track surveys

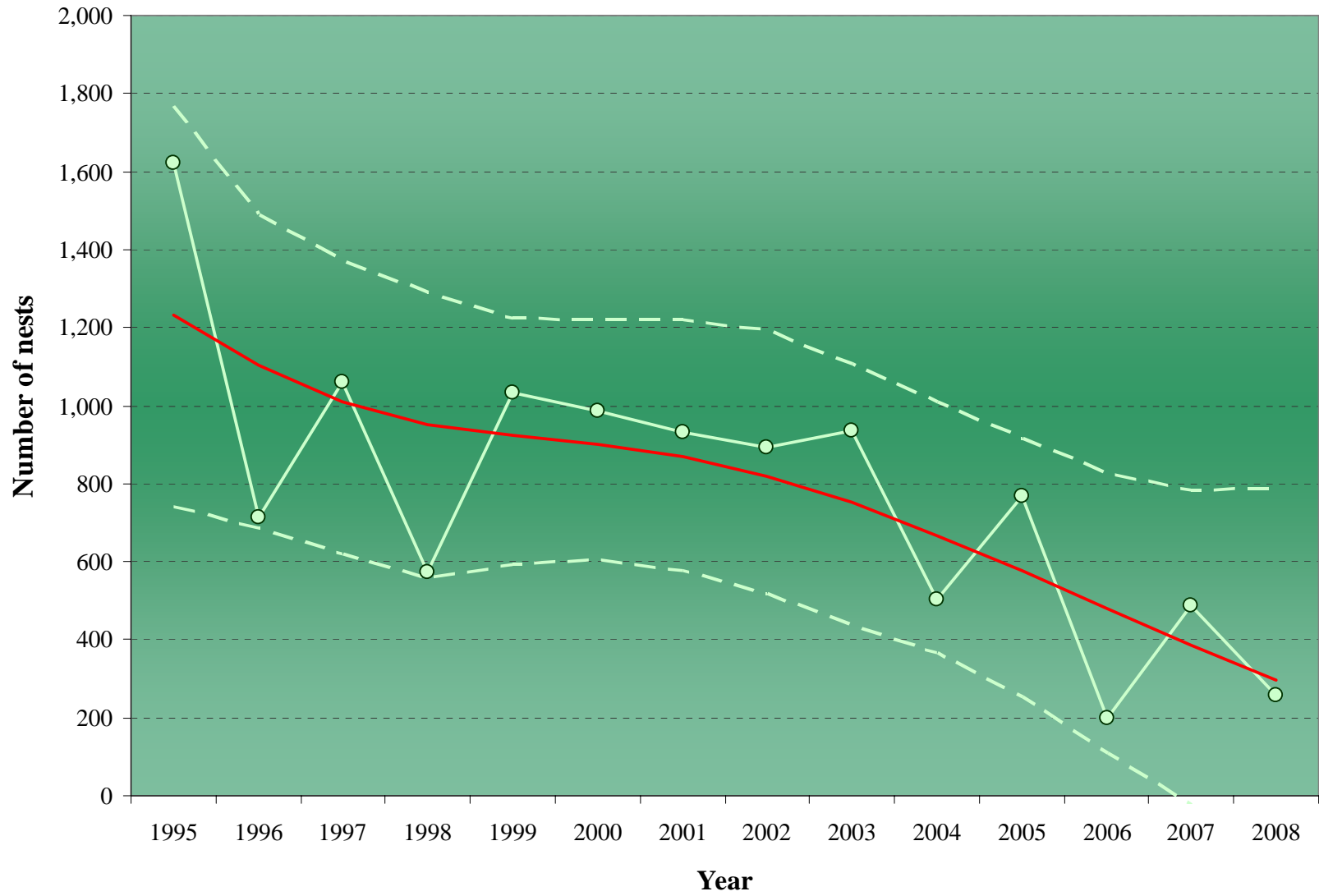


Table 1. Number of turtle nests and level of illegal poaching, as determined from track surveys conducted by FC and RAs every three days during the 2008 Leatherback Program

Date	Leatherback			Green turtle			Hawksbill		
	Nests	Min no. poached	Min % poached	Nests	Min no. poached	Min % poached	Nests	Min no. poached	Min % poached
13-Mar	40	0	0.0	30	2	6.7	0	N/A	N/A
16-Mar	12	1	8.3	5	0	0.0	0	N/A	N/A
19-Mar	11	0	0.0	10	1	10.0	0	N/A	N/A
22-Mar	10	0	0.0	12	1	8.3	0	N/A	N/A
25-Mar	17	2	11.8	21	2	9.5	0	N/A	N/A
28-Mar	14	1	7.1	22	0	0.0	0	N/A	N/A
31-Mar	22	0	0.0	11	0	0.0	0	N/A	N/A
3-Apr	26	0	0.0	8	0	0.0	0	N/A	N/A
6-Apr	18	0	0.0	19	0	0.0	0	N/A	N/A
9-Apr	23	0	0.0	19	0	0.0	0	N/A	N/A
12-Apr	20	2	10.0	7	0	0.0	0	N/A	N/A
15-Apr	19	2	10.5	20	3	15.0	0	N/A	N/A
18-Apr	19	3	15.8	14	7	50.0	0	N/A	N/A
21-Apr	14	2	14.3	12	2	16.7	0	N/A	N/A
24-Apr	28	2	7.1	16	1	6.3	0	N/A	N/A
27-Apr	18	5	27.8	15	0	0.0	0	N/A	N/A
30-Apr	17	2	11.8	17	0	0.0	0	N/A	N/A
3-May	27	6	22.2	9	0	0.0	2	0	0.0
6-May	17	2	11.8	9	2	22.2	0	N/A	N/A
9-May	14	2	14.3	14	4	28.6	1	1	100.0
12-May	24	2	8.3	7	0	0.0	0	N/A	N/A
15-May	25	9	36.0	13	2	15.4	0	N/A	N/A
18-May	13	1	7.7	5	0	0.0	3	1	33.3
21-May	26	6	23.1	7	0	0.0	2	0	0.0
24-May	14	1	7.1	2	0	0.0	2	2	100.0
27-May	11	3	27.3	6	2	33.3	5	2	40.0
30-May	18	6	33.3	6	0	0.0	5	1	20.0
2-Jun	15	0	0.0	12	1	8.3	1	0	0.0
5-Jun	12	0	0.0	21	0	0.0	1	0	0.0
Total	544	60	11.0	369	30	8.1	22	7	31.8

Figure 3. Spatial distribution of leatherback nests during the 2008 Leatherback Program, as determined by track surveys conducted by FCs and RAs every three days

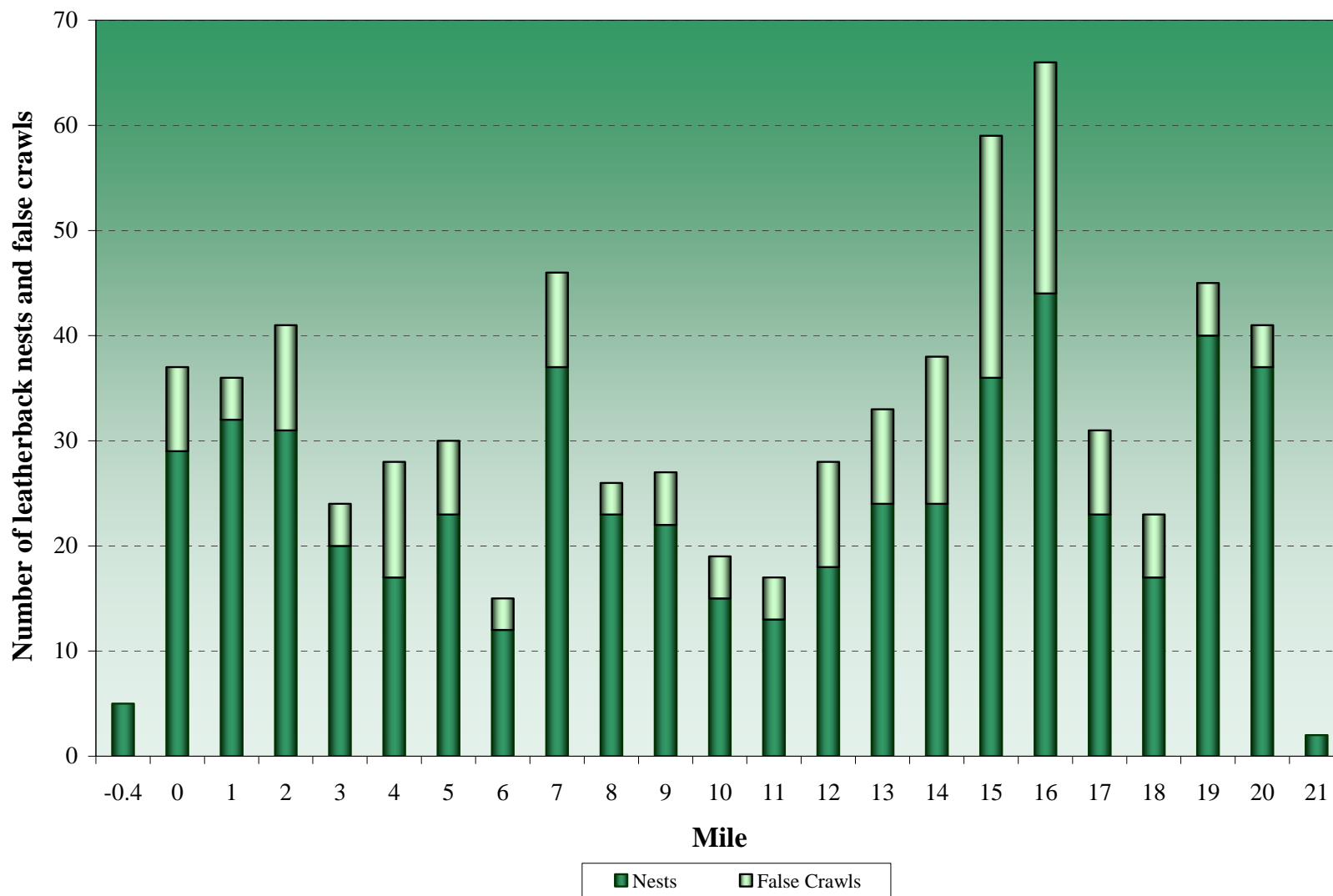
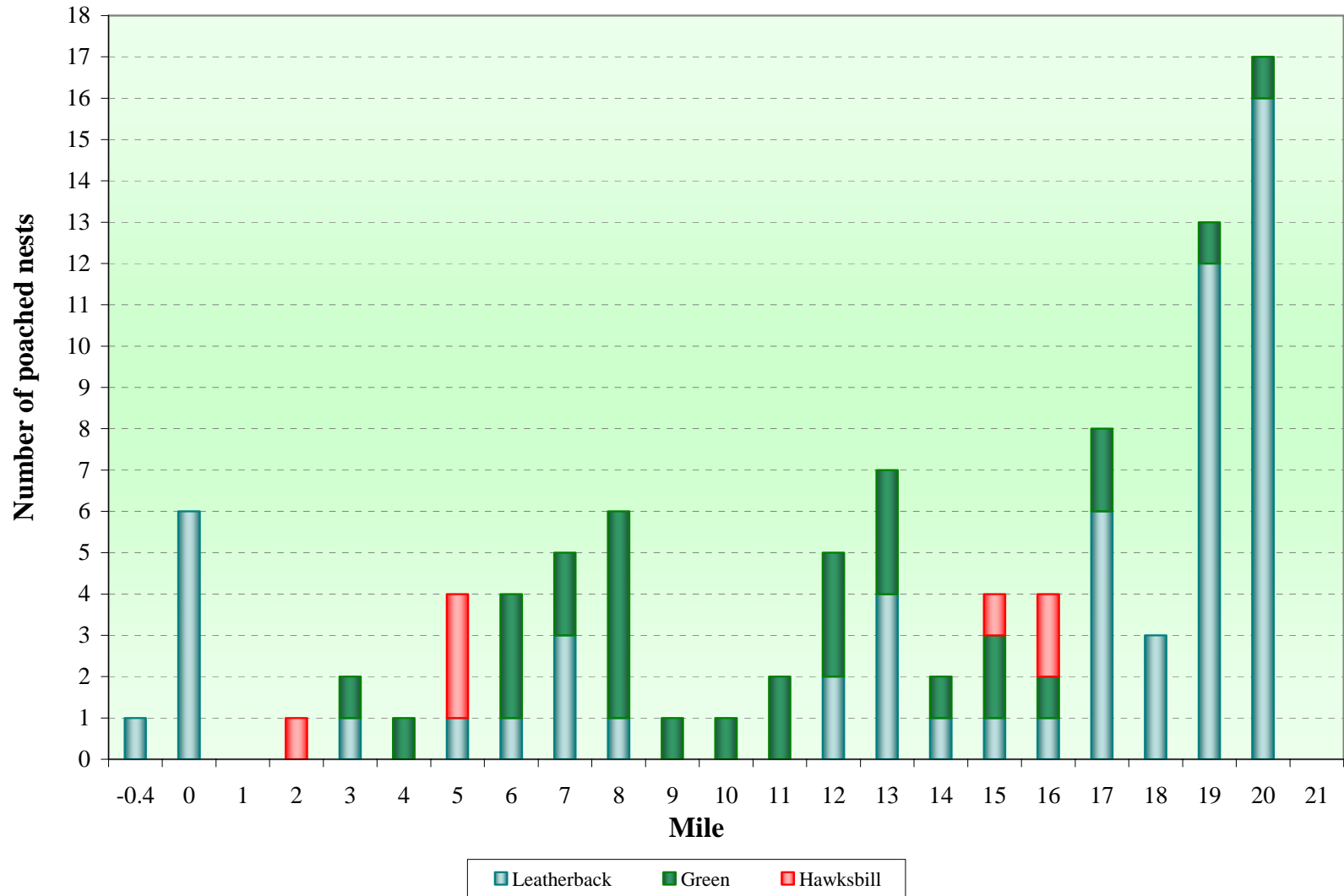


Figure 4. Spatial distribution of illegal poached nests during the 2008 Leatherback Program, as determined by track surveys conducted by FCs and RAs every three days



3.3 Tagging of Nesting Sea Turtles

Tags used during the 2008 Leatherback Program were National Band & Tag Company (NBTC) Monel #49 tags VC1001-1102 (except VC1032-VC1035, VC1037-VC1039 and VC1100) and Inconel #681 tags 110000-110031, 110038-110049, 110051-110054, 110079 and 110081.

Nightly patrols were conducted between 4 March - 3 June 2008 (with the exception of 5, 6, 9, 12, 15, 18, and 22 March, 11 and 17 April and 2 May); in total, 877.3 team patrols hours were logged. During these patrols a total of 111 turtles were encountered; 88 leatherbacks, 24 green turtles, and five hawksbills (See Appendix 1). This is equal to a mean of 0.10 leatherback, 0.03 green and 0.006 hawksbill turtles encountered per patrol hour.

The turtles encountered correspond to 55 individual female leatherbacks, 20 green turtles and four hawksbills. Although more of the leatherback females were tagged when first encountered ($n = 31$), there were 24 individuals newly tagged during the 2008 season, which was a higher percentage than in 2007 and 2006 (See Appendix 1).

Of the previously tagged leatherback turtles encountered in 2008, 35.5% had originally been tagged in Tortuguero ($n = 11$). The remainder were tagged by researchers at Caño Palma (north of the river mouth in Tortuguero; $n = 5$) and other nesting beaches on the southern Caribbean coast of Costa Rica, including Parismina ($n = 7$), Pacuare ($n = 2$), and Gandoca/Manzanillo ($n = 6$). Of the turtles tagged in Tortuguero, two were originally tagged 10 years ago in 1998. Another was first seen in 1999. One green turtle was encountered with tags that were attached at Tortuguero in 2004.

Evidence of holes or notches were found on 20.8% ($n = 5$) of the newly tagged leatherback turtles checked for previous tagging ($n = 24$) when they were encountered for the first time during the 2008 Leatherback Program.

The majority of leatherbacks nested in the open beach zone (87.5%, $n = 77$); 4.5% nested in the border zone ($n = 4$) and 8.0% did not lay eggs ($n = 7$).

3.4 Biometric Data Collection

CCLmin measurements were taken for 53 of the 55 individual leatherback turtles encountered.

Of 20 females observed more than once during the 2008 season, 14 (70%) had their caudal projection consistently identified on each occasion; nine were classified as complete and five as incomplete. The other six females had caudal projections that were either inconsistently categorized on successive sightings or the observers were unsure as to whether it was complete or incomplete. Data from these six individuals were, therefore, excluded from an initial comparison of CCLmin between females with complete or incomplete caudal projections.

The results of this test showed no significant difference in carapace length between individuals with complete or incomplete caudal projection (Wilcoxon test: $Z = -0.76$ $p = 0.45$), and so for further analyses the two categories were pooled and data from all females were included.

Table 2 summarizes the biometric data collected from leatherback females. Mean carapace length was 150.3cm ($n = 53$) and mean clutch size was 72 yolked eggs (range = 9 - 106) and 24 yolkless eggs (range = 1 - 58). If, however, the two very small clutches (9 and 28 eggs) were removed from this analysis the mean clutch size was 81 yolked eggs and 25 yolkless eggs.

Table 2. Mean carapace length and clutch size of leatherback turtles encountered in 2008

Carapace length / cm			Clutch size / no. eggs		
n	\bar{x} CCLmin ± S.D.	Range	n	\bar{x} yolked ± S.D	\bar{x} yolkless ± S.D
53	150.3 ± 7.6	131.2 – 174.8	33	72 ± 20	24 ± 15

Mean carapace length (CCLmin) for green turtles encountered during the 2008 Leatherback Program was 104.6 cm (n = 18). Only one clutch was counted and the female laid 96 eggs (See Table 3). The four hawksbill turtles that were encountered had a mean carapace length (CCLmin) of 87.5 cm. No hawksbill clutches were counted.

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}
Green	18	104.6 ± 5.6	95.6 – 113.0	1	96
Hawksbill	4	87.5 ± 3.6	84.6 – 92.7	0	N/A

The precision of the CCLmin measurements was high in 2008, and was almost identical 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	53	0.3 ± 0.2	0 – 1.0
Green	18	0.4 ± 0.3	0.1 – 0.9
Hawksbill	4	0.3 ± 0.2	0.1 – 0.6

The precision of the CCLmin carapace measurements for leatherback turtles measured during more than one encounter was 1.1 cm for two encounters, 1.8 cm for three encounters, 1.8 cm for four encounters and 1.9 cm for five encounters (See Table 5). It can be seen that the more times a turtle was encountered and measured the greater the difference between the measurements.

Table 5. Precision of carapace measurements for individual leatherbacks encountered more than once during the 2008 Leatherback Program

No. of encounters	n	\bar{x} precision for CCLmin (cm) ± SD	Range / cm
2	11	1.1 ± 0.5	0.2 – 1.8
3	6	1.8 ± 1.0	0.7 – 2.9
4	2	1.8 ± 0.9	1.8 – 1.9
5	1	1.9	N/A

3.5 Determination of Nest Survivorship and Hatching Success

A total of 45 leatherback nests were marked between 19 March and 12 July 2008; three of these were marked during the 2008 Green Turtle Program. One of the nests was removed from the analysis of survivorship and hatching success as it was not found during the excavation and there was no record during the incubation period that it had been washed out or poached. In addition, two other nests were excluded from the analysis because the turtle had a large tumor on her cloaca and had extreme difficulty in trying to lay her eggs; she managed to lay less than 20 eggs on both occasions.

Three green turtle nests were also marked; these will be included in the analysis of nest survivorship and hatching success in the 2008 Green Turtle Report.

The fate, hatching and emerging successes of 42 marked and monitored leatherback nests are summarized in Table 6. The data from the nest excavations are summarized in Table 7.

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

Fate	n	% of total	% Hatching success	% Emerging success
Undisturbed	19	45.2	59.1	55.7
Inundated	9	21.4	2.8	2.5
Depredated by dogs	8	19.1	38.5	37.1
Washed out	3	7.1	0.0	0.0
Unhatched	2	4.8	0.0	0.0
Poached	1	2.4	0.0	0.0
Total	42	100	34.7%¹	32.8%¹
<i>Unknown</i>	<i>1</i>			
<i>Turtle with tumor</i>	<i>2</i>			

¹ Calculated as the mean of all 42 nests

Table 7. Summary of data from nest excavations of marked leatherback nests during the 2008 Leatherback Program

Fate	n	Hatchlings		Empty shells	Pipped	Unhatched eggs			Predated	Deformed	Yolkless eggs	Total number of eggs	\bar{x} clutch size
		Live	Dead			No Embryo	Embryo	Full Embryo					
Undisturbed	19	14	32	771	21	247	116	52	141	6	749	1348	71 ¹
Inundated	9	0	2	22	0	181	345	79	123	10	296	750	83 ¹
Depredated	8	1	9	214	0	87	86	76	132	4	343	595	74 ¹
Washed out	3	0	0	3	0	0	0	0	0	0	55	3	67 ²
Unhatched	2	0	0	0	0	33	47	0	23	0	83	103	52 ¹
Poached	1	0	0	0	0	0	0	0	0	0	27	0	82 ²
Total	42	15	43	1010	21	548	594	207	419	20	1553	2799	72³

¹ Calculated from data at time of excavation

² Calculated from egg counts at time of oviposition

³ Calculated as the mean of the average clutch size for each of the six different fate categories

From Table 6 it can be seen that undisturbed nests had a good hatching and emerging success; 59.1% and 55.7% respectively, and even nests that had been partially predated by dogs had some hatchlings that emerged successfully (38.5% hatching success and 37.1% emerging success). However those nests that were repeatedly inundated during the incubation period were very unsuccessful (less than 3% hatching and emerging success).

Overall mean hatching success of leatherback nests was calculated as 34.7% (n=42). Emerging success was 32.8% (n=42). These values were calculated as the mean of the 42 nests that were marked and the fate of the nest was determined (See Table 6).

The incubation period for undisturbed leatherback nests for which emerging was observed (n = 14) varied between 57 - 65 days, with a mean of 62 days.

The distance from the sand surface to the top egg at the time of excavation for undisturbed nests (n = 19) varied between 44 - 78 cm with a mean of 61.2 cm. The distance from the sand surface to the bottom of the egg chamber for the same nests varied from 65 - 88 cm, with a mean of 77.4 cm.

Twenty deformed embryos were recorded, corresponding to 0.7% of eggs encountered during nest excavations.

3.6 Physical Data Collection

Table 8 summarizes the rainfall and air temperature data collected during the 2008 Leatherback Program. Rainfall between March and June varied considerably (151.8 mm - 661.6 mm per month); with March being the driest month, and June the wettest (See Table 8). Average daily rainfall, over a 24-hour period, ranged from 5.2 mm in March to 22.1 mm, in June.

Daily air temperature at the CCC field station in Tortuguero from March to June 2008 ranged between 23.0 - 29.0°C (See Table 8). Average daily temperatures did not vary greatly during the season; June was the coolest month (25.8°C) and April was the warmest month (27.1°C).

Table 8. Rainfall and air temperature recorded during the 2008 Leatherback Program

Month	Total rainfall mm/month	\bar{x} rainfall mm/24hrs	\bar{x} temperature/°C	Temperature range / °C
March	151.8	5.2 ¹	26.5 ²	23.0 - 28.5
April	275.0	9.8 ³	27.1 ⁴	23.4 - 29.0
May	165.6	5.5 ⁵	26.9 ⁵	23.7 - 28.8
June	661.6	22.1	25.8 ⁶	23.7 - 27.9

¹ Data for 72 hours 12-14 March; ² Data for 48 hours 13-14 March

³ Data for 48 hours 19-20, 27-28 April; ⁴ Data for 48 hours 27-28 April

⁵ Data for 48 hours 16-17 May

⁶ Data for 48 hours 4-5 June

The mean monthly sand temperatures recorded from March - September are shown in Table 9; data from June - September are included as the last marked leatherback nest was excavated on 19 September.

Table 9. Mean monthly sand temperatures recorded March - September 2008

Zone	Vegetation			Border			Open		
	\bar{x} temperature / °C			\bar{x} temperature / °C			\bar{x} temperature / °C		
Depth	30	50	70	30	50	70	30	50	70
March - from 17/3	N/A	25.8	26.0	27.7	27.8	25.8	30.8	30.9	30.8
April	N/A	26.2	26.3	28.2	28.4	25.5 ¹	31.6	31.6	31.4
May	N/A	26.6	26.8	28.7	28.7	²	32.3	32.2	31.9
June	N/A	26.1	26.4	26.8	27.2	²	29.8	30.2	30.3
July - to 8/7	N/A	25.6	25.8	26.6	26.6	²	29.3	28.9	28.6
Retrieval depth 8 July / cm	N/A	52	72	7	45	66	27	48	67
July - from 8/7	N/A	26.0	26.4	27.2	27.1	24.4	29.5	29.5	29.3
August	N/A	26.3	26.7	28.4	27.9	25.1	31.2	30.8	30.3
September	N/A	27.0	27.4	29.6	29.1	26.2	32.4	32.2	31.8
Overall mean	N/A	26.2	26.5	27.9	27.9	25.4	30.9	30.8	30.6

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

¹ To 12 April

² No data as data logger stopped working on 12 April

Mean monthly sand temperatures ranged from 24.4°C (border zone in July) to 32.4°C (open zone in September). From March to September, sand temperatures were consistently higher in the open zone than the border or vegetation zones, at all depths. Except for June and July the mean sand temperature in the open zone did not fall below 30°C; for the vegetation and border zones, the temperature did not exceed 30°C (See Figure 5). Temperatures in all zones, and at all depths, peaked in May and then showed an obvious decline in June and July. Most leatherback nests were laid in the open zone and so would have been subject to temperatures greater than 30°C during incubation.

3.7 Collection of Human Impact Data

3.7.1 Visitors to Tortuguero

The number of people visiting Tortuguero National Park rose in 2008, continuing the trend that has been observed over the last few years (See Table 10). In 2008, data from the Tortuguero Conservation Area (ACTo) show that 134,690 tourists were registered as paying the entrance fee to the park; this is over 17,000 more visitors than in 2007. There also appears to have been a dramatic increase in the number of Costa Rican nationals visiting Tortuguero National Park since 2005; in 2008 over 26,700 were recorded throughout the year (See Table 10).

Figure 5. Mean monthly sand temperatures from March – September 2008

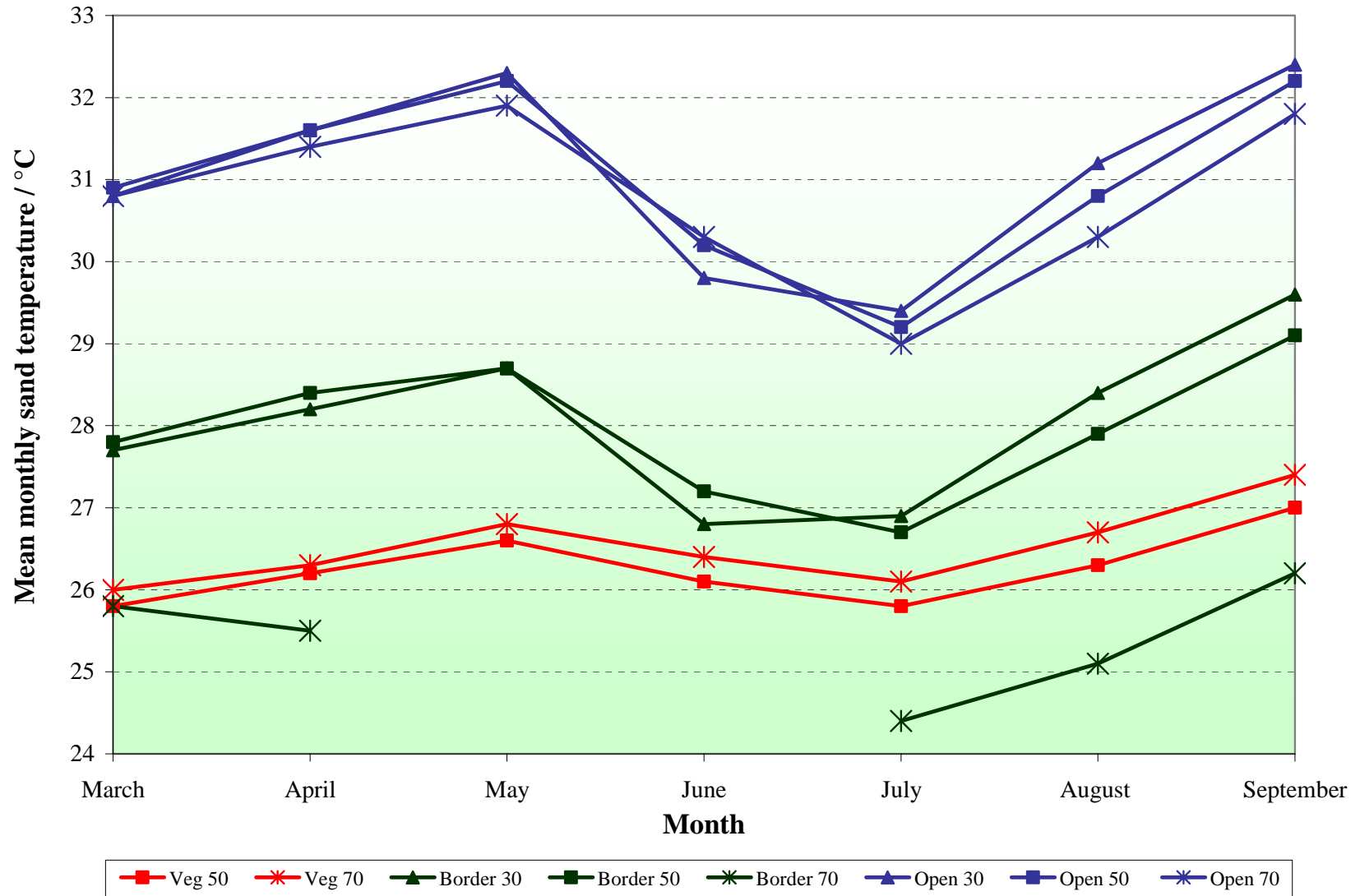


Table 10. Number of paying visitors to Tortuguero National Park, 2005 - 2008

Year	Costa Rican visitors	Foreign visitors	Total no. of visitors
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

Data from Tortuguero Conservation Area (ACTo)

The number of visitors registered at the CCC Natural History and Visitors Center decreased slightly in 2008 from that in 2007, to 29,536 visitors (See Table 11). The overall daily visitation rate to the center was 81 visitors, almost identical to the number recorded in 2007; in February, March, September and December daily visitation was higher in 2008 than the previous year.

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 an increase in visitation observed during July and August coinciding with increased green turtle nesting; which is the major tourist attractions in the area; however this increase was much lower than observed in either 2006 or 2007.

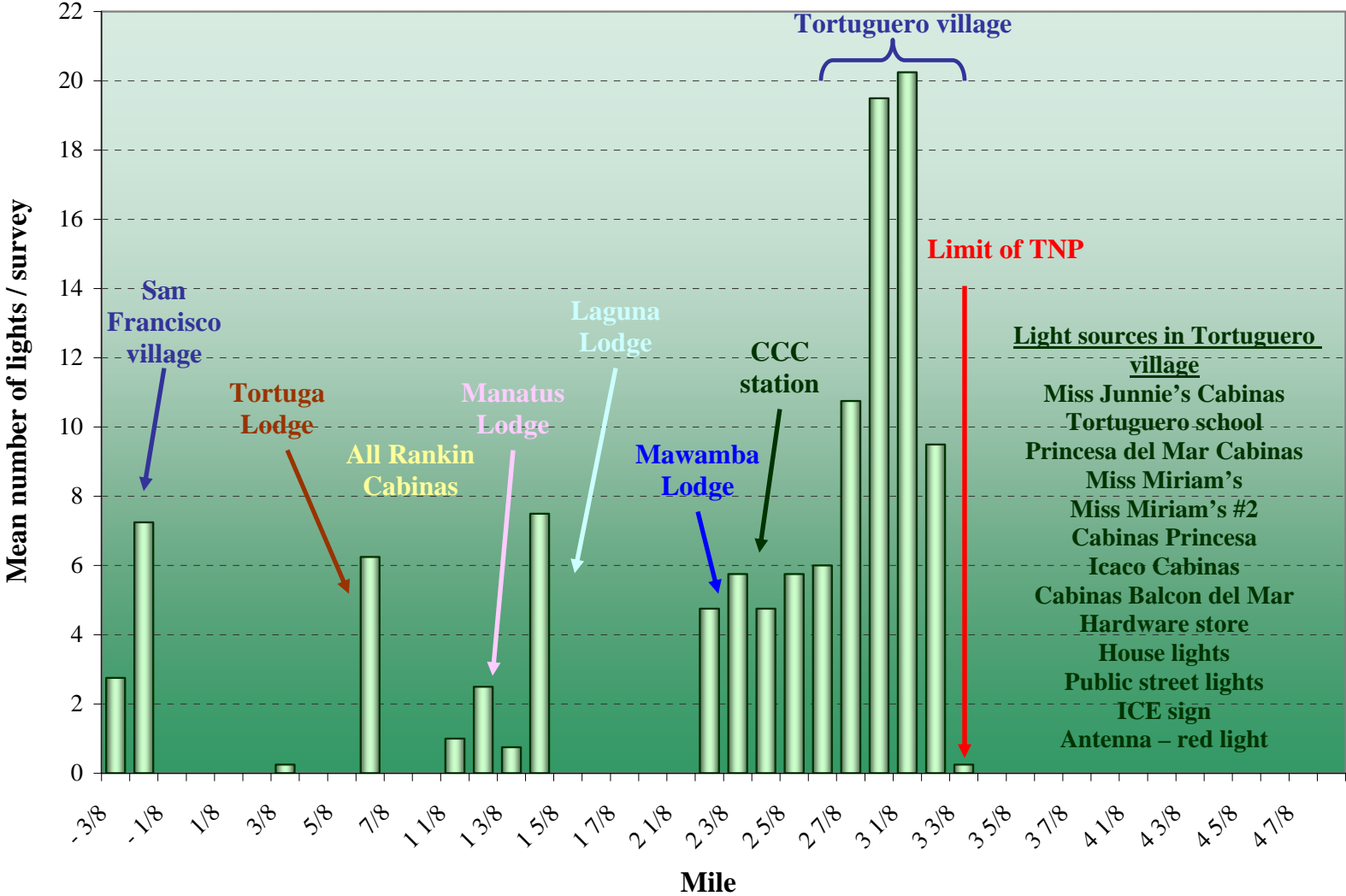
Table 11. Visitors to the CCC Visitors Center, January 2006 - December 2008

Month	2006		2007		2008	
	Total	\bar{x} / day	Total	\bar{x} / day	Total	\bar{x} / day
January	3,061	99	3,842	124	3,398	110
February	3,996	143	3,812	136	4,105	142
March	4,395	142	3,455	111	4,421	143
April	3,020	101	2,904	97	2,515	84
May	1,601	52	1,238	40	1,311	42
June	2,022	67	1,705	57	1,562	52
July	3,610	117	3,007	97	2,420	78
August	3,272	106	2,951	95	2,265	73
September	1,697	57	1,149	38	1,250	42
October	1,338	43	1,298	42	1,310	42
November	2,043	68	2,055	69	2,025,	68
December	2,678	86	2,603	84	2,954	95
Total	32,733	90	30,019	82	29,536	81

3.7.2 Artificial lights

Light surveys were conducted in March, April, May and June of the 2008 Leatherback Program. The spatial distribution of the artificial lights visible on the beach is shown in Figure 6; the bars represent the average number of lights counted in each 1/8 mile section during the four surveys.

Figure 6. Spatial distribution of artificial lights visible on the beach at Tortuguero, as determined by monthly light 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 6).

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 either on the beach or on the opposite side of the river. This pattern of lights visible on the beach remains the same as that observed in previous years although there has been a definite increase in the number of lights visible from San Francisco village and also from the majority of the larger lodges north of the CCC station.

3.8 Dead Turtles

3.8.1 Illegal Take of Turtles

Eighteen turtles were poached from March-June 2008; 15 green turtles and three hawksbills (See Table 12). If no body was found the turtle was classified as poached if one or more of the following forms of evidence were present; obvious drag mark from a turtle flipped on its carapace, blood or entrails on the beach, signs of a struggle but no jaguar prints close by. All the turtles were taken illegally from within Tortuguero National Park, and the evidence suggested they had been removed from the beach by boat.

Table 12. Turtles killed by humans during the 2008 Leatherback Program

Date	Species	Sex	Mile	Comments
25-Mar-08	CM	F	6 4/8	Found dead without plastron, meat or flippers
9-Apr-08	CM	F	16	Found dead with evidence of blows to the neck
24-Apr-08	CM	F	12	Found freshly killed
30-Apr-08	CM	F	13	Drag marks leading to the sea
3-May-08	CM	F	10 4/8	Found dead – plastron open and missing flippers
15-May-08	CM	F	11 4/8	Evidence of a poached turtle
18-May-08	EI	F	5 4/8	Evidence of a poached turtle
18-May-08	EI	F	7	Evidence of a turtle killed on the beach
21-May-08	EI	F	5 4/8	Found head and carapace on the beach
24-May-08	CM	F	7 4/8	Drag marks found on beach
24-May-08	CM	F	8 4/8	Drag marks found on beach
24-May-08	CM	F	12 4/8	Drag marks found on beach
27-May-08	CM	F	7	Drag marks found on beach
29-May-08	CM	F	11 4/8	Drag marks found on beach
29-May-08	CM	F	10	Drag marks found on beach
2-Jun-08	CM	F	7	Drag marks found on beach
5-Jun-08	CM	F	9	Drag marks found on beach
5-Jun-08	CM	F	16	Drag marks found on beach

CM = Green turtle; EI = Hawksbill

3.8.2 Jaguar Predation of Turtles

In addition to the turtles that were taken illegally by poachers, 54 green turtles were encountered during the 2008 Leatherback Program, all of which had been killed by jaguars (See Table 13). One of these turtles showed evidence that the meat had been taken by poachers after it had been killed by a jaguar; another turtle was found flipped over and prepared for removal from the beach. Predation occurred from March to June and the majority of turtles were killed between miles 7 and 13, although one turtle was predated within one mile of Tortuguero village.

Table 13. Turtles killed by jaguars during the 2008 Leatherback Program

Date	Species	Sex	Mile	Comments
10-Mar-08	CM	F	19	Killed by jaguar – meat taken by people
13-Mar-08	CM	F	10 4/8	Killed by jaguar – flipped over by people
22-Mar-08	CM	F	10	Killed by jaguar
22-Mar-08	CM	F	10 4/8	Killed by jaguar
22-Mar-08	CM	F	11 4/8	Freshly killed by jaguar
22-Mar-08	CM	F	13	Killed by jaguar – only found skeleton
25-Mar-08	CM	F	10	Freshly killed by jaguar
27-Mar-08	CM	F	11	Freshly killed by jaguar
27-Mar-08	CM	F	14 4/8	Freshly killed by jaguar
31-Mar-08	CM	F	6 4/8	Freshly killed by jaguar
31-Mar-08	CM	F	7 4/8	Freshly killed by jaguar
31-Mar-08	CM	F	11	Freshly killed by jaguar
3-Apr-08	CM	F	12	Killed by jaguar – tags 92054 / 92055
3-Apr-08	CM	F	13	Freshly killed by jaguar
6-Apr-08	CM	F	7	Freshly killed by jaguar
6-Apr-08	CM	F	13	Killed by jaguar
12-Apr-08	CM	F	7	Freshly killed by jaguar
12-Apr-08	CM	F	7 4/8	Freshly killed by jaguar
12-Apr-08	CM	F	10	Freshly killed by jaguar
12-Apr-08	CM	F	11	Freshly killed by jaguar
18-Apr-08	CM	F	9 4/8	Killed by jaguar – several days old
18-Apr-08	CM	F	12 4/8	Killed by jaguar – tag CP0610
18-Apr-08	CM	F	17	Killed by jaguar – several days old
18-Apr-08	CM	F	16	Freshly killed by jaguar
21-Apr-08	CM	F	12 4/8	Killed by jaguar – only found carapace
22-Apr-08	CM	F	17	Freshly killed by jaguar
24-Apr-08	CM	F	14	Killed by jaguar – only found flipper
24-Apr-08	CM	F	7 4/8	Killed by jaguar – tag 98007
27-Apr-08	CM	F	9 4/8	Killed by jaguar – tags 110021 / 110023

Table 13 Continued.

Date	Species	Sex	Mile	Comments
30-Apr-08	CM	F	8 4/8	Freshly killed by jaguar
27-Apr-08	CM	F	12	Killed by jaguar – several days old
30-Apr-08	CM	F	9 4/8	Killed by jaguar – several days old
3-May-08	CM	F	6 4/8	Freshly killed by jaguar
3-May-08	CM	F	9	Killed by jaguar
3-May-08	CM	F	13	Killed by jaguar
6-May-08	CM	F	12	Freshly killed by jaguar – tag 110012
9-May-08	CM	F	10 4/8	Freshly killed by jaguar
9-May-08	CM	F	14 4/8	Freshly killed by jaguar
15-May-08	CM	F	5 4/8	Freshly killed by jaguar
15-May-08	CM	F	9	Killed by jaguar – flippers possibly taken by people
15-May-08	CM	F	14	Very recently killed by jaguar
17-May-08	CM	F	8	Killed by jaguar – tag 110044
18-May-08	CM	F	9	Freshly killed by jaguar
21-May-08	CM	F	10 4/8	Freshly killed by jaguar
27-May-08	CM	F	6	Killed by jaguar
27-May-08	CM	F	8 4/8	Killed by jaguar – very decomposed
27-May-08	CM	F	13	Killed by jaguar
29-May-08	CM	F	11	Probably killed by jaguar – found decomposed on beach
2-Jun-08	CM	F	6	Freshly killed by jaguar
2-Jun-08	CM	F	10	Killed by jaguar
2-Jun-08	CM	F	12	Killed by jaguar – several days old
2-Jun-08	CM	F	15	Killed by jaguar – several days old
5-Jun-08	CM	F	4 3/8	Killed by jaguar
5-Jun-08	CM	F	15 4/8	Freshly killed by jaguar

CM = Green turtle

3.9 Environmental Education and Outreach Activities

3.9.1 Environmental Education Program

In previous years problems have been encountered concerning the programming of events with the different education centers in Tortuguero and San Francisco. To alleviate this problem the FCs visited the schools and high school at the start of the 2008 Leatherback Program to coordinate a more formalized plan of events with the directors and teachers.

The FCs and RAs worked together to determine the theme that would link all the environmental education activities for the season; they chose pollution and its effect on the environment. The RAs then worked as a group to develop a series of different activities that were conducted with students from the schools in Tortuguero and San Francisco, and also the Tortuguero high school. Table 13 summarizes the events that were conducted; it includes the objectives of the activity, a brief summary of the activity and the student group involved. Photographs of some of the activities are included in Appendix 2.

Table 14. Summary of environmental education activities conducted during the 2008 Leatherback Program

Date	Description of activity	Objectives	Student Group
26-Mar-08	<p>Game to teach the difference between a clean and a dirty beach, and the importance of keeping the beach clean.</p> <p>Beach clean competition; the first to collect 10 pieces of rubbish from the beach.</p>	<p>For the students to understand the importance of keeping the beach clean.</p>	<p>2nd grade Tortuguero school</p>
27-Mar-08	<p>“Captain Tortuga” explained to students that they were his ‘Guardians of the Beach’.</p> <p>Game to test their knowledge about pollution and its impacts on the environment.</p> <p>Beach clean competition; which group could collect the most rubbish.</p>	<p>For the students to understand the importance of keeping the beach clean.</p>	<p>1st grade Tortuguero school</p>
8-Apr-08	<p>Talk about the need to keep the village clean.</p> <p>Drew pictures of a clean and a dirty village and discussed the differences.</p> <p>Cleaned the rubbish from around the school.</p>	<p>For the students to understand the importance of keeping the village and their homes clean.</p>	<p>1st, 2nd and 3rd grade San Francisco school</p>
10-Apr-08	<p>Game about pollution and its impacts on different habitats.</p> <p>Game in which RAs were different characters with puzzles to solve to earn pieces of a secret message.</p>	<p>For the students to understand that it is important to ensure that the rivers and oceans are free of pollution.</p>	<p>3rd grade Tortuguero school</p>

Table 14 Continued.

Date	Description of activity	Objectives	Student Group
22-Apr-08	<p>RA Rafael Marrón Fiol talked about his work for a turtle conservation project in Los Cabos, Mexico.</p> <p>Received letters from students at a school in Los Cabos and wrote replies about Tortuguero National Park, turtles and what they do to help conserve them.</p>	To learn about other turtle conservation projects and to establish contact with children in a different country who they have something in common with.	4 th grade Tortuguero school
25-Apr-08	Conducted a clean-up of the village, separated the rubbish collected and visited the recycling center to learn how it operates.	To teach conscientiousness and responsibility for the cleanliness of their own village and the importance of separating rubbish.	5 th grade Tortuguero school
7-May-08	<p>Preparation for a debate about the planned (hypothetical) development of a megaresort in Tortuguero.</p> <p>Students were divided into groups and given information about their character. They selected their representative for the debate and formulated their arguments.</p>	To raise awareness of the costs and benefits of different kinds of tourism in Tortuguero and to help show the importance of being involved in the sustainable development of their village.	Tortuguero high school
8-May-08	Conducted a debate about the development of a megaresort in Tortuguero with different characters in favor or against the proposal.	To teach students how to participate and express themselves in a debate.	Tortuguero high school
2-Jun-08	Painted barrels that were used as recycling containers for the school	To reinforce the idea about the importance of separating the rubbish in the village	5 th grade Tortuguero school
3-Jun-08	Second letter exchange with students from Mexico; received replies and wrote another letter.	To learn about other turtle conservation projects and to establish contact with children in a different country who they have something in common with	4 th grade Tortuguero school
4-Jun-08	Learned how to make recycled paper.	To show that they can have fun and make something useful while reducing waste	4 th , 5 th and 6 th grade San Francisco school

3.9.2 Outreach Activities - Veterinary Clinic

Several meetings of the committee for the spay/neuter program in Tortuguero were held prior to the start of the 2008 Leatherback Program; they identified individuals and organizations interested in helping to coordinate the education program and veterinarian clinic. The committee includes representatives from CCC, MINAET, ProParques (an environmental NGO based in San Jose) and local residents from 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 and a local vet from Cariari, Dr Hernán Barrantes Lobo. In addition a survey was conducted in Tortuguero in 2007 to determine the number of dogs in the village; each house was visited and homeowners asked to complete a questionnaire about the number of animals they owned.

The first educational talks were given at the Tortuguero and San Francisco schools from 19-21 February, 2008. A member of AHPPA, assisted by staff from ProParques and Tortuguero National Park, gave the students information about the benefits of having their pets castrated and provided advice on animal care. Further presentations were given to staff at several of the local lodges, to give residents information about the clinic.

The first veterinarian clinic took place the 28-30 March, 2008. 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 three days a total of 93 animals were castrated; the majority were dogs although several cats were also brought in by their owners. In addition many 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 the vets with food during their stay in Tortuguero. Photographs from the clinic are shown in Appendix 3.

3.10 Independent Research Projects

To try to increase the possibility of encountering a turtle laying below the high tide line, and so increase the sample size of relocated nests, in 2008 the decision was made to not only relocate nests with the northern five miles of beach, but to also relocate nests in the southernmost four miles close to the Jalova lagoon, where night patrols were also conducted.

Unfortunately no females were encountered during night patrols in these two sections of the beach laying nests in the designated relocation zone (below or within 1m of the high tide line) and so no nests were relocated during the 2008 Leatherback Program.

4. Discussion

4.1 Preparations

While it is appreciated that the work of replacing and painting the mile markers along the entire 22 miles of beach is incredibly strenuous and time consuming for the newly arrived RAs at the start of each Leatherback Program these mile markers are, however, absolutely indispensable during night-time patrols and track surveys. In addition to the CCC research activities the

markers are often utilized by park rangers and tour guides to locate themselves on the beach. Following the suggestion from 2007 about the possibility of hiring an ATV from the village to help with this task, the FCs approached one of the owners and he agreed to assist during the 10-mile section between miles 5-15, which had previously been completed on foot. This greatly improved the efficiency of the team who were able to complete the task much quicker. They also took GPS readings of the location of each mile marker which can be used as a reference in future years, thus minimizing the need to measure between markers. It is strongly recommended that both these modifications to the protocol for preparing the mile markers should be incorporated in future years.

Several RAs from the 2007 Leatherback Program had made the suggestion that the training and orientation period should be extended so that there was more time available to prepare the mile markers and also receive all the necessary information about the monitoring activities, and so in 2008 there were two full weeks at the beginning of the program dedicated to the beach preparations, training presentations and protocol practice sessions. In addition to the tour of Tortuguero to present the RAs to key members of the community and a visit to the schools of Tortuguero and San Francisco, the orientation program also included a talk by Tortuguero National Park staff about the creation of the park and the environmental laws of the country principally related to sea turtles and the RAs also went on a canal tour in the park to familiarize themselves with the flora and fauna of the region. To give them a better understanding of the history of Tortuguero village they received a talk from a member of one of the founding families, who told them how Tortuguero used to be and how it had developed. To help develop good relationships between the RAs several group activities were also conducted, including a visit to the Caño Palma biological research station where the RAs met the researchers who are conducting turtle monitoring activities on the beach north of the Tortuguero river mouth (Playa Norte). All of the RAs responded positively to the new training program and gave a few comments on minor improvements for future groups.

4.2 Track Surveys

Leatherback nesting was observed during weekly track surveys from February to June, although false crawls continued to be seen until the middle of August, and RAs encountered leatherbacks during night patrols until 12 June. There was no clear peak nesting period as has been observed in previous years; instead there were two smaller but distinct peaks in April and early June (See Figure (See Figure 1). Track surveys conducted by the FCs and RAs (March – June) cover the period of heaviest leatherback nesting (See Figure 1 and Table 1).

Estimated leatherback nesting decreased in 2008 compared to 2007 (See Figure 2); this continues to the overall trend that has been observed in Tortuguero over the last thirteen years. It would be interesting to conduct an analysis of the entire region and include all of the nesting beaches in Costa Rica and Panama, for it is known that individual females can move between different beaches within and between seasons. Such an analysis would determine if this is a localized decline for Tortuguero, or if there are more worrying indications for the entire Caribbean coast population in general.

As observed in some previous years, the two methods used for estimating the number of leatherback nests laid in 2008 showed quite disparate values for the season; the estimate from weekly track surveys was 256 nests compared to 448 nests from the 3-day surveys for the same 18 miles of beach. The temporal distribution for the season was well correlated, however, with

both methods recording a peak in April. If the number of leatherback nests continues to decline it might be necessary to use a different statistical analysis to determine annual nesting estimates, one that is more robust when dealing fewer, more dispersed data points. It is therefore valuable to continue with the 3-days surveys during future Leatherback Programs to act as a comparison for the weekly survey data.

The spatial distribution of leatherback nests in 2008 was quite different to the pattern of nesting observed along the beach in other years. In previous years there has been an obvious concentration of nesting towards the southern end of the beach (close to the Jalova lagoon); in 2008, although this section of beach still showed a high density of nests, there was more nesting activity recorded in miles 0 - 5 than in other years. It would be interesting to determine if other leatherback nesting beach projects along the Caribbean coast of Costa Rica and Panama experienced a similar shift in spatial distribution during this season, to ascertain whether it was a phenomenon affecting the entire population, or an anomaly displayed by those females nesting at Tortuguero. Another potential 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.

Illegal poaching of turtle nests occurred throughout the 2008 Leatherback Program. The percentage of poached nests was higher than those recorded in 2007, but did not reach levels observed in 2006. Poaching was between 8.1% and 31.8% of nests, depending on the species (See Table 1); with 11% of leatherback nests taken. The majority of poaching occurred in the four miles between Jalova and Parismina (outside the southern limit to Tortuguero National Park); 32.6% of all leatherback nests laid in that section were poached (See Figure 4). Despite raising concerns with personnel from Tortuguero National Park over the last few years about the amount of poaching occurring in this area there were no patrols initiated by park rangers during 2008. In future years it might be beneficial to try and conduct more patrols in that section of the beach to deter poaching, if sufficient research assistants are available. A combined patrol effort with researchers from Parismina would be a means of reducing the number of CCC volunteers that would be needed and also be a good way of building a cooperative relationship between the two turtle conservation projects.

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.

The number of leatherback turtle encounters during nightly patrols in 2008 ($n = 117$) was lower than the number of encounters recorded in 2007. In addition 100 fewer patrol hours were conducted by the FCs and RAs; primarily due to a reduced number of 7-hour patrols in Jalova. Fewer patrols were carried out at the southern end of the beach as the observed shift in spatial distribution of nesting, with more females emerging closer to the CCC station, meant that it did not warrant having a team in Jalova. This increased patrol effort closer to the station was justified in the fact that the encounter rate per patrol hour was almost identical in 2008 to that in 2007 (0.1 leatherbacks per hour compared to 0.13, respectively). Furthermore, patrols within the northern five miles of beach had the potential to mark nests and determine their survivorship and hatching success. The number of green turtle ($n = 24$) and hawksbill ($n = 5$) encounters recorded

in 2008 was comparable to those recorded for other Leatherback Programs.

The proportion of new leatherback turtles (individuals that did not have tags when first encountered) observed during the 2008 season was considerably higher to that observed in previous years (43.6%). This figure is encouraging on one hand as it potentially suggests that there are more females reaching sexual maturity and recruiting to the adult nesting population; however, it might also imply that ‘new’ females form a higher proportion of the encounters as mature adult females that have nested on at least one previous occasion and been observed by patrols are suffering higher mortality and not surviving between nesting seasons. Considering this alternative, it was encouraging to see, therefore, that two of the remigrant females (those encountered with tags from previous seasons or different projects) had originally been tagged at Tortuguero in 1998, 10 years earlier.

Over half the female leatherbacks encountered during 2008 had already been tagged when first observed (56.4%), either at Tortuguero or at other nesting beaches in the region. This frequent movement 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 2008 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 Tortuguero in 2004; interesting she was originally tagged during the Leatherback Program, suggesting that her temporal nesting pattern is consistently early for this species, which typically nesting from June – October in Tortuguero.

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 150.3 cm (See Table 2), which is comparable to that observed in previous years. There was also a similar size diversity in the size of leatherback females encountered in 2008 to that seen during other nesting seasons; ranging from very small (131.2 cm) to very large individuals (174.8 cm). This would suggest therefore, that there is a mixture of young and old females within the Tortuguero nesting population; also supported by the fact that there was a significant proportion of ‘new’ individuals (those without tags, and therefore possibly recruits to the nesting population) encountered during 2008.

The majority of leatherback females (70%) that were encountered on more than one occasion had their caudal projection consistently identified by the different researchers. As in 2007 care was taken during the training sessions to clearly define the distinction between ‘complete’ and ‘incomplete’ caudal projections, to help the RAs reliably categorize each individual. Obviously there will still be some observer differences as it is a somewhat subjective distinction, and the idea of collecting photographs that show different caudal projections could further improve RA training.

The precision of leatherback, green turtle and hawksbill carapace measurements was high in 2008 (0.3 - 0.4cm); reflecting good training of the RAs and care being taken when collecting biometric data. Volunteer participants should be carefully supervised when they assist with measurements, to ensure that they follow the protocol. As in previous years, there was a

significant decrease in precision for females seen more than once during the nesting season (See Table 5), reflecting considerable observer variation in measuring the same turtle.

4.5 Determination of Nest Survivorship and Hatching Success

Due to the altered spatial distribution along the beach, with more leatherbacks nesting closer to the CCC station, the FCs and RAs were able to mark a lot more nests than usual during the 2008 Leatherback Program; 45 nests in total, although three were subsequently excluded from the final analysis of survivorship and hatching success. In previous years a considerable number of nests were not encountered during excavation and so their fates could not be determined; in 2008, to try and improve the proportion of nests that were positively identified during excavation a small piece of flagging tape with the nest code written on was inserted into the bottom of the egg chamber prior to oviposition. In addition, the FCs stressed to the RAs during training, and throughout the program, the importance of marking the nests accurately and monitoring them carefully throughout the incubation period to record any obvious signs of poaching, predation or erosion. Of the 45 nests marked only one could not be found during the excavation, and there was no evidence during the incubation period that this nest had been disturbed in any way. It is important that in future years the FCs and RAs continue to make every possible effort to determine the fate of each nest marked and so gain as much information as possible about leatherback nest survivorship and hatching success.

It was encouraging to observe that the majority of leatherback nests remained undisturbed in 2008 (45.2%) and their hatching and emerging success was relatively high for this species; 59.1% and 55.7%, respectively. Several nests were inundated by high tides repeatedly throughout the incubation period and they showed very low hatching success; less than 3%. In addition to the nests that were inundated, three other nests were completely washed out due to erosion of the beach. Unfortunately several nests showed signs of dog predation; this was typically observed close to the time of hatching, presumably when the hatchlings had emerged from the eggs but remained within the egg chamber prior to emergence. The fact that almost 20% of the marked nests suffered some signs of dog predation is an indication of the extent of the problem with uncontrolled dogs in the village, and provides ample justification for the establishment of the veterinary clinic (See Section 3.9). Fortunately only one of the marked nests was poached. Taking into account all of the different nest fate categories the overall hatching and emerging success of leatherback nests was calculated as 34.7% and 32.8% respectively; this is within the range observed for this species over the last few years.

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. RAs should be encouraged to try and mark every nest that they observe, even if the female has already started laying when she is encountered and so they are unable to count the eggs.

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 2008 March had the lowest recorded rainfall (151.8mm in total) and it was June that had most rain (661.6mm). The difference in the monthly rainfall during the program, 151.8 - 661.6 mm, was also greater than that observed in other years. Not surprisingly June had the coolest average

daily temperature (25.8°C), though March was not the warmest month.

The mean monthly sand temperatures recorded in the open zone, where 95% of leatherback nests were recorded during 2008, remained constantly above 30°C (See Table 9), except in June and July; they reached temperatures of 32.4°C. Thus during much of the incubation period the temperatures were above those that could result in embryo mortality, and could have resulted in the embryonic death observed in several nests during excavation (See Table 7). Another environmental factor that could have caused the embryos to die during incubation is groundwater flooding; in future years it would be interesting to also record ground water levels if possible to try to determine if this is impacting leatherback nests.

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 nests laid at this beach and their subsequent survivorship and hatching success. A future research project should focus on analyzing the data that have been collected over the last decade to determine if there have been any changes in any of the environmental variables.

4.7 Collection of Human Impact Data

The positive trend in visitation to Tortuguero witnessed over the last few years continued in 2008, with over 134,000 tourists paying the entrance fee to Tortuguero National Park (See Table 10); an increase of more than 17,000 than in 2007. And once again the increase in tourists was shown by both national and international visitation. CCC is conscious of the fact that such increases in the number of people entering the area could have potentially harmful consequences, not just on the turtles nesting on the beach, but also the other flora and fauna in the park, and on the inhabitants of the Tortuguero community. As such, the organization is dedicated to ensuring that it remains aware of any new development close to the village or the park, and is willing to inform MINAET of any concerns about tourism activities that impact turtles, especially the critically endangered leatherback.

Despite the continuing growth in tourism to Tortuguero National Park, the CCC Visitor Center showed a slight decline in visitation during 2008 (See Table 11); around 500 fewer tourists came to the centre, compared to numbers recorded in 2007. 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.

As has been said previously, the CCC Visitor Center is in desperate need of some drastic changes to allow it to function more effectively and also provide visitors with more detailed information about the organization and its valuable work in Tortuguero. A complete revision of the information displays, an update of the video and a modernization of the entire facility is long overdue, and it only a shortage of funds that have prevented this from occurring to date. It is also important to incorporate the Visitor Center administrator into the research activities on a regular basis, so that they can answer tourist questions from first-hand experience of the beach patrols. The RAs who assist in the Visitor Center also have an important function, as they can impart their experiences to tourists and encourage them to support the research efforts by adopting a turtle or purchasing a souvenir from the gift store, and it is also a great opportunity for

them to interact with the local guides and develop a good working relationship that can aid everyone when on the beach at night. Searching for funding to allow the Visitor Center improvements must remain a priority for CCC in the near future.

The problems associated with increasing construction in the communities of Tortuguero and San Francisco persist; once again in 2008 there was an increase in the number of artificial lights visible on the nesting beach close to the river mouth (from San Francisco) and also in front of the village of Tortuguero (See Figure 6). Fortunately no evidence of hatchling disorientation was observed during the Leatherback Program. As the biggest problem close to the village, between miles 2 7/8 and 3 2/8, are the tall public street lights that are unshaded, it might be worth liaising with the electricity company to ask them to cooperate with the CCC and together determine a way of minimizing the amount of light on the beach, but meanwhile safeguarding that residents have sufficient light to walk the village at night in safety. The issue of light pollution will only increase as development within Tortuguero and San Francisco continues, and so it is imperative that local residents and the relevant bodies are made aware of the problem, and offered solutions that are beneficial to turtles in the long term.

4.8 Dead Turtles

It was disturbing to observe an increase in the illegal take of both nests and female turtles during the 2008 Leatherback Program in comparison to recent years. What was most worrying is that of the 18 females recorded as poached, three were critically endangered hawksbills, presumably taken for their shell and not their meat. All of the turtles taken were within Tortuguero National Park, and the evidence showed that the majority were removed from the beach by boat. This strongly highlights the lack of patrols being conducted by park rangers, due to an apparent lack of personnel and resources. All of the information about the location of poached turtles was passed to National Park staff throughout the course of the program; in an effort to aid them focus their limited resources on the areas under greatest threat. Unfortunately, the leatherback nesting season does not appear to be given the same priority by the protection authorities as the green turtle nesting season, despite the fact that leatherbacks are critically endangered and all the evidence suggests that the population is in decline. Greater emphasis must be placed on trying to support the park rangers in whatever way possible, and to assist them in the acquisition of additional funding to contract more staff, especially during the leatherback nesting season.

Jaguar predation showed an increase in 2008, with more than 50 green turtles documented as killed by jaguars from March - June. The distribution of turtles killed by jaguars showed a peak towards the southern end of the park, around mile 13. However, jaguar footprints were observed on all track surveys and these animals were active along the entire beach from close to the village to beyond the Jalova lagoon. A proposal has been circulated by a group of researchers to try and estimate the size of the jaguar population in Tortuguero National Park, using photographic identification from camera traps; CCC has been approached to assist this research and it is something that we should be involved in. Another study of jaguar predation is being conducted by staff and volunteers from the Caño Palma research station; although to date no results have been published.

4.9 Environmental Education and Outreach Activities

There was a very definite development and improvement in the program of environmental education activities conducted during the 2008 Leatherback Program. With knowledge of the

difficulties and problems experienced in previous years, the FCs were very conscious of the need to effectively coordinate their efforts with the teachers and directors of the Tortuguero school and high school, and the San Francisco school, and remain in constant communication with them throughout the year. To facilitate this Field Coordinator Dagnia Nolasco took on the role of community liaison, and oversaw all of the environmental education activities in 2008. One objective was to develop a clear program of activities, linked through a specific theme that was chosen among the RAs and FCs at the start of the Leatherback Program. The idea was to get the RAs involved in all aspects of this program, from determining the general topic, sharing ideas to develop different activities, to actually conducting them with the students in Tortuguero and San Francisco. Indeed some of the RAs were chosen because of their prior experience in environmental education in similar settings.

This new approach proved to be effective; there were still some slight issues with regards to coordination with the schools, but this was often due to a lack of communication amongst the staff at the school, rather than bad planning on the part of CCC. The program was very well organized and covered the theme of pollution and its impacts on different habitats. It was decided to not focus just on turtle conservation, but to have a broader approach to teach the students about the impact of pollution on a range of different habitats through various games, songs and activities. They were all very well received by the staff and students, and most of the students participated enthusiastically. In addition to learning about pollution and its harmful impacts, students also learned some important skills, such as debating and voicing their opinions, and the need to be active in matters affecting their community. The younger students also had an opportunity to forge friendships with children from another country via the letter exchange.

The environmental education program was also an opportunity for the RAs to develop relationships with members of the community and to share their personal experiences with the people of Tortuguero. It also was a chance for local residents (particularly the children) to understand more the work of CCC and develop an interest in the research and conservation activities occurring on their beach to help protect own of their natural resources. It is planned for a similar program of activities to be established for each of the CCC Leatherback and Green Turtle Programs in future, building upon the relationships that have been developed by Field Coordinators Dagnia Nolasco and Xavier Debade with key members of the communities.

The need to control the dog population in Tortuguero has been raised in recent years due to the obvious increase in the number of dogs around the village, compounded by the observation that there has been an increase in the level of predation of turtle nests. Concerns were expressed to MINAET by local tour guides and also CCC, and over the course of several months a committee was formed with representatives from MINAET, CCC, ProParques (an NGO based in Costa Rica focused on aiding the national parks around the country) and interested residents. Aided by veterinarians from various organizations with experience in such clinics, and the veterinary medicine school at the National University, a combined program of activities was organized that included a regular spay/neuter clinic and a series of educational talks, aimed at teaching local residents the importance of caring for their domestic animals and having them spayed or neutered. Prior to the first vet clinic a survey of homeowners was conducted to try and estimate the number of animals in Tortuguero and so assess the scale of the problem. CCC also agreed to document evidence of dog predation of nests and distribute the findings as necessary.

The first clinic took place in March 2008 and was extremely successful; there was considerable support from the communities of Tortuguero and San Francisco (vets were divided between the

two locations) with almost 100 animals spayed or neutered. Some logistical problems were encountered, and committee meetings were organized to address these issues for future clinics. Following advice from the veterinarians it was suggested to try and conduct a clinic every 3 or 4 months during the first year, and then less frequently as the percentage of un-neutered animals decreased over time. Everyone involved was extremely pleased with the outcome, especially the interest of the community. However, the issue of the control of feral dogs without owners remains prevalent, as these are the animals that need to be spayed or neutered if the population is to be effectively controlled. In addition, there was clear evidence that there is an obvious need for further education about appropriate care of pets. Future clinics will be preceded by educational presentations, announcing the upcoming clinic. CCC played an important part in the organization of this first clinic, and provided logistical support throughout the three-day event. With an obvious interest in finding a solution to the dog problem in Tortuguero in an effort to reduce nest predation levels it is suggested that CCC remains involved in the committee and helps facilitate future clinics.

4.10 Independent Research Projects

The study that was initiated in 2007 to look at the effect of nest relocation on its subsequent survivorship and hatching success was continued during the 2008 Leatherback Program. Despite extending the protocol to also include the section of beach close to Jalova, in an effort to increase the sample size of relocated nests to that needed for statistical analysis, no females were observed nesting below the high tide line and so no nests could be relocated. This was unfortunate as the research project offered the possibility to determine whether nest relocation, as a possible conservation management strategy for the Tortuguero nesting population, could be an effective tool to try and improve the survivorship of nests that would otherwise have been doomed having been laid in an unsuitable location on the beach. The Masters student will be altering the focus of her thesis, based on the lack of field data, and will look instead at individual nesting behavior to try and determine if females show any particular patterns with regard to where on the beach they deposit their nests within a single year, or over a number of different nesting seasons.

5. References

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6. Appendices

Appendix 1. Nightly sea turtle encounters for the 2008 Leatherback Program

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

Appendix 1. Continued

Date	Leatherback				Green				Hawksbill			
	New	REM	REN	Total	New	REM	REN	Total	New	REM	REN	Total
12-Apr	1	1	1	28	2			2				0
13-Apr			1	29				2				0
14-Apr				29	2			4				0
15-Apr		2		31				4				0
16-Apr				31	1			5				0
17-Apr				31				5				0
18-Apr	2	1		34	1			6				0
19-Apr				34				6				0
20-Apr			1	35	2			8				0
21-Apr	1			36	1			9				0
22-Apr	1	1		38	1	1		11				0
23-Apr		2	1	41	1			12				0
24-Apr	1		2	44	1			13				0
25-Apr		1	1	46				13				0
26-Apr				46				13				0
27-Apr		1		47	2		1	16				0
28-Apr				47				16				0
29-Apr				47				16				0
30-Apr			1	48				16				0
1-May	1		3	52				16				0
2-May				52				16				0
3-May				52				16				0
4-May			2	54	1			17				0
5-May	1			55				17				0
6-May	1		1	57				17				0
7-May				57				17				0
8-May		1		58				17				0
9-May		1	1	60	1		1	19				0
10-May			2	62				19				0
11-May		1	1	64			1	20				0
12-May				64				20				0
13-May			1	65	1			21				0
14-May	1		1	67				21				0
15-May	1			68			1	22				0
16-May			1	69				22				0
17-May				69				22				0
18-May				69				22	1			1
19-May		3	3	75				22	2			3
20-May			1	76				22				3
21-May				76				22				3
22-May				76				22				3

Appendix 1. Continued

Date	Leatherback				Green				Hawksbill			
	New	REM	REN	Total	New	REM	REN	Total	New	REM	REN	Total
23-May		1	1	78				22				3
24-May				78				22				3
25-May				78				22				3
26-May				78				22				3
27-May				78				22				3
28-May	1			79				22				3
29-May	1	2		82				22				3
30-May	1			83				22				3
31-May			1	84				22				3
1-Jun				84				22				3
2-Jun		2	2	88				22				3
3-Jun				88	2			24			1	4
Total	24	31	33	88	19	1	4	24	4	0	1	5
%	27.3	35.2	37.5		79.2	4.2	16.7		80.0	0.0	20.0	

New = Turtles that had no tags on first encounter in 2008

REM = Remigrant; turtles that had tags from previous years/other projects on first encounter in 2008

REN = Renester; turtles that were encountered more than once during 2008

Appendix 2. Photographs of some of the environmental education activities conducted during the 2008 Leatherback Program



Students from San Francisco School meet ‘Captain Tortuga’



RA Rafael Marrón Fiol and a student read a letter

Appendix 2. Continued



High school students debate the megaresort proposal



Students learn how to make recycled paper



Students from Tortuguero school paint recycle containers

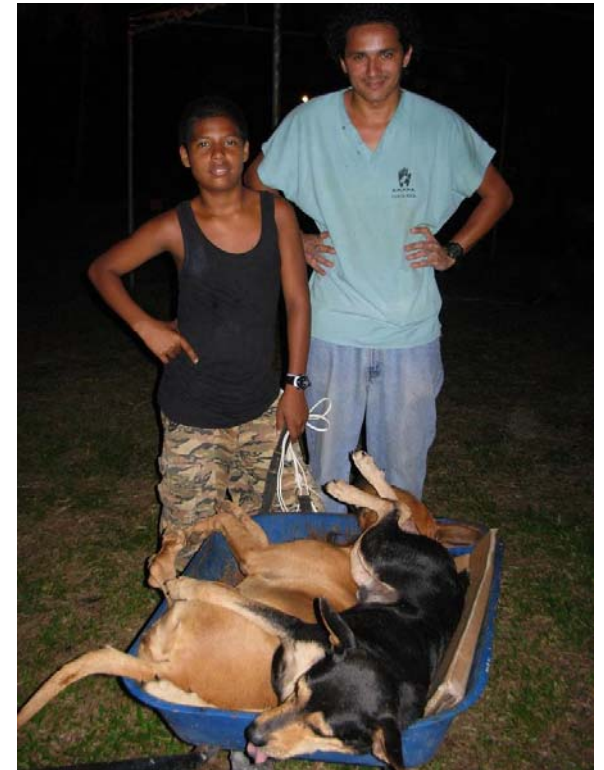
Appendix 3. Photographs of the veterinarian spay/neuter clinic conducted during the 2008 Leatherback Program



Vets perform spay operation watched by children in Tortuguero



Dogs recover in kiosk after surgery



AHPPA vet Alfonso Córdoba with some patients going home