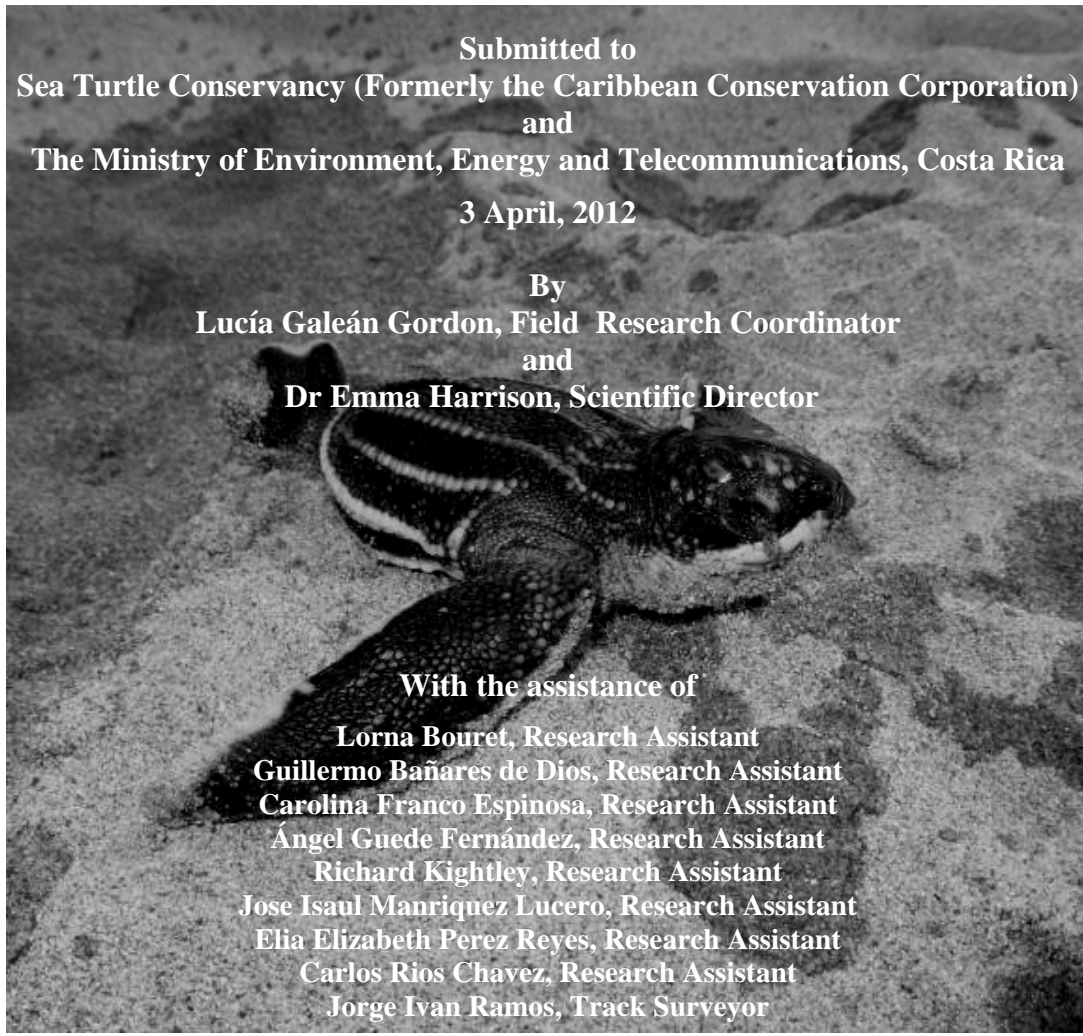


REPORT ON THE 2011 LEATHERBACK PROGRAM AT TORTUGUERO, COSTA RICA



Submitted to
Sea Turtle Conservancy (Formerly the Caribbean Conservation Corporation)
and
The Ministry of Environment, Energy and Telecommunications, Costa Rica
3 April, 2012

By
Lucía Galeán Gordon, Field Research Coordinator
and
Dr Emma Harrison, Scientific Director

With the assistance of
Lorna Bouret, Research Assistant
Guillermo Bañares de Dios, Research Assistant
Carolina Franco Espinosa, Research Assistant
Ángel Guede Fernández, Research Assistant
Richard Kightley, Research Assistant
Jose Isaul Manriquez Lucero, Research Assistant
Elia Elizabeth Perez Reyes, Research Assistant
Carlos Rios Chavez, Research Assistant
Jorge Ivan Ramos, Track Surveyor



Address:	Apartado Postal 246-2050 San Pedro COSTA RICA	4424 NW 13 th St. Suite B-11 Gainesville, FL 32609 USA
Phone:	INT+ 506 2297 5510	INT+ 1 352 373 6441
Fax:	INT+ 506 2297 6576	INT+ 1 352 375 2449
Email:	emma@conserveturtles.org	stc@conserveturtles.org
Webpage:	http://www.conserveturtles.org	

Table of Contents

Table of Contents	i
List of Figures	ii
List of Tables	ii
Acknowledgements.....	1
Monitoring and Research Activities Conducted	2
Conclusions	4
Recommendations	4
1. Introduction.....	6
2. Methods.....	6
2.1 Preparations.....	6
2.2 Track Surveys	7
2.3 Tagging of Nesting Sea Turtles.....	7
2.4 Biometric Data Collection	8
2.5 Determination of Nest Survivorship and Hatching Success	8
2.6 Physical Data Collection.....	9
2.7 Collection of Human Impact Data	9
2.8 Dead Turtles.....	10
2.9 Environmental Education and Outreach Activities.....	10
3. Results	10
3.1 Preparations.....	10
3.2 Track Surveys	11
3.3 Tagging of Nesting Sea Turtles.....	16
3.4. Biometric Data Collection.....	18
3.5 Determination of Nest Survivorship and Hatching Success	19
3.6. Physical Data Collection.....	22
3.7 Collection of Human Impact Data	22
3.8 Dead Turtles.....	27
3.9 Environmental Education and Outreach Activities.....	27
4. Discussion.....	28
4.1 Preparations.....	28
4.2 Track Surveys	28
4.3 Tagging of Nesting Sea Turtles.....	29
4.4 Biometric Data Collection	30
4.5 Determination of Nest Survivorship and Hatching Success	31
4.6 Physical Data Collection.....	31
4.7 Collection of Human Impact Data	32
4.8 Dead Turtles.....	32
4.9 Environmental Education and Outreach Activities.....	33
5. References	33
6. Appendices.....	34

List of Figures

Figure 1. Temporal distribution of leatherback nesting activity during 2011, as determined during weekly track surveys	12
Figure 2. Annual leatherback nesting trend at Tortuguero from 1995 - 2011, as determined from weekly track surveys.....	13
Figure 3. Spatial distribution of leatherback nests during the 2011 Leatherback Program, as determined by track surveys conducted by FRC and RAs every three days	14
Figure 4. Spatial distribution of illegally poached nests during the 2011 Leatherback Program, as determined by track surveys conducted by FRC and RAs every three days	17
Figure 5. Tourist visitation to the STC Visitors Centre, 2003 - 2011.....	24
Figure 6. Spatial distribution of artificial lights visible on the beach at Tortuguero, as determined by monthly light surveys.....	26

List of Tables

Table 1. Number of turtle nests and level of illegal poaching, as determined from track surveys conducted by FRC and RAs during the 2011 Leatherback Program.....	15
Table 2. Mean carapace length and clutch size of leatherback turtles encountered in 2011	18
Table 3. Mean carapace length and clutch size of green and hawksbill turtles	18
Table 4. Precision of carapace measurements for the different species of turtle.....	19
Table 5. Precision of carapace measurements for individual leatherback and green turtles encountered more than once during the 2011 Leatherback Program	19
Table 6. Fate, hatching and emerging success of marked leatherback nests	20
Table 7. Summary of data from nest excavations of marked leatherback nests during the 2011 Leatherback Program.....	21
Table 8. Rainfall recorded during the 2011 Leatherback Program.....	22
Table 9. Number of paying visitors to Tortuguero National Park, 2002 - 2011	23
Table 10. Visitors to the STC Visitor Center, January 2008 - December 2010	23
Table 11. Turtles killed by jaguars during the 2011 Leatherback Program.....	27
Table 12. Summary of veterinary clinics 2008 – 2011	28

Acknowledgements

The 2011 Leatherback Program monitoring and research activities were conducted under a research permit from the Tortuguero Conservation Area (ACTo) of the Ministry of Environment, Energy and Telecommunication of Costa Rica (MINAET), detailed in resolution number ACTo-GASP-PIN-01-2011.

All data presented in this report were collected by the Field Research Coordinator, Lucía Galeán Gordon (Spain) and her hardworking team of Research Assistants: Lorna Bouret (USA), Carolina Franco Espinosa (Colombia), Guillermo Bañares de Dios (Spain), Ángel Guede Fernández (Spain), Richard Kightley (Australia), Jose Isaul Manriquez Lucero (Mexico), Elia Elizabeth Perez Reyes (Colombia) and Carlos Fernando Rio Chavez (Mexico). They were assisted by numerous Eco-Volunteers whose help is gratefully recognized. Also, the support of Global Vision International staff, interns and volunteers is acknowledged for facilitating monitoring activities close to Jalova, and for sharing their field base with the RAs during the program.

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

The dedicated staff members of the John H. Phipps Biological Field Station were an integral part of the 2011 Leatherback Program. Station Manager Jorge Ivan Ramos provided logistical support; Indira Torrez was the administrator of the Visitor Center; boat captain Juan Sarante Aleman safely transported researchers on the canals and kept the station and grounds maintained; Juanita Fernández kept the station staff well fed; Jacqueline Brandt was responsible for keeping the station tidy and ensuring that everyone had clean clothes; and the station was kept secure at night by Luis Urbina Alvarez.

Elena Vargas Ramírez and the park rangers of ACTo are acknowledged for their on-going efforts to protect sea turtles in Tortuguero National Park.

The continued support of tour guides and the entire community of Tortuguero during the 2011 Leatherback Program is much appreciated.

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

For financial assistance during the 2011 Leatherback Program we would like to thank the Bay and Paul Foundation, Caravan tours, the Firedoll Foundation, the Marisla Foundation, USFWS – Marine Turtle Conservation Fund and all of the Eco-Volunteers.

Executive Summary

Monitoring and Research Activities Conducted

- 1 A total of 27 track surveys were conducted between the Tortuguero river mouth and Jalova lagoon between 8 January and 10 July 2011.
- 2 The majority of leatherback nesting was recorded from late February to June; but there was no leatherback nest recorded during the track survey conducted on 12 November.
- 3 Two peaks in nesting were recorded; on 16 April and 7 May five fresh leatherback nests were recorded from the previous night.
- 4 The Field Research Coordinator (FRC) and the Research Assistants (RAs) conducted a total of 26 additional track surveys between the Tortuguero and Parismina river mouths between 13 March and 30 May, 2011.
- 5 402 leatherback, 75 green turtle and 23 hawksbill nests were recorded during the track surveys of the entire 22 miles of beach.
- 6 Poaching was estimated at a minimum of 9.5% of leatherback nests, 2.7% of green turtle nests and 8.7% of hawksbill nests.
- 7 Comparison of the leatherback nesting estimates obtained from track surveys conducted either by the track surveyor (188 nests) or by the FC and RAs (300 nests) between Tortuguero river mouth and Jalova lagoon between 13 March – 30 May revealed that the two methods showed quite different results.
- 8 Only one green turtle was taken illegally during the 2011 Leatherback Program.
- 9 A total of 82 encounters with nesting females were recorded during 1,117.7 hours of night patrols between 4 March and 2 June, 2011; 72 leatherbacks, five green turtles and five hawksbills.
- 10 Of the 58 leatherbacks encountered; 69.0% (n = 40) were females with tags from previous years and/or other nesting beaches. Of these previously tagged leatherback turtles, 22.5% were originally tagged in Tortuguero (n = 9); the others were tagged in Caño Palma (n = 2), Parismina (n = 9), Pacuare (n = 10), Mondonguillo (n = 5) and Gandoca/Manzanillo (n = 1). There were also two females originally tagged in Panama. One of the females tagged in Tortuguero was first observed in 1995, 15 years previously.
- 11 Only 22.2% (n = 4) of the newly tagged leatherback turtles (n = 18) showed evidence of old tag holes or notches when they were encountered for the first time.
- 12 Most leatherback turtles nested in the open zone (91.7%, n = 66); 2.8% nested in the border zone (n = 2) and 5.5% did not lay eggs (n = 5).
- 13 No significant difference in carapace length (CCLmin) was found between turtles with complete or incomplete caudal projections. However, there was a significant difference in the CCLmin of newly tagged and previously tagged females.
- 14 Mean curved carapace length (CCLmin) of newly tagged leatherbacks was 149.6cm (n = 16);

for previously tagged females it was 153.3cm (n = 37).

- 15 Mean clutch size for newly tagged leatherback females was 78 yolked and 28 yolkless eggs (n = 7); for previously tagged leatherbacks it was 73 yolked and 24 yolkless eggs (n = 2).
- 16 Mean carapace length (CCLmin) was 102.9cm for green turtles (n = 5), 86.9cm for hawksbill turtles (n = 5).
- 17 Mean clutch size for green turtles was 82 eggs (n = 2) and 146 for hawksbills (n = 1).
- 18 Precision of the CCLmin measurement during the same encounter was relatively high in 2011, and was similar for all species; between 0.4cm – 0.5cm.
- 19 Precision of the CCLmin measurement for leatherback turtles measured during more than one encounter was 1.6cm for two encounters (n = 8), 2.4cm for three encounters (n = 1) and 2.5cm for four encounters (n = 1).
- 20 A total of 40 leatherback nests were marked for monitoring; 18 at the northern end of the beach and 22 at the southern end close to Jalova.
- 21 Three green turtle and two hawksbill nests were also marked for monitoring; they will be included in the analysis of hatching success in the 2011 Green Turtle Program Report.
- 22 Overall hatching success for monitored leatherback nests (n = 30) was 26.0% and overall emerging success was 22.6%.
- 23 Mean distance between the sand surface and the top egg at the time of excavation for undisturbed nests (n = 20) was 50.9cm. Mean distance from the sand surface to the bottom of the egg chamber was 74.7cm.
- 24 The incubation period for leatherback nests for which emergence was observed (n = 6) ranged from 56-65 days, with a mean of 62 days.
- 25 Six deformed embryos, one albino embryo and one twin embryo were recorded during nest excavations.
- 26 Rainfall was heaviest in May (722.3mm), and September was the driest month (82.1mm).
- 27 It was not possible to measure the air temperature during the 2011 Leatherback Program.
- 28 A total of 117,817 visitors paid to enter Tortuguero National Park (TNP) in 2011; an increase in almost 3,000 visitors from 2010.
- 29 The visitation at the STC Visitor Center decreased again in 2011, continuing the trend observed since 2006. A total of 23,529 visitors were registered for the year, an average of 64 visitors per day.
- 30 The pattern of artificial lights visible on the beach remains the same as that recorded in other years; most lights are in Tortuguero village and several lodges and cabinas north of the village.
- 31 Two turtles were found dead on the beach during monitoring activities; the cause of death could not be determined.

- 32 Nine turtles were recorded as killed by jaguars during the 2011 Leatherback Program; seven green turtles and two leatherbacks.
- 33 There was no Outreach and Education Coordinator for the 2011 Leatherback Program, and so there was no program of environmental education activities for students at the Tortuguero School and High School.
- 34 STC staff and RAs assisted with the sixth spay/neuter clinic held 20-22 May; 66 animals were castrated.

Conclusions

- 1 In 2011, leatherback nesting decreased slightly from levels recorded in 2010.
- 2 Leatherback nesting in 2011 was concentrated in the southern half of the beach, from mile 9 – 20.
- 3 The two methods, track surveyor and FRC/RAs track surveys, used to estimate the number of leatherback nests gave quite dissimilar results for the 2011 leatherback nesting season.
- 4 Poaching was concentrated in miles 19 and 20, outside Tortuguero National Park.
- 5 Only one green turtle was recorded as poached during the 2011 Leatherback Program.
- 6 The number of leatherback turtles encountered during nightly patrols (n = 72) was much lower than in 2010.
- 7 It was possible to continue the marking of nests at the southern end of the beach close to Jalova with the support of GVI staff and volunteers.
- 8 Overall hatching and emerging success of leatherback nests was much lower in 2011 than that observed in previous years; although it was within the range typical of this species.
- 9 The lack of a dedicated Outreach and Education Coordinator significantly reduced the potential for conducting community activities during the 2011 Leatherback Program.
- 10 The sixth spay/neuter clinic was very successful and well supported by the communities of Tortuguero and San Francisco.

Recommendations

- 1 The collaboration with GVI allowed for increased patrol effort and the possibility of marking nests close to Jalova; it should be continued in future years.
- 2 Track surveys conducted by the FRC and RAs every three days should be continued in future Leatherback Programs.
- 3 Continuing high levels of poaching south of the limit of Tortuguero National Park (between miles 18 – 22) highlights the need for increased protection by park rangers in this section of beach during the leatherback nesting season.
- 4 STC should initiate night patrols in the section of beach between Jalova and Parismina to conduct a pilot study to investigate whether nest relocation or camouflaging of nests could be

appropriate strategies to reduce poaching of critically endangered leatherback nests.

- 5 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.
- 6 Greater emphasis needs to be placed on the monitoring and excavation of marked nests during RA training, to improve the percentage of nests for which hatching is observed, and to have a more accurate record of the excavation data from which the fate of each marked nest is determined.
- 7 It is important to replace the data loggers that were lost in 2009 to allow collection of important data relating to sand temperatures on the nesting beach. Care should be taken when choosing their locations to minimize the risk of them being disturbed during the nesting season.
- 8 STC should work together with the Costa Rica Energy Institute (ICE) to reduce artificial lighting on the beach, especially the public street lights that are the most problematic.
- 9 A full time Outreach and Education Coordinator should be contracted to supervise the education program and act as a liaison between STC, the National Park and the local community.
- 10 STC should continue to be an active member of the committee organizing the spay/neuter clinics in Tortuguero and should support the clinics however possible.

1. Introduction

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

'STC 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'

STC 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 2011 Leatherback Program represents the seventeenth consecutive leatherback program and the fourteenth year of implementing the new monitoring protocol.

The objectives of this report are to summarize the results of the 2011 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

Prior to the start of the 2011 Leatherback Program STC signed an agreement with Global Vision International (GVI), a volunteer organization that has a project in Tortuguero National Park. The agreement detailed how GVI staff and volunteers would be trained by STC and assist in monitoring activities close to the Jalova lagoon.

At the start of the 2011 Leatherback Program the Research Assistants (RAs) completed an extensive orientation and training program; they received lectures about sea turtle biology and conservation, and the Leatherback Program monitoring protocol was explained in detail. In addition to theoretical instruction they received practical training in flipper tagging, nest marking and other data collection procedures from the Field Research Coordinator (FRC). GVI staff participated in training sessions related to the monitoring protocol and data collection. 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 FRC demonstrated field techniques and supervised RAs collecting data and tagging turtles. Additional training patrols were also conducted at the southern end of the beach, close to the Jalova lagoon. The RAs were also introduced to key members of the community, including staff at the National Park ranger station. They learned about the history of the National Park, environmental laws relating to sea turtles, and the historical development of Tortuguero. They were also taken on a canal tour to learn about the flora and fauna of the park.

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

positioned at each location for the rest of the beach. All markers were painted white, with the mile painted in black.

2.2 Track Surveys

2.2.1 Weekly track surveys

Track surveys between the Tortuguero river mouth and Jalova lagoon (18 miles) were conducted approximately weekly by the STC track surveyor. Track surveys started near Tortuguero river mouth around 5:00am and were completed at Jalova lagoon at approximately 10:30am. Only fresh sea turtle tracks from the previous night were counted. Notes were also kept on the number of turtles depredated by jaguars (*Panthera onca*) or taken by poachers, and the number of poached fresh nests.

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

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

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

2.2.2 Three-day track surveys

Track surveys were conducted by the FRC and RAs between the Tortuguero and Parismina river mouths, every three days during the 2011 Leatherback Program, following the completion of the RA orientation and training period. The beach was divided into four sections: Tortuguero river mouth - STC station (mile 2 5/8); STC station - Juana López trail (mile 15); Juana López trail - Jalova lagoon (mile 18) and Jalova lagoon - Parismina river mouth (mile 21 4/8). GVI staff and volunteers conducted the track survey from the Juana López Trail to the Jalova lagoon when they had sufficient personnel.

All tracks since the previous survey were recorded, to get a total count of all nesting activity throughout the season. Once a track had been recorded two lines were drawn through it, and sticks were placed in a cross formation over the nest, to ensure that it was not counted on future surveys. Notes were also kept on jaguar predation, and levels of illegal take of turtles and nests.

2.3 Tagging of Nesting Sea Turtles

Nightly tagging patrols were conducted, with varying frequency, on three different beach sections; Tortuguero river mouth - STC station (mile 2 5/8), STC station - mile 5, and Jalova lagoon (mile 18) - mile 14. In 2011 the section of beach that was patrolled close to Jalova was divided into two patrols; one led by GVI staff, the other by STC RAs.

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

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

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

2.4 Biometric Data Collection

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

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

2.5 Determination of Nest Survivorship and Hatching Success

If a leatherback turtle was encountered along the beach section between the Tortuguero river mouth (mile - 3/8) and the mile 5 marker, or between miles 14 – 18 close to the Jalova lagoon, 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 these sections of beach if the female had not covered the egg chamber.

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

Each morning at 6.00am the marked nests were inspected so that the fate of the nest could be determined. Evidence of depredation, poaching or beach erosion were noted and resulted in

termination of monitoring for that nest; if the evidence was inconclusive, monitoring continued as normal, but the date of the observed disturbance was recorded, so that any resulting anomalous excavation data could be accounted for.

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

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

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

In addition the depth from the surface to the top of the egg chamber (to the first egg encountered), and the bottom of the egg chamber (after the last egg was removed) was measured to the nearest centimeter. Any other observations about the nest contents were also noted.

2.6 Physical Data Collection

Throughout the 2011 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 STC station. The data loggers were set to take a temperature reading every hour. The data were downloaded at the end of the 2011 Leatherback Program.

2.7 Collection of Human Impact Data

2.7.1 Visitors to Tortuguero

The number of tourists that paid to enter the STC 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 2011.

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, beginning as close as possible to 8.00pm.

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. The FRC and RAs also conducted environmental education activities at the Tortuguero school and high school, involving children in grades 1 - 9.

The Castration Clinic for Pets in Tortuguero, which was initiated in 2008, continued in 2011. STC was involved with organizing educational talks to members of the community regarding pet care and also in helping to coordinate a veterinarian spay/neuter clinic.

3. Results

3.1 Preparations

The agreement between STC and GVI facilitated collaboration between the two organizations; GVI staff and volunteers assisted in the collection of data for STC's 2011 Leatherback Program. The additional personnel allowed for an expansion in the section of beach that could be patrolled close to Jalova lagoon and extra patrols to be conducted.

The FRC arrived in Tortuguero on 26 February to prepare for the 2011 Leatherback Program. Training and orientation sessions were conducted from 1-13 March by the FRC with support from the Scientific Director. In addition to talks about sea turtle biology, history of the STC and a presentation about the laws pertaining to sea turtles in Costa Rica, the RAs also had the

opportunity to learn about the history and development of Tortuguero community from a member of one of the founding families of the community, Alonzo Rankin. They also visited the other biological research station, Caño Palma to talk to staff about the work being done there.

As in previous years, many of the mile markers on the beach needed to be replaced at the start of the 2011 Leatherback Program; STC staff and RAs were assisted in this task by GVI staff and volunteers who painted the mile markers between miles 15 – 18.

3.2 Track Surveys

3.2.1 Weekly track surveys

A total of 27 weekly track surveys were conducted between 8 January and 10 July 2011, during which 28 leatherback nests and 16 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 the majority of leatherback nesting occurred from the start of February to mid-July. However, there was also a leatherback nest recorded during the survey on 12 November (See Figure 1), which is a very unusual record for this species. It is possible that this female nested very late in the season, as there were other leatherback nests reported by GVI in October. There were two distinct peaks in leatherback nesting activity observed during the 2011 season; the first occurred in mid-April, with five nests recorded during the survey on 16 April; five nests were also recorded on 7 May (See Figure 1).

Using the methodology described in Troëng *et al.* (2004) extrapolations from the weekly survey data suggest that 188 leatherback nests were laid between Tortuguero river mouth and Jalova lagoon. However, the FRC and RA track surveys, conducted every three days from March - June, recorded 300 leatherback nests along the same beach section.

Figure 2 shows the annual leatherback nesting trend at Tortuguero for the last 17 years. Leatherback nesting decreased slightly in 2011; overall, since 1995 there has been an 88.5% decrease in leatherback nesting. Using the nesting estimates calculated from the weekly track surveys, in the last five years an average of 281 leatherback nests have been laid per season.

3.2.2 Three-day track surveys

The FRC and RAs conducted 26 track surveys of the 22 miles of nesting beach between 13 March and 30 May, 2011. They recorded 402 leatherback, 75 green turtle and 23 hawksbill nests; in addition 91 leatherback, 58 green turtle and 28 hawksbill false crawls were also counted.

The temporal distribution of leatherback nesting (as determined from the from the 3-day surveys) was different to that observed in previous years; there was no distinct peak, but rather several small peaks, the largest of which was recorded on 6 April when 26 leatherback nests had been laid during the previous three nights (See Figure 2).

The spatial distribution of leatherback nesting during the 2011 Leatherback Program is shown in Figure 3. Distribution of leatherback nesting in 2011 was similar to that observed in previous years, with the majority of leatherback nests recorded in the southern half of the beach (beyond mile 9), particularly between Jalova and Parismina (See Figure 3). Miles 19 and 20 had the highest nesting density; 78 leatherback nests were recorded in these two miles, accounting for 19.4% of the total (See Figure 3).

Figure 1. Temporal distribution of leatherback nesting activity during 2011, as determined during weekly track surveys

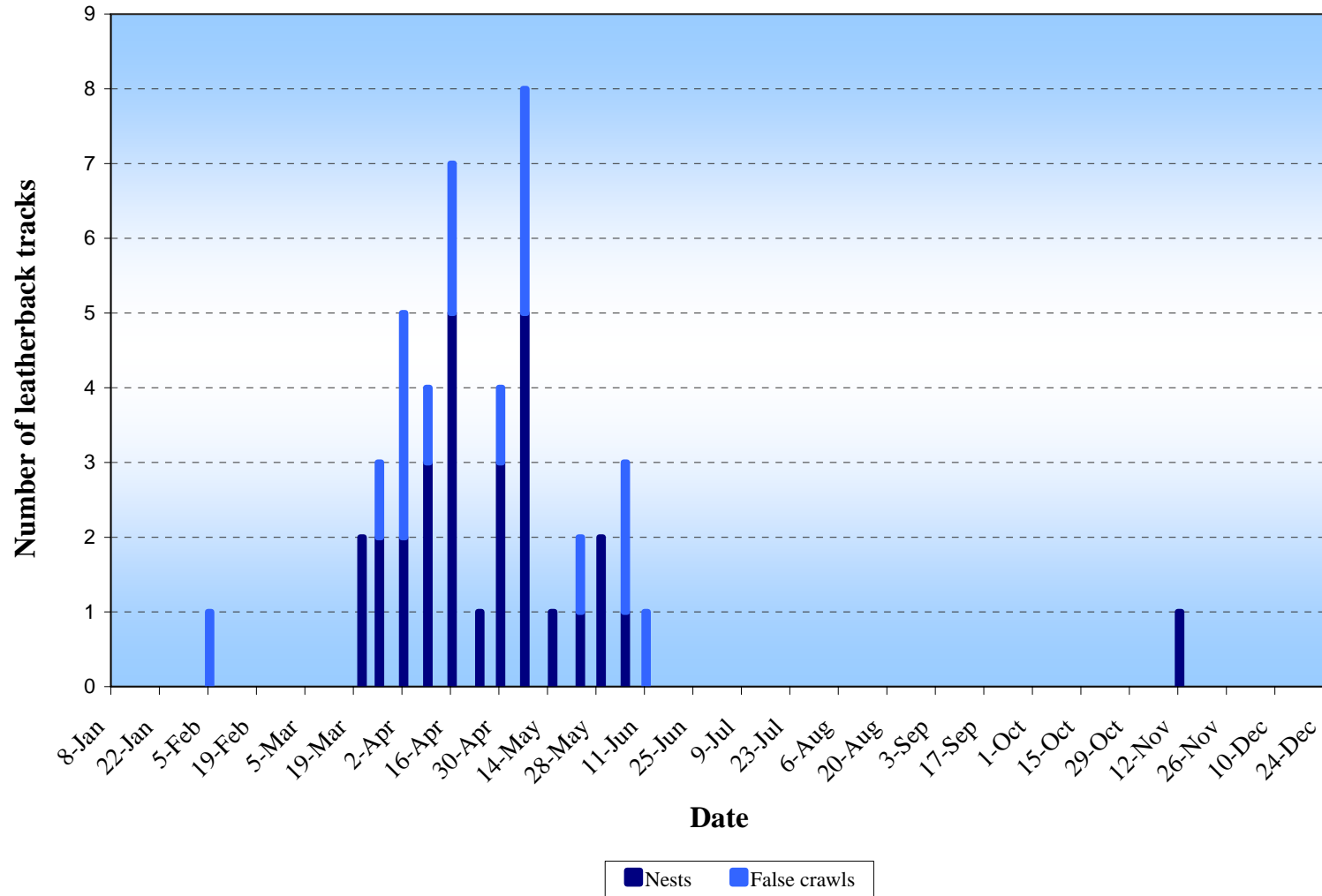


Figure 2. Annual leatherback nesting trend at Tortuguero from 1995 - 2011, as determined from weekly track surveys

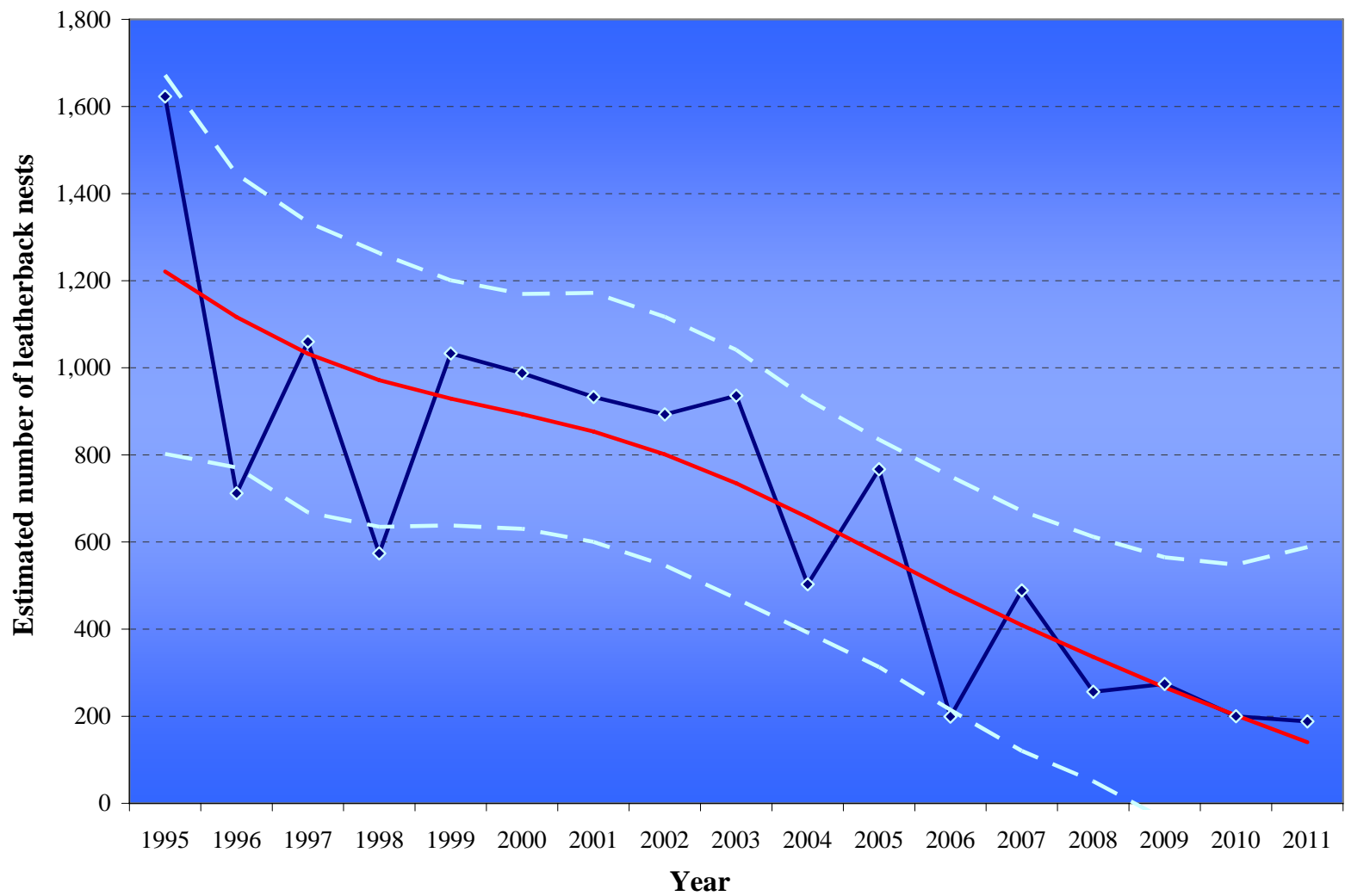
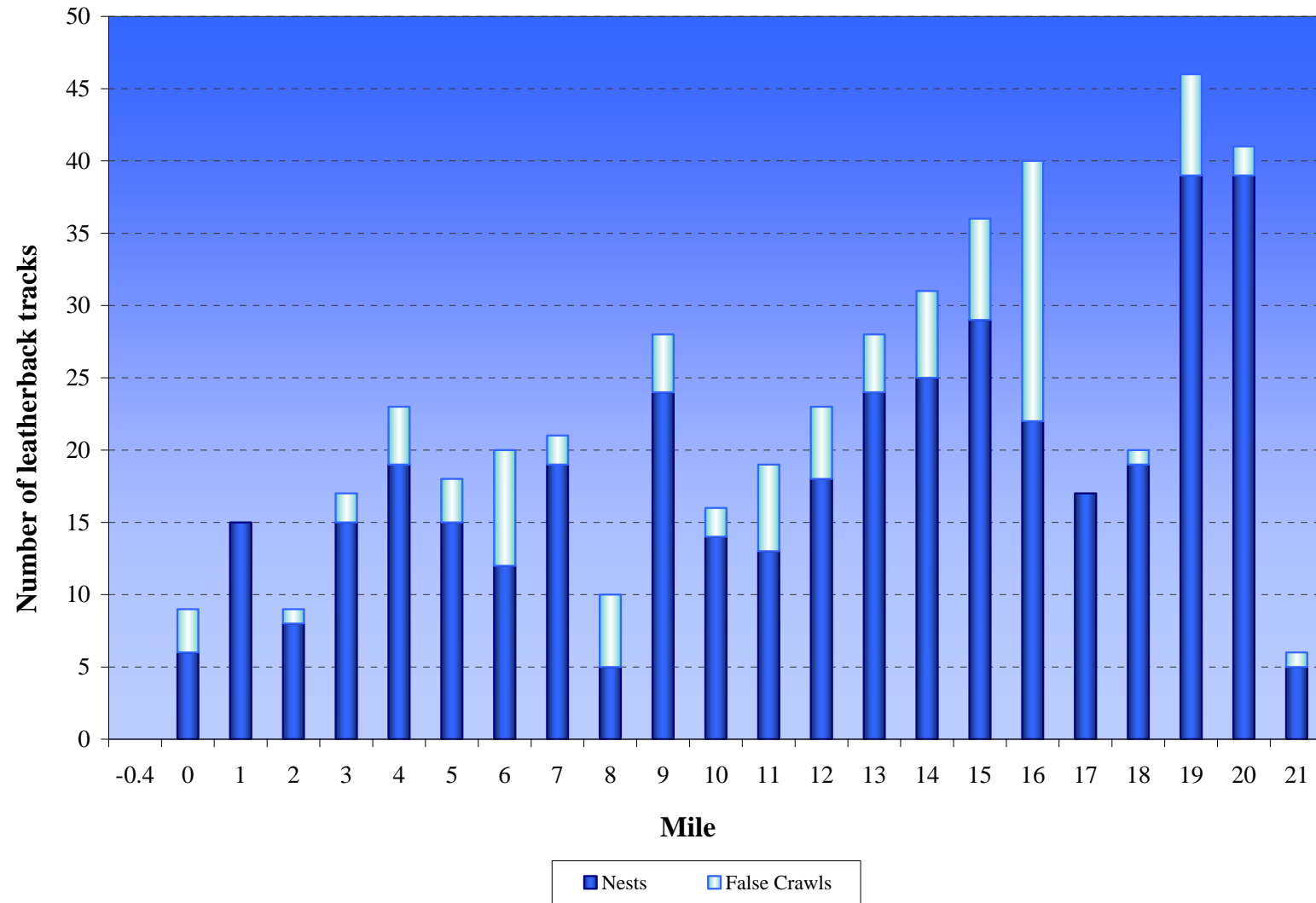


Figure 3. Spatial distribution of leatherback nests during the 2011 Leatherback Program, as determined by track surveys conducted by FRC and RAs every three days



3.2.3 Illegal Take of Turtles and Nests

Illegal poaching of nests was observed throughout the 2011 Leatherback Program (See Table 1).

Table 1. Number of turtle nests and level of illegal poaching, as determined from track surveys conducted by FRC and RAs during the 2011 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	15	0	0.0	2	0	0.0	0	0	0.0
16-Mar	12	2	16.7	1	0	0.0	0	0	0.0
19-Mar	0	0	0.0	0	0	0.0	0	0	0.0
22-Mar	14	0	0.0	3	0	0.0	0	0	0.0
25-Mar	10	0	0.0	1	0	0.0	0	0	0.0
28-Mar	15	1	6.7	1	0	0.0	0	0	0.0
31-Mar	20	0	0.0	1	0	0.0	0	0	0.0
3-Apr	25	4	16.0	2	0	0.0	0	0	0.0
6-Apr	26	2	7.7	2	0	0.0	0	0	0.0
9-Apr	23	5	21.7	2	0	0.0	0	0	0.0
12-Apr	7	1	3.1	1	0	0.0	0	0	0.0
15-Apr	22	2	9.1	1	0	0.0	3	0	0.0
18-Apr	12	0	0.0	1	0	0.0	0	0	0.0
21-Apr	16	1	6.3	4	0	0.0	1	0	0.0
24-Apr	19	3	15.8	7	0	0.0	0	0	0.0
27-Apr	15	0	0.0	3	0	0.0	0	0	0.0
30-Apr	21	3	14.3	2	0	0.0	0	0	0.0
3-May	12	0	0.0	4	1	25.0	0	0	0.0
6-May	11	2	18.2	4	0	0.0	1	1	100.0
9-May	23	1	4.3	5	1	20.0	0	0	0.0
12-May	23	4	17.4	3	0	0.0	1	1	100.0
15-May	5	0	0.0	0	0	0.0	2	0	0.0
18-May	5	1	20.0	3	0	0.0	1	0	0.0
21-May	14	0	0.0	4	0	0.0	1	0	0.0
24-May	11	3	27.3	5	0	0.0	6	0	0.0
27-May	6	1	16.7	4	0	0.0	4	0	0.0
30-May	20	2	10.0	9	0	0.0	3	0	0.0
Total	402	38	9.5	75	2	2.7	23	2	8.7

A total of 42 (8.4%) nests were reported as poached during track surveys conducted by the FRC

and RAs; 38 leatherback, two green turtle and two hawksbills. The minimum poaching level of leatherback nests was lower in 2011 than that recorded in 2010 (9.5% compared to 14.8%, respectively), poaching of green turtles was lower in 2011 but poaching of hawksbill nests was higher in 2011 than in 2012 (8.7% compared to 0.0%, respectively).

The spatial distribution of illegal take of nests is shown in Figure 4. As in other years, poaching was concentrated in the four-mile section of beach between the Jalova lagoon and the Parismina river mouth; which lies just outside the limits of Tortuguero National Park (TNP). There were 30 nests poached from this section of beach, which accounts for 78.9% of all nests taken from the entire 22 miles of beach. Few nests were taken within TNP, or close to the village of Tortuguero (See Figure 4); but both of the hawksbill nests were taken from within TNP.

Only one nesting female turtle was recorded as poached during track surveys conducted from March-June 2011. On 15 April, two RAs found evidence of a green turtle that had been flipped over and dragged off the beach at mile 11.

3.3 Tagging of Nesting Sea Turtles

Tags used during the 2011 Leatherback Program were National Band & Tag Company (NBTC) Monel #49 tags VC1212-VC1217, VC1801-VC1819, VC1826-VC1869, VC1874-VC1879, VC1886-VC1894 and Inconel #681 tags 120418-120425, 120460-120469, 120482-120483, 120511-120515.

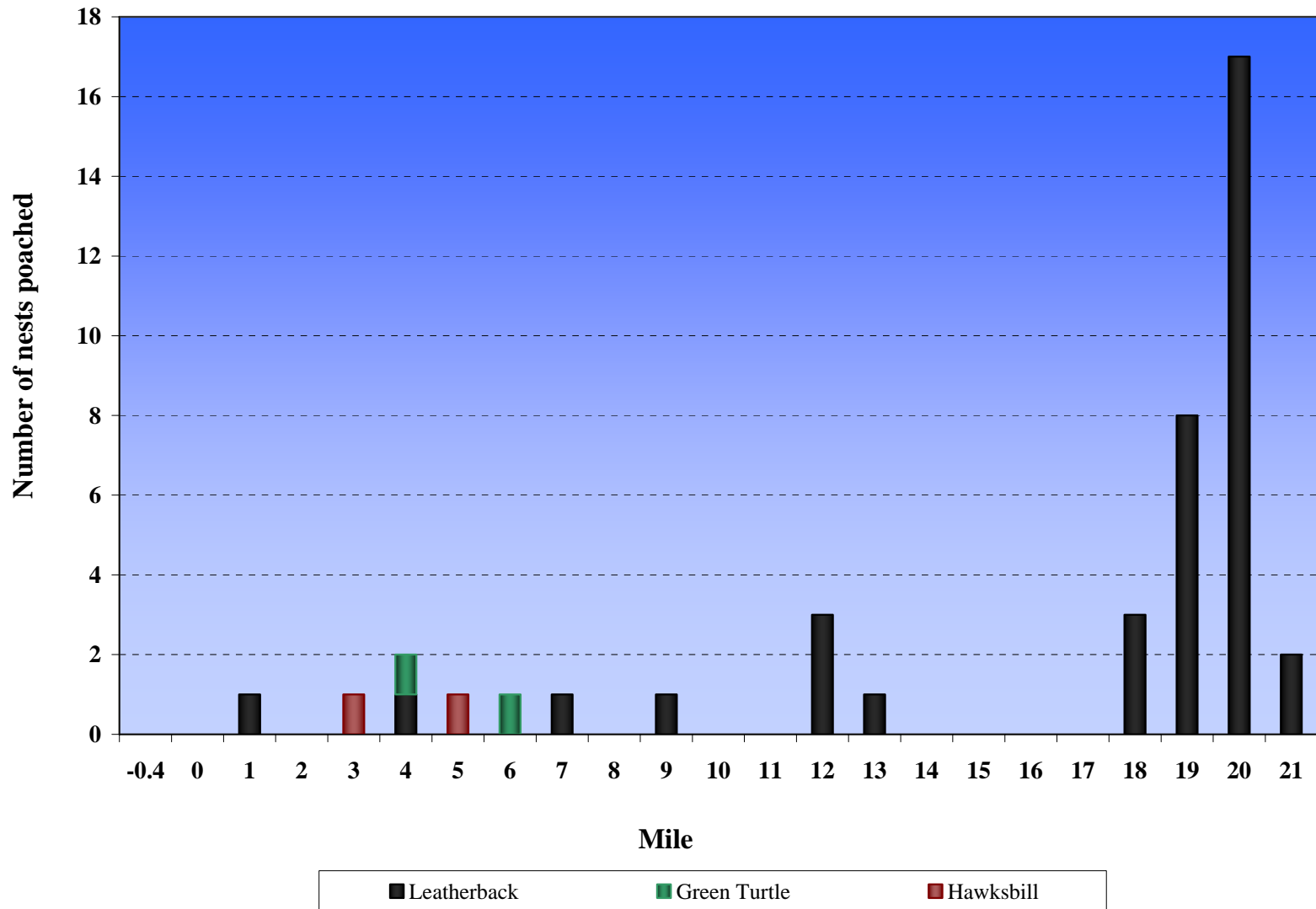
Nightly patrols were conducted between 4 March - 2 June 2011 (with the exception of 5, 9, 12, 16, 21 and 24 March); up to six patrols were conducted per night in the different sections of beach, and a total of 1,117.7 team patrol hours were logged. During these patrols a total of 82 turtles encounters were recorded; 72 leatherbacks, five green turtles and five hawksbills (See Appendix 1). This is equal to an average of 0.06 leatherback, 0.004 green and 0.004 hawksbill turtles encountered per patrol hour.

The turtles encountered correspond to 58 individual female leatherbacks, five green turtles and five hawksbills. Although the majority (69.0%) of leatherback females were already tagged when first encountered ($n = 40$), there were 18 individuals newly tagged during the 2011 season, which is about average compared to recent years (See Appendix 1).

Of the 40 previously tagged leatherback turtles encountered in 2011, 22.5% had originally been tagged in Tortuguero ($n = 9$). The remainder were tagged by researchers at Caño Palma (north of the river mouth in Tortuguero; $n = 2$) and other nesting beaches on the southern Caribbean coast of Costa Rica, including Parismina ($n = 9$), Pacuare ($n = 10$), Mondonguillo ($n = 5$) and Gandoca/Manzanillo ($n = 1$). There were two leatherbacks originally tagged in Panama. Of the turtles tagged in Tortuguero, one was originally tagged 15 years ago in 1996.

Evidence of holes or notches were found on 22.2% ($n = 4$) of the newly tagged leatherback turtles checked for previous tagging ($n = 18$) when they were encountered for the first time during the 2011 Leatherback Program. The majority of leatherbacks nested in the open beach zone (91.7%, $n = 66$); 2.8% nested in the border zone ($n = 2$) and 5.5% did not lay eggs ($n = 5$).

Figure 4. Spatial distribution of illegally poached nests during the 2011 Leatherback Program, as determined by track surveys conducted by FRC and RAs every three days



3.4. Biometric Data Collection

Table 2 summarizes the biometric data collected from leatherback females. CCLmin measurements were taken for 53 of the 58 individual leatherback turtles encountered. An initial analysis was conducted to compare the carapace length of turtles with complete and incomplete caudal projections; this analysis was limited to previously tagged turtles. The results showed no significant difference in CCLmin between these two groups (Mann-Whitney test: $U = 129.0$, $p = 0.362$).

A second analysis was conducted to see if there was any difference in CCLmin between newly tagged and previously tagged females; again, the results indicated that there was a significant difference (Mann-Whitney test: $U = 187.0$, $p = 0.036$). Therefore, the data from newly tagged and previously tagged turtles were analyzed separated (See Table 2). To ensure the independency of the data only measurements taken on the first encounter with each female were used.

Table 2. Mean carapace length and clutch size of leatherback turtles encountered in 2011

Category of female	Carapace length / cm			Clutch size / # of eggs		
	n	\bar{x} CCLmin \pm S.D.	Range	n	\bar{x} yolked \pm S.D	\bar{x} yolkless \pm S.D
Newly tagged	16	149.6 \pm 5.4	139.3 – 159.3	7 ¹	78 \pm 28	28 \pm 9
Previously tagged	37	153.3 \pm 7.2	133.2 – 166.7	21 ²	73 \pm 19	24 \pm 12

¹Excludes one nest with only 22 eggs; ²Excludes one nest with only 26 eggs

Mean carapace length for newly tagged turtles was less than for previously tagged individuals (149.6cm and 153.4cm, respectively). The mean clutch size for newly tagged females was slightly larger than previously tagged turtles (78 eggs and 73 eggs, respectively); an analysis indicated that there was no significant difference between the two categories (Mann-Whitney test: $U = 81.0$, $p = 0.710$). Two small clutches were excluded from the analysis.

Table 3 summarizes the biometric data collected for other species encountered during the 2011 Leatherback Program. Mean carapace length (CCLmin) was calculated for five green turtle females; 102.9cm. Only two green turtle clutches were counted and the average size was 82 eggs. The five hawksbill turtles that were encountered had a mean carapace length (CCLmin) of 86.9cm. Only one hawksbill clutch was counted; the female laid 146 eggs.

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

Species	Carapace length / cm			Clutch size / # of eggs	
	n	\bar{x} CCLmin \pm S.D.	Range	n	$\bar{x} \pm$ S.D.
Green	5	102.9 \pm 4.0	99.0 – 108.7	2	82
Hawksbill	5	86.9 \pm 4.8	83.2 – 94.5	1	146

The precision of the CCLmin measurements taken during 2011 was relatively high, and was very similar for all 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) \pm S.D.	Range / cm
Leatherback	66	0.5 \pm 0.3	0 – 1.2
Green	5	0.5 \pm 0.4	0.2 – 1.0
Hawksbill	5	0.4 \pm 0.3	0.1 – 0.8

The precision of the CCLmin carapace measurements for leatherback turtles measured during more than one encounter is shown in Table 5. For the eight leatherbacks measured on two occasions precision was 1.6cm; for the female encountered three times, precision was 2.4cm and for the female observed four times, precision was 2.5cm. The biggest different in measurements was 3.5cm; no obvious recent injury was recorded that could account for this large difference between the two measurements.

Table 5. Precision of carapace measurements for individual leatherback and green turtles encountered more than once during the 2011 Leatherback Program

Species	No. of encounters	n	\bar{x} precision for CCLmin (cm) \pm SD	Range / cm
Leatherback	2	8	1.6 \pm 1.1	0.6 – 3.5
	3	1	2.4	N/A
	4	1	2.5	N/A

3.5 Determination of Nest Survivorship and Hatching Success

A total of 40 leatherback nests were marked between 25 March and 1 June 2011. Three green turtle and two hawksbill nest were also marked; these will be included in the analysis of nest survivorship and hatching success in the 2011 Green Turtle Program Report.

The continued collaboration with GVI allowed leatherback nests to be marked at the southern end of the beach again in 2011; GVI staff and volunteers were responsible for conducting the daily inspection of marked nests throughout the incubation period and excavations following hatching. This greatly increased the number of nests that were monitored; of the 40 leatherback nests that were marked, 22 were in this section of beach.

Unfortunately, of the 40 marked nests, nine (22.5%) had to be removed from the analysis of survivorship and hatching success. The fate could not be determined for two nests that were not found during excavation and there was no record during the incubation period that they had been washed out or poached. All three tapes were lost for two nests and for another two nests the excavation data were not recorded. For three other nests the data from the excavations were inconclusive by they were possibly poached. Another nest was also excluded from the analysis because very few eggs were encountered during the excavation. This left a total of 30 nests

included in the subsequent analyses. The fate, hatching and emerging successes of 30 marked and monitored leatherback nests are shown in Table 6. The data from the nest excavations are summarized in Table 7; data are combined from both northern and southern ends of the beach.

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

Fate	Tort	Jal	Total	% Hatching success	% Emerging success
Undisturbed	9	10 ¹	19 ¹	43.4	37.7
Unhatched	0	1	1	0.0	0.0
Depredated	1	0	1	0.0	0.0
Eroded	0	1	1	0.0	0.0
Washed over	0	1	1	0.0	0.0
Poached	1	4	5	0.0	0.0
Partially poached ²	2	0	2	0.0	0.0
Relocated – unhatched	1	0	1	0.0	0.0
Total	14	17	31	26.0³	22.6³

Not included in analysis	Tort	Jal	Total
<i>Unknown – All tapes lost</i>	0	2	2
<i>Unknown – Not found</i>	2	0	2
<i>Unknown – Possibly poached</i>	1	2	3
<i>Unknown – No data</i>	1	1	2
Total	4	5	9

¹ One nest excluded from analysis because very few eggs encountered; ² Only yolkless eggs encountered during the excavation; ³ Calculated as the mean of all 30 nests; ‘Tort’ refers to the northern five miles of beach close to Tortuguero village and ‘Jal’ refers to the southernmost five miles of beach close to Jalova

From Table 6 it can be seen that undisturbed nests had a reasonable hatching and emerging success; 43.4% and 37.7%, respectively; this is within the normal range observed for this species. Unfortunately, 16.1% of marked nests were poached; the majority of these five nests were close to Jalova, within TNP. Obviously nests that were poached, depredated or eroded had a zero percent hatching or emerging success as all eggs were lost. The partially poached nests also had zero percent hatching success, as only yolkless eggs were encountered.

Overall mean hatching success of leatherback nests was calculated at just 26.0% and emerging success was 22.6%). These values were calculated as the mean of the 30 nests that were marked and the fate of the nest was determined (See Table 6).

The information from the nest excavations is summarized in Table 7; data from Tortuguero and Jalova are combined.

The incubation period for undisturbed leatherback nests for which emerging was observed (n = 6) varied between 56 - 65 days, with a mean of 62 days.

Table 7. Summary of data from nest excavations of marked leatherback nests during the 2011 Leatherback Program

Fate	n	Hatchlings		Empty shells	Pipped	Unhatched eggs			Predated eggs	Yolkess eggs	Total number of eggs
		Live	Dead			No embryo	Embryo	Full embryo			
Undisturbed	18	16	52	553	11	235	185	98	205	532	1,287
Unhatched	1	0	0	0	0	18	53	3	0	30	74
Washed over	1	0	0	0	0	0	34	2	30	46	66
Partially poached	2	0	0	0	0	0	0	0	0	97	0
Relocated - Unhatched	1	0	0	0	0	65	0	0	11	2	76
Total	23	16	52	0	11	318	272	103	246	707	1,503

The distance from the sand surface to the top egg for undisturbed nests at excavation varied between 22 - 73 cm with a mean of 50.9cm (n = 20). The distance from the sand surface to the bottom of the egg chamber for the same nests varied from 51 - 95 cm, with a mean of 74.4cm.

Only six deformed embryos, one albino embryo and one twin embryo were recorded, corresponding to 0.53% of eggs encountered during nest excavations.

3.6. Physical Data Collection

Table 8 summarizes the rainfall data collected during the 2011 Leatherback Program; data for July thru September are included as several leatherback nests were still incubating during those months. There was no thermometer at the station during the 2011 Leatherback Program and so no data were recorded on air temperature.

Rainfall between March and September varied considerably, between 82.1mm – 722.3mm per month; with May being the wettest month, and September the driest (See Table 8). Average daily rainfall, over a 24-hour period, ranged from 2.7mm in September to 23.3mm, in May.

Table 8. Rainfall recorded during the 2011 Leatherback Program

Month	Total rainfall mm/month	\bar{x} rainfall mm/24hrs ¹
March	136.5	4.4
April	145.6	4.9
May	722.3	23.3
June	190.1	6.3
July	474.1	15.3
August	107.2	3.5
September	82.1	2.7

¹Data for 96 hours: 18-21 May

Unfortunately there were no data loggers on the beach during the 2011 Leatherback Program, and so no sand temperature data are available.

3.7 Collection of Human Impact Data

3.7.1 Visitors to Tortuguero

The number of people visiting Tortuguero National Park increased in 2011 (See Table 9). Data from Tortuguero Conservation Area (ACTo) show that 117,817 tourists were registered as paying the entrance fee to the park in 2011; this is almost 3,000 more visitors than in 2010. The number of Costa Rican visitors includes 13,225 locals (guides, boat captains, etc) who entered the Park with tour groups. Admission fees to TNP in 2011 raised ₡394,911,518, which is approximately \$789,823 (MINAET – ACTo, 2011).

Table 9. Number of paying visitors to Tortuguero National Park, 2002 - 2011

Year	Costa Rican visitors	Foreign visitors	Total no. of visitors
2002	5,745	44,594	50,339
2003	8,643	59,026	67,669
2004	9,545	71,912	81,457
2005	9,292	77,291	87,083
2006	21,257	80,087	101,344
2007	23,898	92,853	116,751
2008	26,727	107,963	134,690
2009	23,632	90,691	116,323
2010	25,592	89,296	114,888
2011	26,753	91,064	117,817

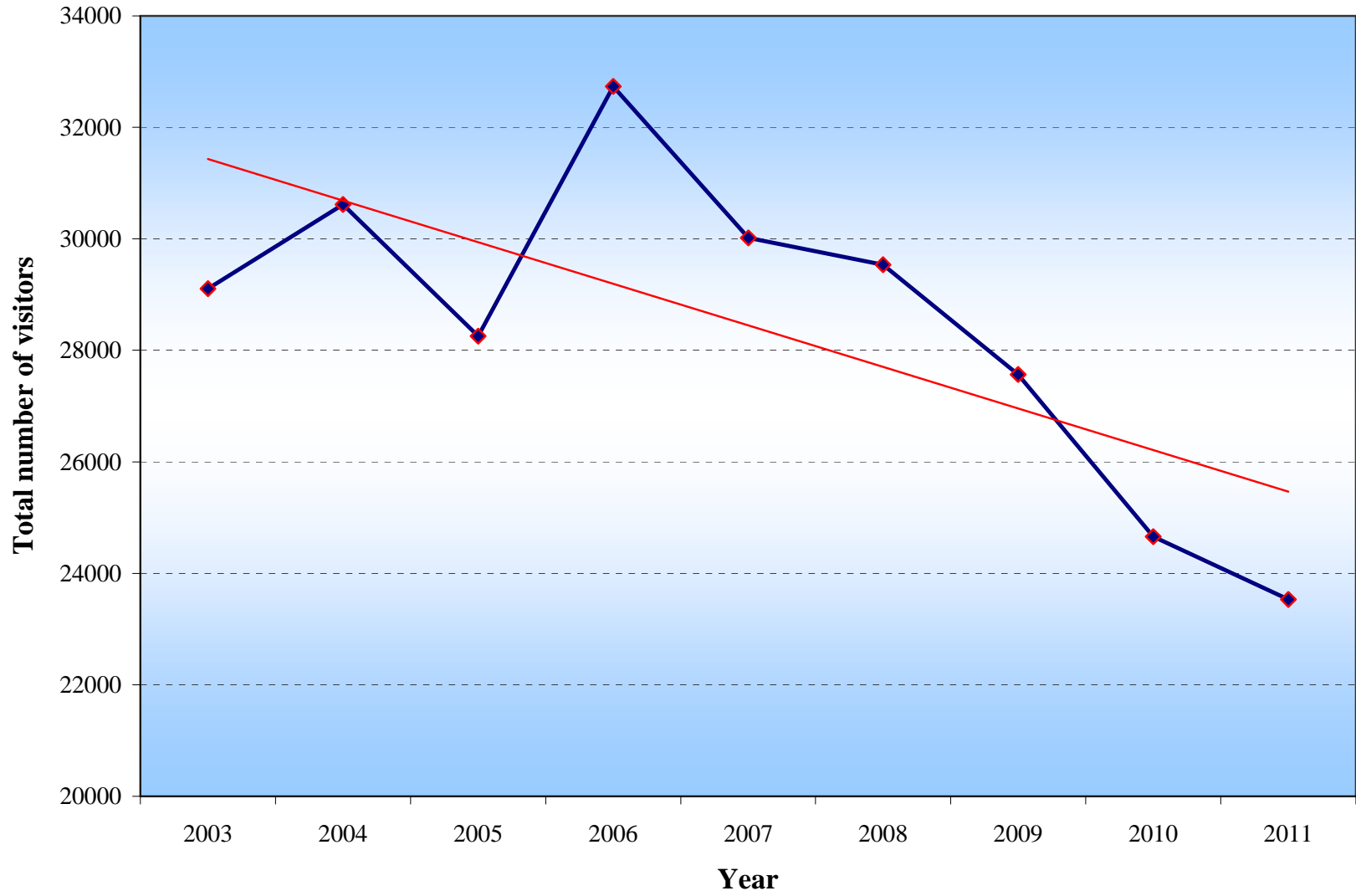
Data from Tortuguero Conservation Area (ACTo)

The number of visitors registered at the STC Visitor Center decreased again in 2011 to 23,529 visitors (See Table 10); continuing the trend observed since 2006 (See Figure 5). The overall daily visitation rate to the center was 64 visitors. However, in three months (January, February and March) visitation was higher in 2011 than in 2010.

Table 10. Visitors to the STC Visitor Center, January 2008 - December 2010

Month	2009		2010		2011	
	Total	\bar{x} / day	Total	\bar{x} / day	Total	\bar{x} / day
January	4,001	129	3,114	101	3,347	108
February	3,617	129	3,221	115	4,081	146
March	4,100	132	3,719	120	4,398	142
April	2,382	79	2,476	83	1,810	60
May	963	31	1,012	33	936	30
June	1,492	50	1,628	54	1,126	38
July	2,385	77	2,099	68	1,450	47
August	2,024	65	1,390	45	1,116	36
September	815	27	590	20	443	15
October	1,328	43	832	27	848	27
November	1,879	63	2,060	69	1,791	60
December	2,579	83	2,513	81	2,183	70
Total	27,565	76	24,654	68	23,529	64

Figure 5. Tourist visitation to the STC Visitors Centre, 2003 - 2011



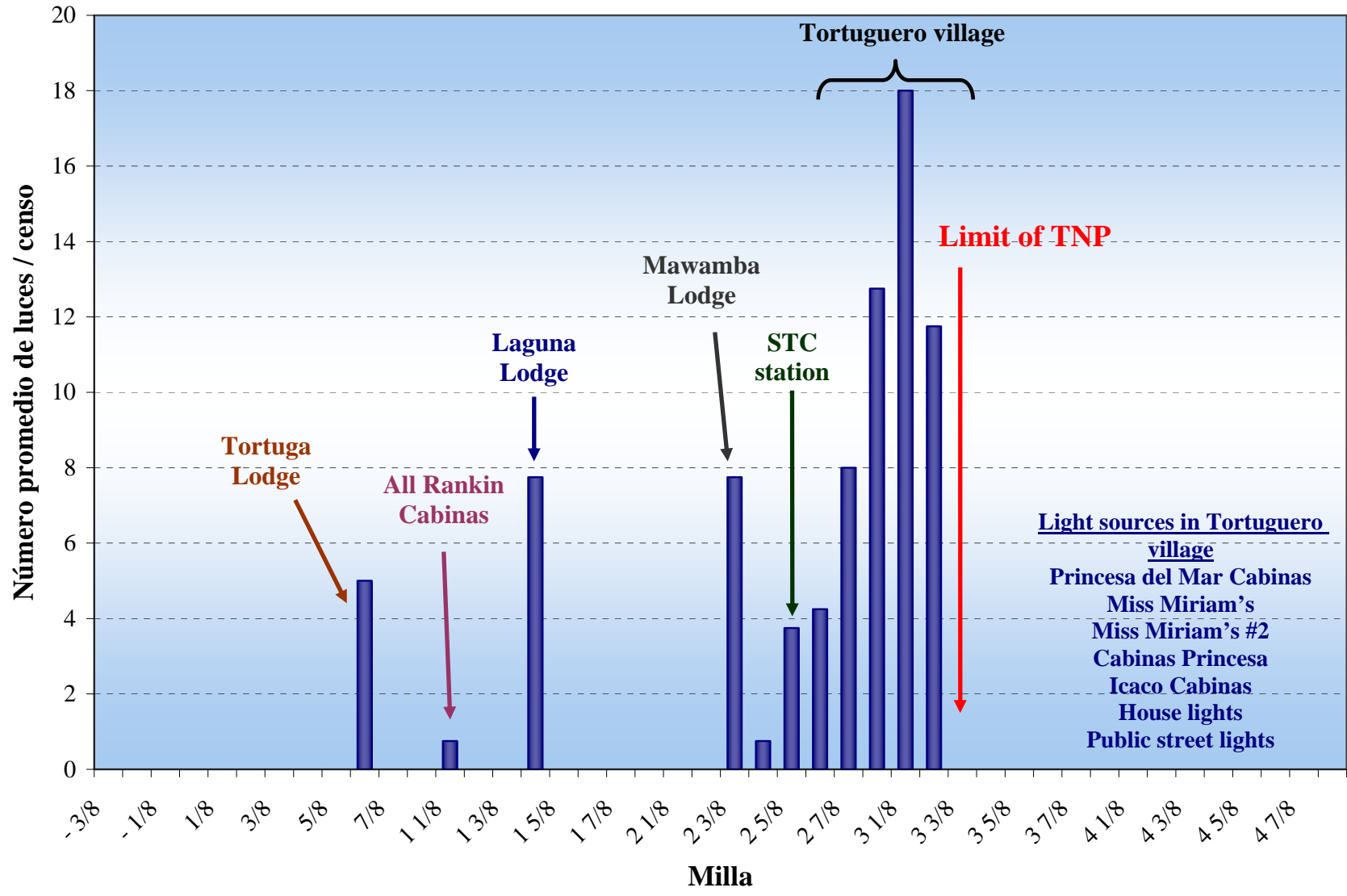
The pattern of visitation was similar to that observed previously; most visitors came in January – March, with a significant decline starting in April. A slight increase in visitation was observed in July; this coincides with increased green turtle nesting, which is the major tourist attraction in the area. As in previous years, there was a dramatic decrease in September, with an average visitation of just 15 people per day (See Table 10); this is the lowest average visitation level observed in at least the last nine years.

3.7.2 Artificial lights

Light surveys were conducted in March, April and May (two) during the 2011 Leatherback Program. The surveys were started at the airport (mile 6/8) due to the severe erosion of the beach that occurred from that point north to the river mouth; it was too dangerous to walk this section of beach at night. 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.

The average number of lights counted per survey was 81 (range = 61 – 112); 43 of these lights (53.1%) were visible between miles 3 – 3 2/8; which corresponds to the section of beach in front of Tortuguero village. There was an increase in the number of lights visible on the beach, when compared to data from 2010. The limit to TNP is in mile 3 3/8; there were no sources of artificial light visible on the beach inside TNP (See Figure 6).

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



3.8 Dead Turtles

In addition to the green turtle that was taken illegally by poachers on 15 April, no other dead turtles were encountered during monitoring activities for the 2011 Leatherback Program. Nine turtles were recorded as killed by jaguars during the track surveys conducted every three days during the 2011 Leatherback Program; seven green turtles and two leatherbacks (See Table 11).

All jaguar predation occurred within TNP, between miles 7 and 13; there did not appear to be a particular mile where predation was more prevalent, and jaguar tracks were observed on all track surveys. It is unusual to record leatherback turtles that have been attacked by jaguars, as they typical prey on the smaller species.

Table 11. Turtles killed by jaguars during the 2011 Leatherback Program

Date	Species	Mile	Comments
3 April	Cm	10 4/8	Killed by jaguar – no tags
9 April	Cm	11	Killed by jaguar – no tags
	Cm	12 4/8	Killed by jaguar – no tags
21 April	Cm	7	Killed by jaguar – no tags
24 April	Dc	13	Tag # VA4759 – From Panama
27 April	Cm	9	Tag #s 120420 and 120420 (Tagged in 2011)
7 May	Cm	???	Tag # 107129
12 May	Cm	10	Killed by jaguar – no tags
21 May	Dc	12	Tag # VC1877

Cm = Green turtle; Dc = Leatherback

3.9 Environmental Education and Outreach Activities

3.9.2 Environmental Education Activities

There was no dedicated Outreach and Education Coordinator for the 2011 Leatherback Program; the FRC, Lucía Galeán Gordon organized outreach activities with the RA, but there was no comprehensive program of events conducted with students at the school or high school. It was also not possible to run the Junior Research Assistant Program.

The FRC and RAs produced flyers to advise tourists and local residents about the regulations for observing sea turtles on the beach; these flyers were posted in prominent locations around the village to increase awareness about the restrictions in place on Tortuguero beach during turtle nesting season to reduce negative impacts on the nesting turtles.

3.9.2 Outreach Activities

3.9.2.1 Veterinary Clinic

STC continued to be a key member of the organizing committee for the veterinary clinic program throughout 2011. As in previous years it was a joint initiative between STC, MINAET, ProParques (an environmental NGO based in San Jose) with support from local residents in Tortuguero and San Francisco. Veterinarian support was provided by the Humane Association

for Animal Protection in Costa Rica (AHPPA).

The sixth veterinary clinic took place 20 – 22 May, 2011. Due to a reduced number of veterinarians, it was only possible to conduct one clinic each day, not simultaneous clinics in Tortuguero and San Francisco. As in previous years, the clinic in Tortuguero was held at the park ranger station, and at the school in San Francisco. STC Scientific Director Emma Harrison assisted with the logistics of the Tortuguero clinic; Leatherback Program RAs helped during the clinic as needed, and STC provided the vets with lodging and food during their stay in Tortuguero. Table 12 summarizes the results of the clinics since 2008; in May, 2010 a total of 158 animals were treated; of these 66 were castrated, bringing the total in the four years of the program to 360.

Table 12 Summary of veterinary clinics 2008 – 2011

Location	Mar 2008	Jun 2008	Mar 2009	Sept 2009	Mar 2010	May 2011
Tortuguero	51	43	28	42	27	-
San Francisco	42	20	14	17	10	-
Total	93	63	42	59	37	66

4. Discussion

4.1 Preparations

In 2011, STC was able to contract a full complement of eight RAs for the Leatherback Program; that and the availability of additional volunteers from GVI greatly facilitated the preparation of the mile markers along the 22 miles of nesting beach.

The two-week training and orientation program has become standard practice and was implemented again in 2011; providing the RAs with theoretical and practical sessions regarding the monitoring protocol, in addition to informative talks about Tortuguero National Park and environmental laws in Costa Rica, and an introduction to the history and development of Tortuguero over the years. In addition, the RAs were introduced to researchers from the other biological field station, Caño Palma, to meet those responsible for conducting sea turtle monitoring activities on the beach north of the Tortuguero river mouth, and also visited the GVI base close to Jalova.

4.2 Track Surveys

As in previous years leatherback nesting was observed during weekly track surveys from late-February to June; though one leatherback was encountered by RAs during a night patrol in July. There was a peak in nesting observed in mid-April (See Figure 1) and then another peak in May. The three-day track surveys conducted by the FRC and RAs in 2011 covered the main nesting period for leatherbacks. The report of a leatherback nest during a track survey in November was very unusual; there were also two reports from GVI staff of leatherback nests in October, therefore it is possible that they were all from the same female. It is unclear whether this individual arrived very late in the 2011 season, or if she was very early for the 2012 season.

Unfortunately there was a slight decrease in the estimated number of leatherback nests laid in 2011 compared to 2010 (See Figure 2), continuing the negative trend that has been observed in Tortuguero since the Leatherback Program began in 1995. However, it is interesting to note that once again there was quite a large discrepancy between the estimated number of nests (as determined from data collected during the weekly surveys) and the number of nests counted by the FRC and RAs during the three-day surveys (188 compared to 300, respectively). It would be interesting to do a comparative analysis of the two data sets over the last 15 years to obtain a clearer understanding of the status of the Tortuguero leatherback population. It is valuable, therefore, to continue to conduct the three-day surveys in future Leatherback Programs, to compare with results from the weekly surveys. Even given the difference in the numbers of recorded leatherback nests between the two different methods, there is an observed decline in nesting, which is particularly disturbing given the ‘critically endangered’ status of the leatherback.

The spatial distribution of leatherback nests in 2011 was more typical of nesting patterns observed in previous years; with the highest concentration of nesting occurring in the southern half of the beach, from mile 9 to 20 (See Figure 3). However, the pattern was not as marked as in other years; there was also considerable nesting activity on the northern end of the beach. As noted previously, highest nesting density occurs outside of Tortuguero National Park, in miles 19 and 20; these two miles accounted for 19.4% of all leatherback nesting recorded in 2011.

Unfortunately illegal poaching of turtle nests occurred throughout the 2011 Leatherback Program (See Table 1), but the percentage of poached leatherback nests was lower than that recorded in 2010 (9.5% compared to 14.8%, respectively). Poaching of green turtle nests was also lower in 2011 than in 2010, but there was an increase in the percentage of hawksbill nests reported as poached in 2011 (See Table 1). The spatial distribution of poaching was similar to that observed in the last few years, with once again, the stretch of beach between Jalova and Parismina showing the highest levels of poaching for the entire beach; almost 30% of all leatherback nests laid in that section were poached (See Figure 4). Poaching is definitely concentrated at the southern end of the nesting beach; only sporadic nests were poached further north in the park, or close to Tortuguero village. To improve the long-term survival outlook for the Tortuguero leatherback population, which appears to be in decline, it is imperative that a concerted effort is made to reduce the level of poaching. This might require additional funding for MINAET, to conduct patrols on sections of beach that are subject to high poaching pressure; while undoubtedly the problem is greater outside TNP, all turtles are covered by Costa Rican law and so are due some level of protection from the government authority charged with enforcing laws and conserving wildlife. Another measure might be to conduct more monitoring activities, specifically night patrols, in the section of beach between Jalova and Parismina; with additional GVI volunteers available to patrol within TNP it might be feasible to have STC RAs work together with researchers from the Parismina turtle project on the beach to the south of the Jalova lagoon. It would be interesting to implement a pilot study to compare levels of poaching of relocated or camouflaged nests with those left *in situ*; these techniques could be implemented as part of a conservation strategy for leatherback turtles in Tortuguero, if they were found to be effective.

4.3 Tagging of Nesting Sea Turtles

The availability of additional volunteers and staff from GVI facilitated additional night patrols close to Jalova. Previously, patrols at the southern end of the beach have been limited to a single

group of RAs covering four miles of beach; in 2011 it was possible to extend the patrol area to five miles, and have two groups working each night during the season.

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

Unfortunately there was a decrease in the number of encounters recorded during night patrols; 2011 was a very low nesting season, and so even with the additional patrols it was only possible to record a total of 82 encounters. The number of hawksbills observed ($n = 5$) was similar to the number seen during the leatherback nesting season in previous years.

The proportion of new leatherback turtles (individuals that did not have tags when first encountered) observed during the 2011 season was similar to that recorded in 2011. An interesting study would be to compare the percentage of neophyte encounters at nesting beaches along the Caribbean coast of Costa Rica, and in the Bocas del Toro province of Panama; as it is known that the individuals using these nesting beaches are part of the same population.

More than 73% of female leatherbacks encountered during 2011 had tags when first observed, either from Tortuguero or other nesting beaches in the region. The majority of females were tagged originally at Pacuare Nature Reserve; although individuals tagged at all the other Costa Rican nesting beaches south of Tortuguero were encountered and there were also two females with tags from Panama. There was a female who was originally tagged in Tortuguero in 1995. Such observations are a source of encouragement, that there are some individuals that are able to survive the myriad of threats that females face while migrating between nesting and foraging sites during the course of the two/three year period between nesting seasons.

4.4 Biometric Data Collection

No significant difference was detected in the mean carapace length (CCLmin) of female leatherback turtles with complete or incomplete caudal projections; but it was interesting to detect a significant difference in CCLmin between newly tagged and previously tagged turtles. The mean CCLmin for newly tagged turtles was less than that of previously tagged individuals. The size range of leatherback females (both newly tagged and previously tagged turtles) encountered in 2011 was similar to that seen during other nesting seasons; ranging from very small (133.2cm) to very large individuals (166.7cm). This suggests therefore, that there is a mixture of young and old females within the Tortuguero nesting population; a healthy nesting population should consist of individuals from different age classes.

Four females observed on more than one occasion had their caudal projections inconsistently identified. All the other females observed more than once during the season had their caudal projection consistently identified by different researchers. Obviously there will still be some observer differences as it is a somewhat subjective distinction, and it would be good to have a range of photographs depicting complete and incomplete caudal projections, to use during RA training.

The precision of carapace measurements taken during the same encounter was very similar for leatherbacks, green turtles and hawksbills in 2011 (0.4 – 0.5cm). However, for leatherbacks that were observed on more than one occasion throughout the nesting season the precision was low (more than 1.6cm); for one leatherback there was a difference of 3.5cm in CCLmin

measurements from the first and second encounter, and no observation of any damage to the caudal projection that could account for the discrepancy. It is very important to ensure that during the RA training sessions emphasis is made on using the same defining carapace measurements, to ensure that there is less variability between observers. Also, RAs need to take care when leading groups of short term volunteers that they are supervising closely all data collection activities to reduce errors such as incorrect measuring of the carapace.

4.5 Determination of Nest Survivorship and Hatching Success

For the second time in 2011 it was possible to mark nests in the southern section of the beach, close to Jalova lagoon; this was due to the fact that GVI staff and volunteers were available to conduct the daily monitoring that is required for marked nests throughout the incubation period. Additional night patrols close to Jalova also increased the total number of nests that were marked and monitored; 40 leatherback nests, plus three green turtle and two hawksbill nests. Although the mean hatching success of leatherback nests marked in Jalova and Tortuguero appeared very different (55.6% and 31.2%), the difference was not significant. It would be interesting to continue to compare hatching success of nests laid on different sections of the beach, to identify any future changes.

The majority of nests that were marked were monitored and excavated successfully; this was a definite improvement on 2010 when 60% of the marked nests were excluded from the analysis as it was not possible to find them at excavation. During the training sessions for the RAs and GVI personnel the FRC put considerable emphasis on the importance of the daily monitoring of marked nests, and the excavation protocol.

It was encouraging to observe that in total, 61% of leatherback nests for which the fate of the nest was determined remained undisturbed during the incubation period. The mean hatching and emerging success in 2011 was very low; 26.0% and 22.6%, respectively. These values are at the lower limit of the range observed previously for this species at Tortuguero.

Five of the 40 marked nests (12.5%) were poached; four of these were at the southern end of the beach, within TNP. Poaching is typically observed at much higher levels close to Jalova, and so it is not a surprise that this is tendency is reflected in the survivorship data of marked nests. An important thing to mention is that some nests were reported as poached after more than three days, which is not normal; typically the eggs are taken the same night that they are laid, or within a day or two. It is possible that the nests reported as poached, actually weren't taken; it is important to ensure during training that everyone is clearly able to distinguish the evidence of a poached nest, so that there is no over-estimation of illegal take of nests in Tortuguero and Jalova.

4.6 Physical Data Collection

In the last six years that has been considerable variation in the rainfall pattern observed at Tortuguero during the months of the Leatherback Program, with different months recorded as the wettest or driest. In 2011, May was the wettest month (722.3mm total rainfall and 23.3mm per day). September, the month with least rain recorded in 2011, is typically one of the driest months of the year. Data for June thru September were included as there were still several leatherback nests incubating during these months; environmental conditions experienced by the nest can influence survivorship and hatching success.

There was no thermometer to measure air temperature; it is important to replace the thermometer broken in 2012, as these physical data are important, and form part of a long-term data set for the area.

Unfortunately the problems with the data loggers persisted throughout the first few months of 2011; the data loggers were replaced very late in the season, and so a lot of valuable data from the leatherback nesting season were not collected. The data loggers are expensive, but the data are important, especially to help evaluate possible effects of climate change at Tortuguero, and assess the impacts on the populations of endangered sea turtles that may be affected in the future.

4.7 Collection of Human Impact Data

Information from 2011 demonstrated that the decline in visitation to TNP observed from 2008 – 2010 did not continue in 2011. There was a small increase in the number of international and national tourists entering TNP. Of the national visitors, almost 50% were local residents, primarily guides and boat captains; it would be interesting to review visitation data for the last few years, with nationals and locals separated, to evaluate the real trend in national visitation to TNP. In the last few days the number of international visitors has remained relatively constant, at around 90,000 people per year.

For another consecutive year there was a decrease in the number of tourists to the STC Visitor Centre; continuing the trend observed since 2006 (See Figure 5). More than 1,000 fewer people were recorded in 2011 compared to 2010. Unfortunately there are still tour guides who walk around the Visitor Centre, making use of the information panels displayed outside to show their tourists, and yet they don't support the STC by bringing their groups in to the Visitor Centre to see the exhibits or the video. In 2010 a film crew took footage to create a new video; this video was in production during 2011, and show be finalized for showing in 2012.

The pattern of artificial lights visible on the beach in front of Tortuguero village continues to be the same as that observed in previous years (See Figure 6). The most problematic lights are the public lights as they are tall, and the bulbs are of a high intensity. STC continued the collaborative efforts started in 2010 in which ICE placed covers on the lights identified by the FRC as being visible on the beach. This is something that each FRC at the start of the Leatherback Program needs to be responsible for, as there is continued support from ICE, who are very open to trying to reduce the negative impacts of artificial lights on the turtles and hatchlings.

4.8 Dead Turtles

It was encouraging to observe that only one green turtle was recorded as poached during the 2011 Leatherback Program.

Fewer turtles were reported killed by jaguars during the 2011 Leatherback Program than in 2010; seven green turtles and two leatherbacks, compared to 33 green turtles, three leatherbacks and two hawksbills. This is the third consecutive year in which leatherbacks have been prey to jaguars, typically it is the smaller species that are taken; this species is in critical danger of extinction and so any female this is killed, for whatever reason, has an impact on the future survival of the population. Predation activity was reported throughout the program; jaguar tracks were observed during all track surveys and along the entire length of the beach, from close to Tortuguero village to Jalova. It is possible that the jaguar population within TNP is increasing,

and in future years there will be more reported sightings and an increase in the number of turtles killed, although the level of depredation is still not a significant threat to green turtle populations in TNP.

4.9 Environmental Education and Outreach Activities

Due to financial constraints it was not possible to contract a full-time dedicated Outreach and Education Coordinator (OEC) for the 2011 Leatherback Program. This had a clear impact on the education and outreach activities that were conducted; it was not possible to develop an intensive program of activities for students at the school and high school. The FRC has a full-time workload, and so is often not able to dedicate the necessary time to coordinate these other activities. While obviously STC's focus is on the continuation of the long-term monitoring program at Tortuguero, it is also necessary for the organization to interact with the community, and the educational activities are an excellent opportunity to share the results of the program with local residents, and hopefully encourage the younger generation to be interested in the natural resources that surround them, and to develop a conservation ethic that is essential for the continuation of STC's work in the future. It should be made a priority to secure additional funding to contract a full-time OEC, and provide sufficient materials to conduct an effective educational program in future years.

In 2011, STC continued to support the veterinary clinic program in Tortuguero and San Francisco, working together with MINAET, ProParques and members of the community. The sixth clinic conducted in May, 2011 was again well supported by local residents. However, the issue of having unsupervised dogs on the beach remains an issue; owners need to be provided with more information about the appropriate control of their animals during the turtle nesting season, eg. keeping dogs tethered, or in an enclosed yard, so that they do not go out on the beach and disturb turtle nests. Such guidelines need to be advertised throughout the village, and the regular castration clinics should be continued, to help reduce the number of domestic animals in the community.

5. References

- Campbell, C.L., Lagueux, C.J., Mortimer, J.A. 1996. Leatherback turtle, *Dermochelys coriacea*, nesting at Tortuguero, Costa Rica, in 1995. *Chel. Cons. Biol.* 2(2), 169-172.
- Carr, A., Carr, M.H., Meylan, A.B. 1978. The ecology and migrations of sea turtles, 7. The west Caribbean green turtle colony. *Bull. Amer. Mus. Nat. Hist.* 162, 1-46.
- Troëng, S., Chacón, D., Dick, B. 2004. Possible decline in leatherback turtle *Dermochelys coriacea* nesting along the coast of Caribbean Central America. *Oryx* 38(4), 395-403.

6. Appendices

Appendix 1. Nightly sea turtle encounters for the 2011 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				0				0				0
18-Mar				0	1			1				0
19-Mar				0				1				0
20-Mar				0	1			2				0
21-Mar				0				2				0
22-Mar				0				2				0
23-Mar				0				2				0
24-Mar				0				2				0
25-Mar				0		1		3				0
26-Mar				0				3				0
27-Mar				0		2		5				0
28-Mar				0		1		6				0
29-Mar				0				6				0
30-Mar				0				6				0
31-Mar				0		2		8				0
1-Apr				0		1		9				0
2-Apr				0	1			10				0
3-Apr				0	1	1		12				0
4-Apr				0		2		14				0
5-Apr				0		2		16				0
6-Apr				0	1	1		18				0
7-Apr				0				18				0
8-Apr				0				18				0

Appendix 1. Continued

Date	Leatherback				Green				Hawksbill			
	New	REM	REN	Total	New	REM	REN	Total	New	REM	REN	Total
9-Apr				0	1			19				0
10-Apr				0			1	20				0
11-Apr				0	1			21				0
12-Apr				0	2	1		24				0
13-Apr	1			1		1	1	26				0
14-Apr				1				26				0
15-Apr				1		1		27				0
16-Apr				1		1		28				0
17-Apr				1		1		29				0
18-Apr				1	3	1		33				0
19-Apr				1		1	2	36				0
20-Apr				1	1	1		38				0
21-Apr				1		2		40				0
22-Apr				1	1		4	45				0
23-Apr				1				45				0
24-Apr				1			1	46				0
25-Apr	1			2		1		47				0
26-Apr				2	1	1		49				0
27-Apr				2	1	2		52				0
28-Apr				2	2	1		55				0
29-Apr				2		1		56				0
30-Apr				2				56				0
1-May				2		1		57				0
2-May				2				57				0
3-May				2		1		58				0
4-May				2				58				0
5-May				2				58				0
6-May				2		1		59				0
7-May				2		1	2	62				0
8-May				2				62				0
9-May				2		1		63				0
10-May				2				63	1			1
11-May				2			1	64				1
12-May				2				64	1			2
13-May				2				64				2
14-May				2				64				2
15-May				2				64	1			3
16-May				2		1		65				3

Appendix 1. Continued

Date	Leatherback				Green				Hawksbill			
	New	REM	REN	Total	New	REM	REN	Total	New	REM	REN	Total
17-May				2				65				3
18-May				2		1		66				3
19-May				2		1		67				3
20-May				2				67				3
21-May				2			1	68				3
22-May	1			3				68				3
23-May				3		1		69				3
24-May				3				69				3
25-May				3				69				3
26-May				3		1		70				3
27-May				3			1	71				3
28-May				3				71	1			4
29-May				3				71				4
30-May				3				71				4
31-May	2			5				71				4
1-Jun				5		1		72				4
2-Jun				5				72	1			5
Total	5	0	0	5	18	40	14	72	5	0	0	5
%	100	0	0		25.0	55.6	19.4		100	0	0	

Legend

New = Turtles that had no tags on first encounter in 2011

REM = Remigrant; turtles that had tags from previous years/other projects on first encounter in 2011

REN = Renester; turtles that were encountered more than once during 2011