

REPORT ON THE 2010 LEATHERBACK PROGRAM AT TORTUGUERO, COSTA RICA

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¹ On 16 June, 2010 the Caribbean Conservation Corporation changed its name to Sea Turtle Conservancy, to better represent the nature and geographical scope of work of the organization.

Executive Summary

Monitoring and Research Activities Conducted

- 1 A total of 28 track surveys were conducted between the Tortuguero river mouth and Jalova lagoon between 3 January and 10 July 2010.
- 2 Leatherback nesting was recorded on track surveys from late February to early July.
- 3 Several peaks in nesting were recorded; on 17 April, 21 May and 12 June seven fresh leatherback nests were recorded from the previous night.
- 4 The Field Research Coordinator (FRC) and the Research Assistants (RAs) conducted a total of 28 additional track surveys between the Tortuguero and Parismina river mouths between 13 March and 2 June 2010.
- 5 636 leatherback, 388 green turtle, four hawksbill and one loggerhead nests were recorded during the track surveys of the entire 22 miles of beach.
- 6 Poaching was estimated at a minimum of 14.8% of leatherback nests and 3.6% of green turtle nests.
- 7 Comparison of the leatherback nesting estimates obtained from track surveys conducted either by the track surveyor (200 nests) or by the FC and RAs (434 nests) between Tortuguero river mouth and Jalova lagoon between 13 March - 2 June revealed that the two methods showed quite different results.
- 8 One green turtle was taken illegally during the 2010 Leatherback Program.
- 9 A total of 101 leatherback turtle encounters were recorded during 1219.2 hours of night patrols between 7 March and 2 June, 2010; 20 were newly tagged females, 56 had tags from previous years and/or other nesting beaches, and 25 were renesters. In addition, 60 green turtle, three hawksbill and one loggerhead encounters were recorded.
- 10 Of the 76 individual leatherback turtles encountered 73.7% (n = 56) bore tags from previous years or other nesting beaches. Of these previously tagged leatherback turtles, 37.5% were originally tagged in Tortuguero (n = 21); the others were tagged in Caño Palma (n = 1), Parismina (n = 4), Pacuare (n = 20), Mondonguillo (n = 5) and Gandoca/Manzanillo (n = 1). There were also three females originally tagged at Chiriquí Beach in Panama. One of the females tagged in Tortuguero was first observed in 1989, 21 years previously; this is a new nesting history record for leatherbacks. Three green turtles and two hawksbills had tags from Tortuguero.
- 11 Only 10% (n = 2) of the newly tagged leatherback turtles (n = 20) 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 (83.8%, n = 83); 8.1% nested in the border zone (n = 8) and 7.1% did not lay eggs (n = 7).
- 13 No significant difference in carapace length (CCLmin) was found between newly tagged and previously tagged leatherback turtles, or between turtles with complete or incomplete caudal

projections.

- 14 Mean curved carapace length (CCL_{min}) of leatherbacks was 152.2cm (n = 72).
- 15 Mean clutch size for leatherback females was 79 yolked and 23 yolkless eggs (n = 37).
- 16 Mean carapace length (CCL_{min}) was 101.6cm for green turtles (n = 41), 90.7cm for hawksbill turtles (n = 3) and 100.0cm for the one loggerhead female observed.
- 17 Mean clutch size for green turtles was 98 eggs (n = 18) and 200 for hawksbills (n = 1).
- 18 Precision of the CCL_{min} measurement during the same encounter was relatively high in 2010, and was the same for all species except loggerhead; 0.4cm and 0.0cm, respectively.
- 19 Precision of the CCL_{min} measurement for leatherback turtles measured during more than one encounter was 2.5cm for two encounters (n = 15) and 2.7cm for four encounters (n = 2). For green turtles measured more than once precision was 0.9cm for two encounters (n = 12) and 1.0cm for three encounters (n = 1).
- 20 A total of 49 leatherback nests were marked for monitoring; nests were monitored at the southern end of the beach for the first time in 2010.
- 21 Twenty-seven green turtle and two hawksbill nests were also marked for monitoring; they will be included in the analysis of hatching success in the 2010 Green Turtle Program Report.
- 22 Overall hatching success for monitored leatherback nests (n = 21) was 33.2% and overall emerging success was 31.5%.
- 23 Mean distance between the sand surface and the top egg at the time of excavation for undisturbed nests (n = 11) was 56.5cm. Mean distance from the sand surface to the bottom of the egg chamber was 77.6cm.
- 24 The incubation period for leatherback nests for which emergence was observed (n = 7) ranged from 58-63 days, with a mean of 60 days.
- 25 No deformed embryos and only one twin embryo were recorded during nest excavations, corresponding to 0.09% of eggs.
- 26 Rainfall was heaviest in March (597.8mm), and September was the driest month (167.9 mm).
- 27 Air temperature ranged from 21 – 31°C. March was the coolest month (Mean air temperature = 23.9°C) and May was the warmest (Mean air temperature = 27.6°C).
- 28 A total of 114,888 visitors paid to enter Tortuguero National Park (TNP) in 2010, continuing a decline observed in 2009.
- 29 The visitation at the STC Visitor Center decreased again in 2010, continuing the trend seen in the last few years. A total of 24,654 visitors were registered for the year, an average of 68 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 Thirty-eight turtles were recorded as killed by jaguars during the 2010 Leatherback Program; 33 green turtles, three leatherbacks and two hawksbills.
- 33 The Outreach and Education Coordinator and RAs conducted 45 environmental education activities, for students at the Tortuguero School and High School.
- 34 The Junior Research Assistant Program (JRAP) was conducted for the third consecutive year.
- 35 A short documentary video about the JRAP was produced.
- 36 A new project was initiated for students at Tortuguero High School; the EcoWallet project aimed to teach students about recycling, to improve their manual skills and raise funds for the high school.
- 37 STC staff and RAs assisted with the fifth spay/neuter clinic held 25-27 March; 37 animals were castrated.

Conclusions

- 1 In 2010, leatherback nesting decreased slightly from levels recorded in 2009.
- 2 Leatherback nesting in 2010 was concentrated in the southern half of the beach, from mile 13 – 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 2010 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 2010 Leatherback Program.
- 6 The number of leatherback turtles encountered during nightly patrols (n = 101) was higher than in 2009; this was in part due to the collaboration with Global Vision International that allowed increased night patrols close to Jalova.
- 7 An increased number of leatherback nests were marked in 2010; it was also possible to mark nests close to Jalova, allowing for an evaluation of survivorship and hatching success in the southern part of the beach for the first time.
- 8 Overall hatching and emerging success of leatherback nests was much lower in 2009 than that observed in previous years; although it was within the range typical of this species.
- 9 An intensive environmental education and outreach program was developed by the Outreach and Education Coordinator during the 2010 Leatherback Program.
- 10 The fifth 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. STC should also coordinate with researchers from the turtle project in Parismina to conduct additional patrols in that section of beach to provide increased presence to try and deter potential poachers.
- 4 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.
- 5 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.
- 6 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.
- 7 A new video needs to be produced for the STC Visitor Centre, to better reflect the current role of the organization in Tortuguero.
- 8 Initial collaboration with the Costa Rica Energy Institute (ICE) to reduce artificial lighting on the beach should be developed in the future.
- 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 2010 Leatherback Program represents the sixteenth consecutive leatherback program and the thirteenth year of implementing the new monitoring protocol.

The objectives of this report are to summarize the results of the 2010 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 2010 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 2010 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 2010 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 13. In 2010 it was possible to extend the section of beach that was patrolled close to Jalova from four to five miles, due to the increased number of personnel available due to the involvement of GVI staff and volunteers; it was divided into two patrols.

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 13 – 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 2010 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 2010 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 2010.

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. In addition, the Outreach and Education Coordinator was responsible for developing an extensive program of 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 2010. 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 2010 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 24 February to prepare for the 2010 Leatherback Program. Training and orientation sessions were conducted from 2-14 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 2010 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. As in 2009 an ATV was used to assist with the section between miles 5-15.

3.2 Track Surveys

3.2.1 Weekly track surveys

A total of 28 weekly track surveys were conducted between 3 January and 10 July 2010, during which 37 leatherback nests and 54 false crawls were recorded by the track surveyor. Figure 1 displays the results of the weekly track surveys; each bar represents the number of leatherback nests and false crawls recorded during a single survey.

It can be seen that leatherback nesting occurred from late-February to early-July. There were two distinct peaks in leatherback nesting activity observed during the 2010 season; the first occurred in mid-April, with seven nests recorded during the survey on 17 April, then later in the season seven nests were recorded on 21 May and 12 June (See Figure 1). Some leatherbacks were still coming ashore in July, although they did not nest.

Using the methodology described in Troëng *et al.* (2004) extrapolations from the weekly survey data suggest that just 200 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 434 leatherback nests along the same beach section.

The annual leatherback nesting trend at Tortuguero for the last 16 seasons is shown in Figure 2. It can be seen that in 2010 there was a decrease in leatherback nesting; overall, since 1995 there has been an 85% decrease in leatherback nesting. Using the nesting estimates calculated from the weekly track surveys, in the last five years an average of 284 leatherback nests have been laid per season.

3.2.2 Three-day track surveys

The FRC and RAs conducted 28 track surveys of the entire 22 miles of nesting beach between 13 March and 2 June, 2010. They recorded a total of 636 leatherback, 388 green turtle, four hawksbill and one loggerhead nests during those surveys; in addition 200 leatherback, 309 green turtle and seven hawksbill false crawls were also counted.

Peak leatherback nesting, as determined from the from the 3-day surveys, was recorded on 18 April; 41 leatherback nests had been laid during the previous three nights. This is close to the first of the peaks in nesting (17 April) recorded by the weekly track surveyor (See Figure 1).

The spatial distribution of leatherback nesting during the 2010 Leatherback Program is shown in Figure 3. Distribution of leatherback nesting in 2010 was similar to that observed in previous years, with the majority of leatherback nests recorded in the southern half of the beach (beyond mile 13), particularly between Jalova and Parismina (See Figure 3). Mile 19 had the highest nesting density; 79 leatherback nests were recorded in that mile, accounting for 12.4% of the total (See Figure 3). It was interesting to observe a small peak in nesting activity in mile 1.

Figure 1. Temporal distribution of leatherback nesting activity during 2010, as determined during weekly track surveys

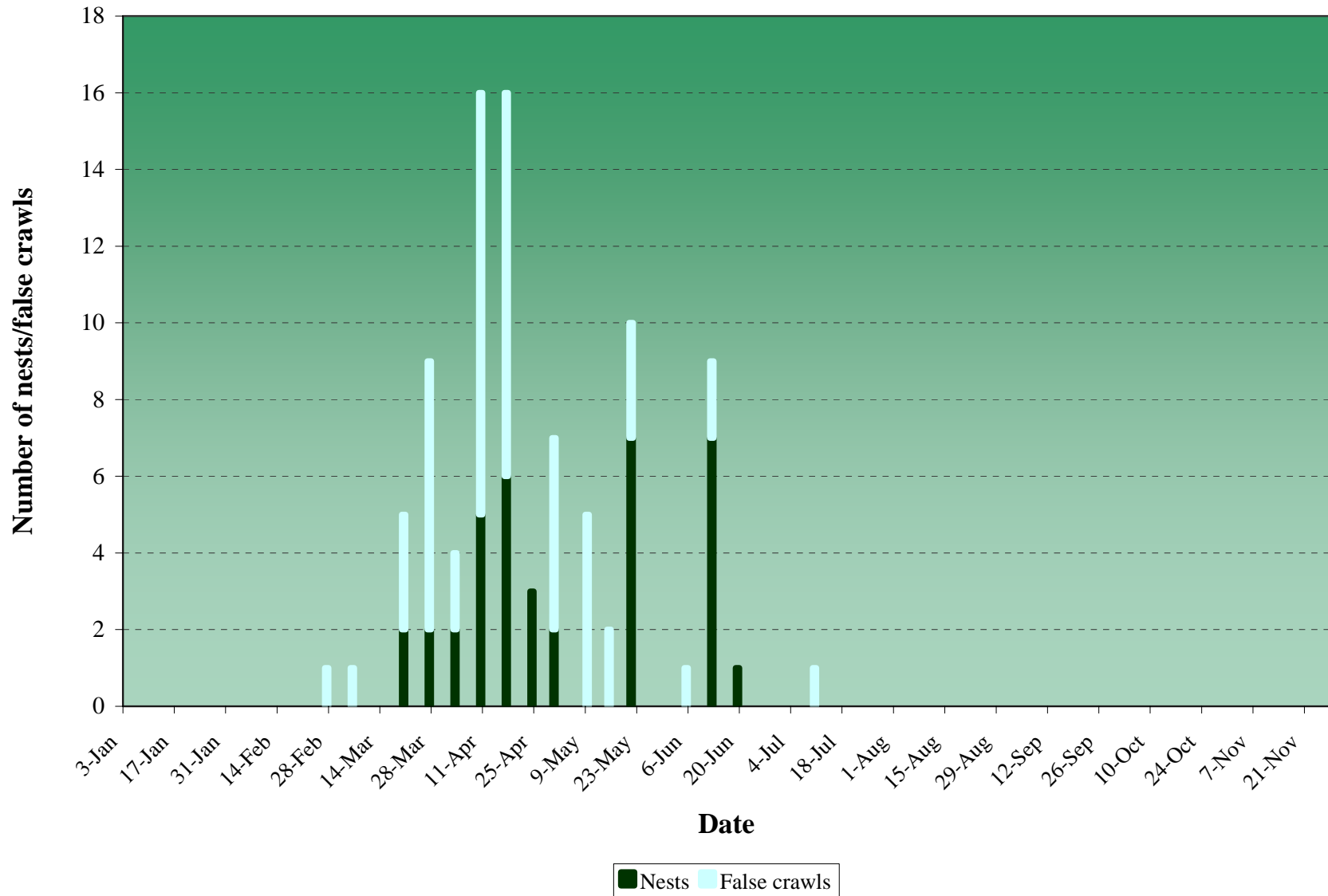


Figure 2. Annual leatherback nesting trend at Tortuguero from 1995 - 2010, as determined from weekly track surveys

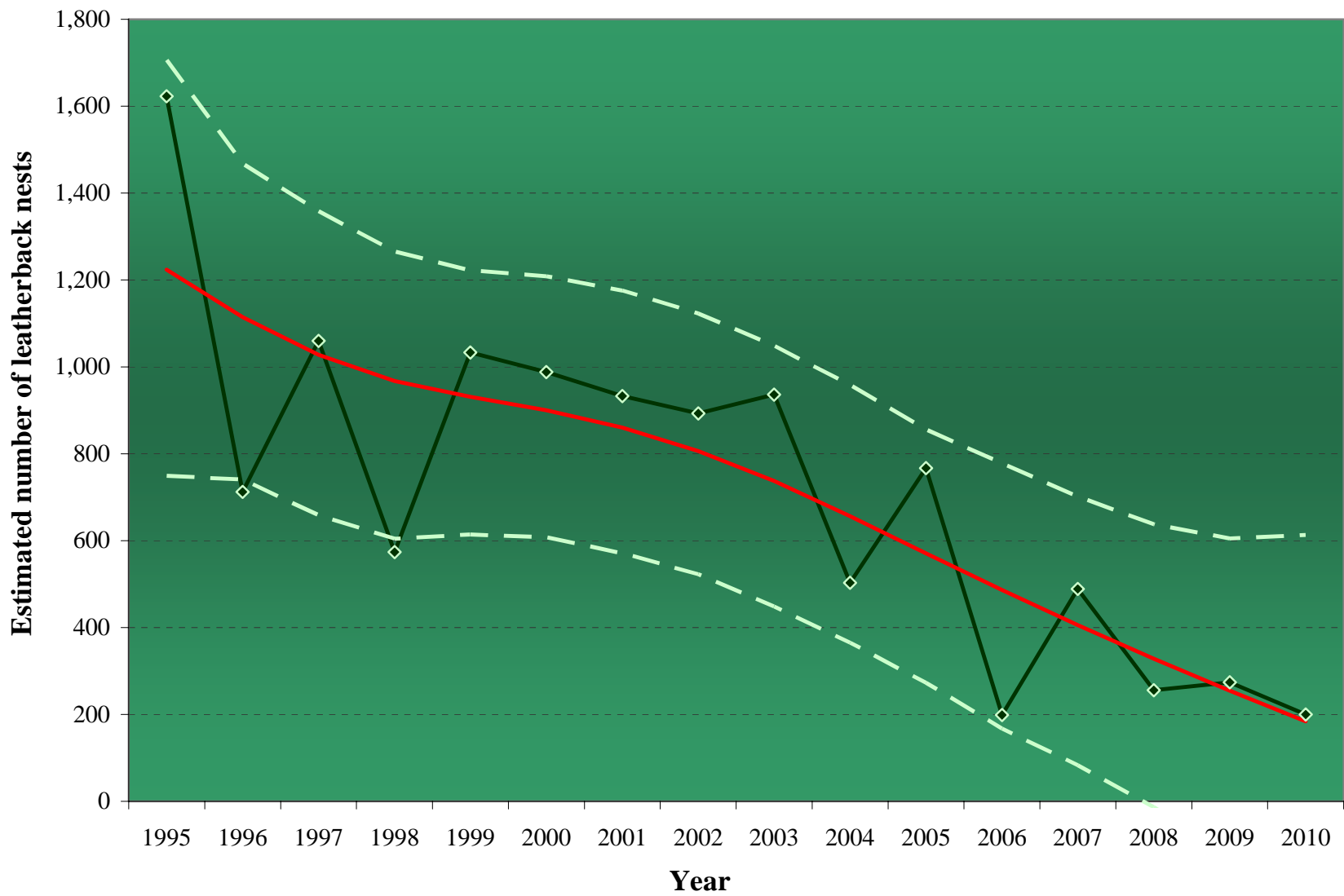
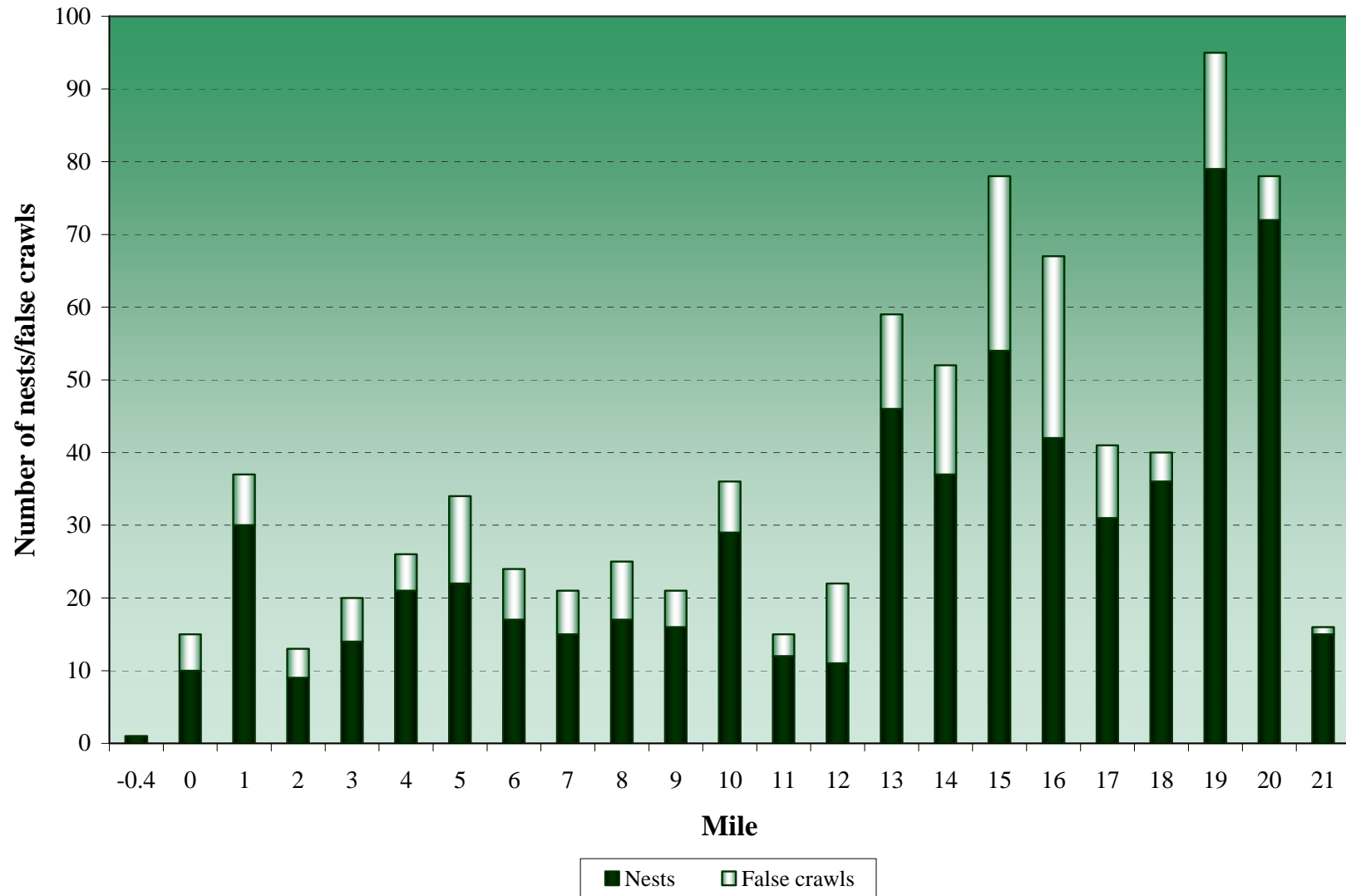


Figure 3. Spatial distribution of leatherback nests during the 2010 Leatherback Program, as determined by track surveys conducted by FRC and RAs every three days



3.2.3 Illegal Take of Turtles and Nests

Illegal poaching of nests was observed throughout the 2010 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 2010 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	21	1	4.8	9	1	11.1	0	0	0
16-Mar	5	0	0.0	1	1	100.0	0	0	0
19-Mar	13	3	23.1	3	0	0.0	0	0	0
22-Mar	13	0	0.0	8	3	37.5	0	0	0
25-Mar	12	1	8.3	9	0	0.0	0	0	0
28-Mar	14	0	0.0	6	0	0.0	0	0	0
31-Mar	33	3	9.1	17	0	0.0	0	0	0
3-Apr	21	1	4.8	12	2	16.7	0	0	0
6-Apr	24	1	4.2	19	1	5.3	0	0	0
9-Apr	32	5	15.6	17	1	5.9	0	0	0
12-Apr	29	4	13.8	34	0	0.0	0	0	0
15-Apr	32	1	3.1	27	0	0.0	0	0	0
18-Apr	41	3	7.3	24	0	0.0	0	0	0
21-Apr	31	2	6.5	16	0	0.0	0	0	0
24-Apr	22	2	9.1	26	0	0.0	0	0	0
27-Apr	34	9	26.5	22	0	0.0	1	0	0
30-Apr	30	11	36.7	12	0	0.0	0	0	0
3-May	25	5	20.0	31	0	0.0	0	0	0
6-May	21	0	0.0	15	0	0.0	0	0	0
9-May	19	2	10.5	9	0	0.0	1	0	0
12-May	16	4	25.0	18	2	11.1	0	0	0
15-May	10	5	50.0	4	0	0.0	1	0	0
18-May	25	2	8.0	11	1	9.1	0	0	0
21-May	24	6	25.0	4	0	0.0	0	0	0
24-May	19	8	42.1	11	0	0.0	1	0	0
27-May	24	1	4.2	11	1	9.1	0	0	0
30-May	26	7	26.9	6	1	16.7	0	0	0
2-Jun	20	7	35.0	6	0	0.0	0	0	0
Total	636	94	14.8	388	14	3.6	4	0	0

A total of 108 (10.4%) nests were reported as poached during track surveys conducted by the FRC and RAs; 94 leatherback and 14 green turtle. The minimum poaching level of leatherback nests was lower in 2010 than that recorded in 2009 (14.8% compared to 17.7%, respectively), poaching of green turtles was at the same level, and no hawksbill nests were recorded as poached (See Table 1).

The spatial distribution of illegal take of nests is shown in Figure 4. As in other years, poaching was very 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. There were 80 nests poached from this section of beach, which accounts for 85.1% of all nests taken from the entire 22 miles of beach. Very few nests were taken within Tortuguero National Park, or close to the village of Tortuguero (See Figure 4).

Only one nesting female turtle was recorded as poached during track surveys conducted from March-June 2010. On 18 May, from a distance two RAs observed someone dragging something on the beach in mile 3 1/8 (in front of the village); when they got to the location they found evidence that a green turtle had been flipped over and dragged off the beach.

3.3 Tagging of Nesting Sea Turtles

Tags used during the 2010 Leatherback Program were National Band & Tag Company (NBTC) Monel #49 tags VC1034-VC1038, VC1114-VC1147, VC1151-VC95, VC1201-VC1211, VC1224-VC1242 and Inconel #681 tags 116711-116723, 116849-16850, 116895-116899, 116901-11700.

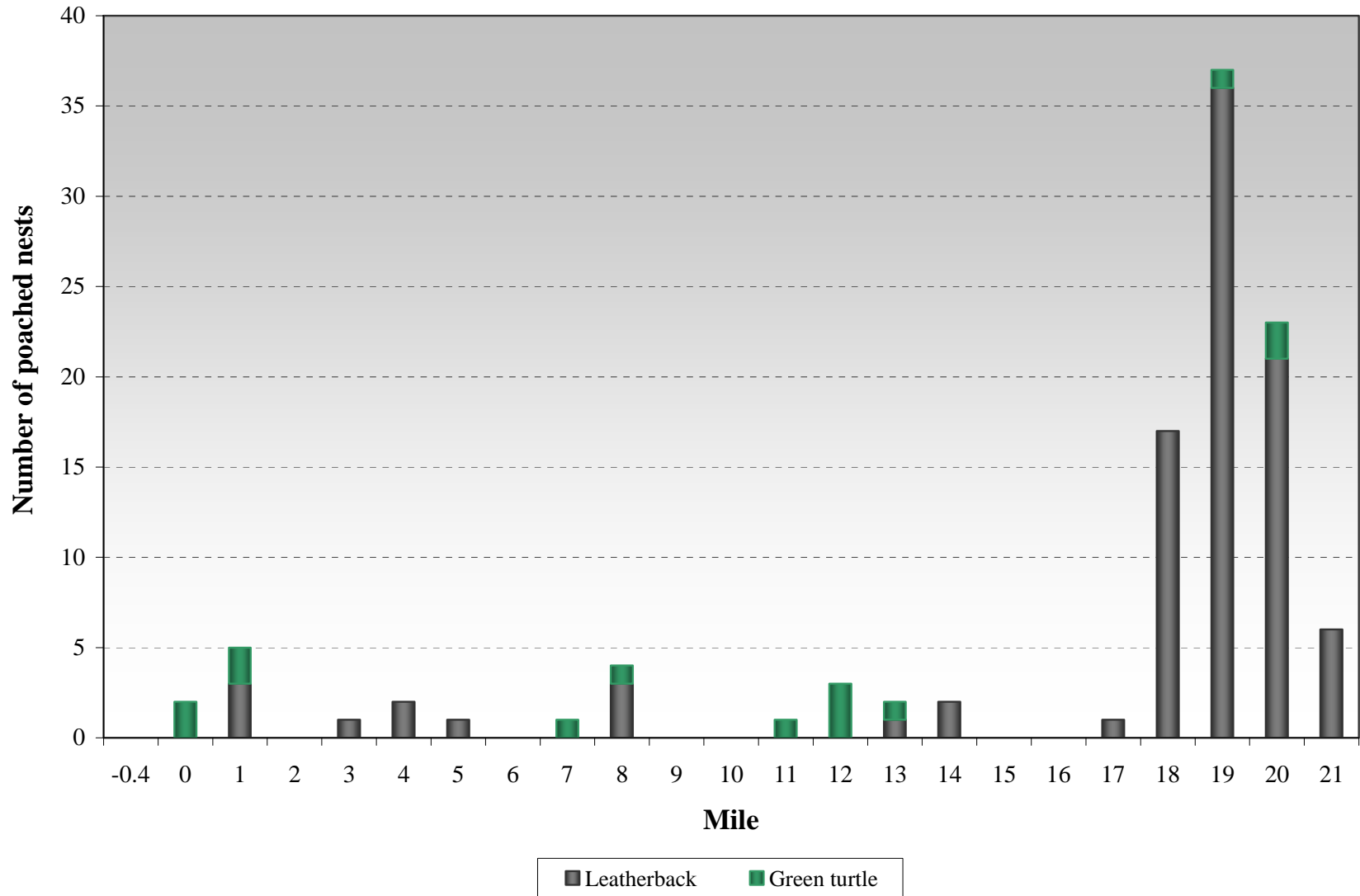
Nightly patrols were conducted between 7 March - 2 June 2010 (with the exception of 9, 12 and 13 March, 30 April, and 30 May); up to six patrols were conducted per night in the different sections of beach, and a total of 1,219.2 team patrol hours were logged. During these patrols a total of 165 turtle encounters were recorded; 101 leatherbacks, 60 green turtles, three hawksbills and one loggerhead (See Appendix 1). This is equal to an average of 0.08 leatherback, 0.05 green, 0.003 hawksbill and 0.0001 loggerhead turtles encountered per patrol hour.

The turtles encountered correspond to 76 individual female leatherbacks, 44 green turtles, three hawksbills and one loggerhead. Although the majority (73.7%) of leatherback females were already tagged when first encountered ($n = 56$), there were 20 individuals newly tagged during the 2010 season, which is about average compared to recent years (See Appendix 1).

Of the previously tagged leatherback turtles encountered in 2010, 37.5% had originally been tagged in Tortuguero ($n = 21$). The remainder were tagged by researchers at Caño Palma (north of the river mouth in Tortuguero; $n = 1$) and other nesting beaches on the southern Caribbean coast of Costa Rica, including Parismina ($n = 4$), Pacuare ($n = 20$), Mondonguillo ($n = 5$) and Gandoca/Manzanillo ($n = 1$). There were three leatherbacks originally tagged in Panama; all at Chiriquí Beach. Of the turtles tagged in Tortuguero, one was originally tagged 21 years ago in 1989; which is a new nesting history record for the project. All the green and hawksbill turtles encountered with tags were from Tortuguero.

Evidence of holes or notches were found on 10% ($n = 2$) of the newly tagged leatherback turtles checked for previous tagging ($n = 20$) when they were encountered for the first time during the 2010 Leatherback Program. The majority of leatherbacks nested in the open beach zone (83.8%, $n = 83$); 8.1% nested in the border zone ($n = 8$) and 7.1% did not lay eggs ($n = 7$).

Figure 4. Spatial distribution of illegally poached nests during the 2010 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 72 of the 76 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 (Wilcoxon test: $Z = 1.84$, $p = 0.07$).

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 no significant difference (Wilcoxon test: $Z = -0.36$, $p = 0.7$). Thus, data from all females were used to calculate the overall mean CCLmin (See Table 2); however, to ensure independency of the data only measurements taken on the first encounter with each female were used for this calculation.

An analysis was also conducted to compare the clutch size between newly tagged and previously tagged females; the results showed no significant difference (Wilcoxon test: $Z = -0.26$, $p = 0.80$), and so data from all females were pooled to calculate the mean clutch size (See Table 2).

Mean carapace length was 152.2cm and mean clutch size was 79 yolked eggs (range = 44 - 120) and 23 yolckless eggs (range = 0 - 45). It should be noted, however, that there were several very small and very large clutches included in the determination of mean clutch size.

Table 2. Mean carapace length and clutch size of leatherback turtles encountered in 2010

Carapace length / cm			Clutch size / no. eggs		
n	\bar{x} CCLmin ± S.D.	Range	n	\bar{x} yolked ± S.D	\bar{x} yolckless ± S.D
72	152.2 ± 7.6	135.4 – 172.5	37	79 ± 20	23 ± 12

Table 3 summarizes the biometric data collected for other species encountered during the 2010 Leatherback Program. Mean carapace length (CCLmin) was calculated for 41 green turtle females; 101.6cm. Eighteen green turtle clutches were counted and the average size was 98 eggs. The three hawksbill turtles that were encountered had a mean carapace length (CCLmin) of 90.7cm. Only one hawksbill clutch was counted; the female laid 200 eggs. The loggerhead turtle encountered had a CCLmin of 100cm.

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

Species	Carapace length / cm			Clutch size / no. eggs	
	n	\bar{x} CCLmin ± S.D.	Range	n	\bar{x} ± S.D.
Green	41	101.6 ± 5.3	91.2 – 113.2	18	98 ± 17.1
Hawksbill	3	90.7 ± 2.3	88.6 – 93.1	1	200
Loggerhead	1	100.0	N/A	N/A	N/A

The precision of the CCLmin measurements taken during 2010 was relatively high, and was the same for all species, except loggerhead, 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	72	0.4 \pm 0.3	0 – 1.2
Green	41	0.4 \pm 0.3	0 – 1.0
Hawksbill	3	0.4 \pm 0.0	0.2 – 0.7
Loggerhead	1	0.0	N/A

The precision of the CCLmin carapace measurements for leatherback and green turtles measured during more than one encounter is shown in Table 5. For the 15 leatherbacks measured on two occasions precision was 2.5cm; for the two females encountered four times, precision was 2.7cm. The biggest different in measurements was 5.9cm; no obvious recent injury was recorded that could account for this large difference between the two measurements. Precision was higher for green turtles observed more than once during the season than leatherbacks; twelve individuals were encountered twice and precision of CCLmin was 0.9cm.

Table 5. Precision of carapace measurements for individual leatherback and green turtles encountered more than once during the 2010 Leatherback Program

Species	No. of encounters	n	\bar{x} precision for CCLmin (cm) \pm SD	Range / cm
Leatherback	2	15	2.5 \pm 1.5	0.5 – 5.9
	4	2	2.7 \pm 0.5	2.3 – 3.0
Green	2	12	0.9 \pm 0.5	0.2 – 2.0
	3	1	1.0	N/A

3.5 Determination of Nest Survivorship and Hatching Success

A total of 49 leatherback nests were marked between 19 March and 2 June 2010. Twenty-seven green turtle and two hawksbill nest were also marked; these will be included in the analysis of nest survivorship and hatching success in the 2010 Green Turtle Program Report.

The collaboration with GVI allowed leatherback nests to be marked at the southern end of the beach for the first time in 2010; 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 49 leatherback nests that were marked, 35 were in this section of beach.

Unfortunately, of the 49 marked nests, 28 (57.1%) had to be removed from the analysis of survivorship and hatching success. The fate could not be determined for seven 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 three nests; another was disturbed and could not be excavated; for nine nests incomplete data were recorded during the excavation, and for a further eight nests no excavation data were recorded. This left a total of 21 nests included in the subsequent analyses. The fate, hatching and emerging successes of 21 marked and monitored leatherback nests are 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	North	South	Total	% Hatching success	% Emerging success
Undisturbed	3	8	11	60.8	57.7
Unhatched	2	0	2	0.0	0.0
Depredated	0	2	2	14.5	13.9
Washed out	1	1	2	0.0	0.0
Poached	1	3	4	0.0	0.0
Total	7	14	21	¹ 33.2	¹ 31.5

Not included in analysis	North	South	Total
<i>Unknown – All tapes lost</i>	3	0	3
<i>Unknown – Not found</i>	2	5	7
<i>Unknown – Disturbed</i>	1	0	1
<i>Unknown – Incomplete data</i>	1	8	9
<i>Unknown – No data</i>	0	8	8
Total	7	21	28

¹ Calculated as the mean of all 21 nests

North refers to the northern five miles of beach close to Tortuguero village and South refers to the southernmost five miles of beach close to Jalova

From Table 6 it can be seen that undisturbed nests had a good hatching and emerging success; 60.8% and 57.7%, respectively; this is within the normal range observed for this species. Almost 20% of marked nests were poached; three of these four nests were at the southern end of the beach, within TNP. Obviously nests that were poached or washed out had a zero percent hatching or emerging success as all eggs were lost. Depredated nests showed a significantly reduced hatching success compared to undisturbed nests; 14.5% compared to 60.8%, respectively.

Overall mean hatching success of leatherback nests was calculated at just 33.2% (n = 21). Emerging success was 31.5% (n = 21). These values were calculated as the mean of the 21 nests that were marked and the fate of the nest was determined (See Table 6). If washed out and poached nests are excluded from this calculation, hatching and emerging success are 46.5% and 44.1%, respectively.

The incubation period for undisturbed leatherback nests for which emerging was observed (n = 7) varied between 58 - 63 days, with a mean of 60 days.

Table 7. Summary of data from nest excavations of marked leatherback nests during the 2010 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	11	8	16	499	2	66	57	29	162	236	815
Unhatched	2	0	0	0	0	72	29	1	20	67	122
Depredated	2	0	1	24	0	13	6	3	93	97	139
Total	15	8	17	523	2	151	92	33	275	400	1,076

The distance from the sand surface to the top egg for undisturbed nests at excavation varied between 44 - 69 cm with a mean of 56.5cm (n = 11). The distance from the sand surface to the bottom of the egg chamber for the same nests varied from 65 - 86 cm, with a mean of 77.6cm.

No deformed embryos and only one twin embryo were recorded, corresponding to 0.09% of eggs encountered during nest excavations.

3.6. Physical Data Collection

Table 8 summarizes the rainfall and air temperature data collected during the 2010 Leatherback Program; data for July thru September are included as several leatherback nests were still incubating during those months.

Rainfall between March and September varied considerably, between 167.9mm – 597.8mm per month; with March being the wettest month, and September the driest (See Table 8). Average daily rainfall, over a 24-hour period, ranged from 5.6mm in September to 19.3mm, in March.

Daily air temperature at the STC field station in Tortuguero from March to September 2010 ranged between 21.0 – 31.0°C (See Table 8). Average daily temperatures did not vary greatly during the season; March was the coolest month (23.9°C) and May was the warmest month (27.6°C).

Table 8. Rainfall and air temperature recorded during the 2010 Leatherback Program

Month	Total rainfall mm/month ¹	\bar{x} rainfall mm/24hrs	\bar{x} temperature/°C ²	Temperature range / °C
March	597.8	19.3	23.9	21.0 – 29.0
April	327.3	10.9	25.9	22.0 – 31.0
May	586.0	18.9	27.6	24.0 – 29.5
June	219.7	7.3	27.2	23.0 – 30.0
July	177.4	5.7	26.3	23.0 – 30.0
August	277.2	8.9	26.5	22.5 – 28.0
September	167.9	5.6	26.4	23.0 – 29.0

¹ Data for 48 hours: 9-10 March; 12-13 April; 30 April – 1 May; 23-24 May; 16-17 & 20-21 June; 22-23 & 30-31 July; 3-4, 5-6, 18-19 & 25-26 August; 11-12 & 23-24 September. Data for 72 hours: 3-5 & 13-15 March; 22-24 August; 8-10 September

² Data for 48 hours: 9-10 & 19-20 March; 12-13, 21-22, 25-26 & 27-28 April; 23-24 May; 2-3, 10-11 & 16-17 June; 22-23 & 26-27 July; 3-4, 5-6, 23-24 & 25-26 August; 8-9, 11-12, 23-24 & 28-29 September. Data for 72 hours: 3-5 & 13-15 March; 29-31 May.

Unfortunately the data loggers lost during the 2009 Green Turtle Program could not be replaced in 2010, and so no data are available for the border and open zones. For the two data loggers in the vegetation zone an error was encountered when trying to download the data at the end of the program, and so no data could be retrieved.

3.7 Collection of Human Impact Data

3.7.1 Visitors to Tortuguero

The number of people visiting Tortuguero National Park decreased for the second consecutive year in 2010 (See Table 9). Data from Tortuguero Conservation Area (ACTo) show that 114,888 tourists were registered as paying the entrance fee to the park in 2010; this is just under 1,500 fewer visitors than in 2009 (MINAET – ACTo, 2011). Interesting, however, the number of Costa Rican visitors increased in comparison to 2009 (See Table 10). Admission fees to TNP in 2010 raised ₡412,935,333, which is approximately \$825,870 (MINAET – ACTo, 2011).

Table 9. Number of paying visitors to Tortuguero National Park, 2001 - 2010

Year	Costa Rican visitors	Foreign visitors	Total no. of visitors
2001	6,175	39,057	45,232
2002	5,745	44,594	50,339
2003	8,643	59,026	67,669
2004	9,545	71,912	81,457
2005	9,292	77,291	87,083
2006	21,257	80,087	101,344
2007	23,898	92,853	116,751
2008	26,727	107,963	134,690
2009	23,632	90,691	116,323
2010	25,592	89,296	114,888

Data from Tortuguero Conservation Area (ACTo)

The number of visitors registered at the STC Visitor Center decreased in 2010 to 24,654 visitors; continuing the trend observed over the last three years (See Table 10). The overall daily visitation rate to the center was 68 visitors. However, in four months (April, May, June and November) visitation was higher in 2010 than in 2009.

The pattern of visitation was similar to that observed previously; most visitors came in January – March, with a significant decline in May. A slight increase in visitation observed during June and July; this coincides with increased green turtle nesting, which is the major tourist attraction in the area. There was a dramatic decrease in September, with an average visitation of just 20 people per day (See Table 10).

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

Month	2008		2009		2010	
	Total	\bar{x} / day	Total	\bar{x} / day	Total	\bar{x} / day
January	3,398	110	4,001	129	3,114	101
February	4,105	142	3,617	129	3,221	115
March	4,421	143	4,100	132	3,719	120

Table 10. Continued

Month	2008		2009		2010	
	Total	\bar{x} / day	Total		Total	\bar{x} / day
April	2,515	84	2,382	79	2,476	83
May	1,311	42	963	31	1,012	33
June	1,562	52	1,492	50	1,628	54
July	2,420	78	2,385	77	2,099	68
August	2,265	73	2,024	65	1,390	45
September	1,250	42	815	27	590	20
October	1,310	42	1,328	43	832	27
November	2,025,	68	1,879	63	2,060	69
December	2,954	95	2,579	83	2,513	81
Total	29,536	81	27,565	76	24,654	68

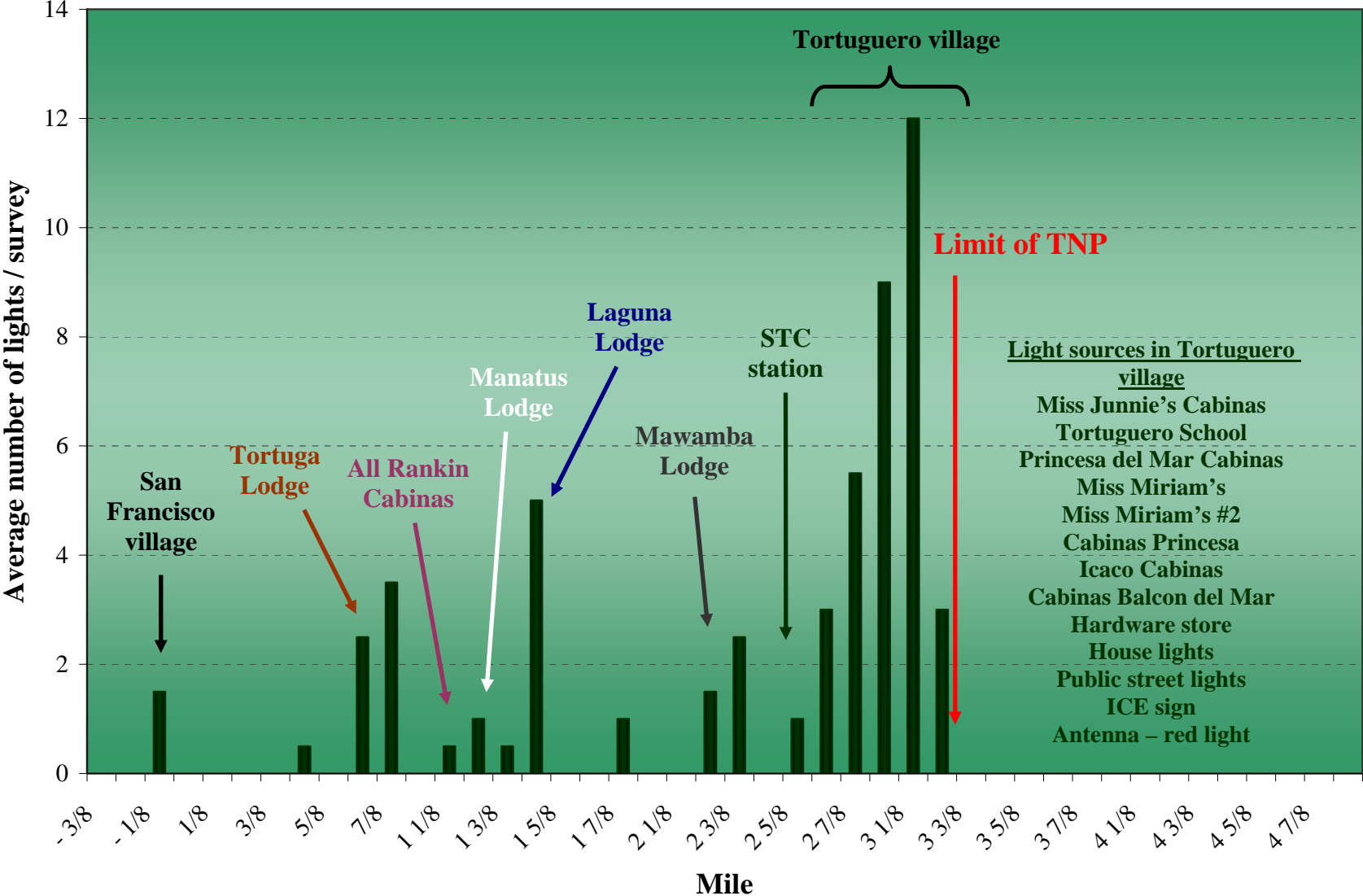
3.7.2 Artificial lights

Light surveys were conducted in March, and May during the 2010 Leatherback Program. The spatial distribution of the artificial lights visible on the beach is shown in Figure 5; the bars represent the average number of lights counted in each 1/8 mile section during the two 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. However, in comparison to previous years there appeared to be a reduction in the number of visible lights. The limit of Tortuguero National Park is at mile 3 3/8; no light sources exist within the national park (See Figure 5).

Lights visible to the north of the village (between miles -3/8 and 2 5/8) are coming from San Francisco village (close to the river mouth) and several of the lodges and cabinas that are located close to the beach or on the opposite side of the river.

Figure 5. 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, two other dead turtles were encountered during monitoring activities for the 2010 Leatherback Program; both were green turtles (See Table 11). Cause of death could not be determined for either turtle.

Table 11. Dead turtles encountered during the 2010 Leatherback Program

Date	Species	Sex	Mile	Comments
15 April	Cm	Female	8 4/8	Cause of death unknown
14 April	Cm	Female	9	Cause of death unknown

Cm = Green turtle

3.8.1 Turtles killed by jaguars

Thirty-eight turtles were recorded as killed by jaguars during the track surveys conducted every three days during the 2010 Leatherback Program; 33 green turtles, three leatherbacks and two hawksbills (See Table 12).

All jaguar predation occurred within TNP, between miles 5 and 18. There were a couple of peaks in activity; in miles 8 4/8 and mile 10. It is unusual to record leatherback turtles that have been attacked by jaguars, as they typical prey on the smaller species.

Table 12. Turtles killed by jaguars during the 2010 Leatherback Program

Date	Species	Mile	Comments
13 March	Dc	14 4/8	Killed by jaguar on 6 March – recorded by track surveyor
13 March	Cm	16 4/8	Killed by jaguar on 6 March
13 March	Cm	17	Killed by jaguar on 6 March – Tag # 104093 in RF flipper
19 March	Dc	12 4/8	Killed by jaguar – Tag # VA4845 in RR flipper
22 March	Cm	11	Killed by jaguar
22 March	Cm	8 4/8	Only found head in vegetation – presumed killed by jaguar
31 March	Cm	9	Killed by jaguar – jaguar seen
31 March	Cm	9 4/8	Killed by jaguar
3 April	Cm	5	Killed by jaguar
3 April	Cm	13	Killed by jaguar – Tag # 104008 in LF flipper
6 April	Cm	6	Killed by jaguar
6 April	Cm	6	Killed by jaguar
9 April	Cm	8	Killed by jaguar
15 April	Cm	7	Killed by jaguar

Table 12. Continued

Date	Species	Mile	Comments
21 April	Cm	8 4/8	Killed by jaguar
21 April	Cm	9 4/8	Killed by jaguar
24 April	Cm	11	Killed by jaguar – very fresh
24 April	Cm	16	Killed by jaguar
27 April	Cm	8 4/8	Killed by jaguar
30 April	Cm	7	Killed by jaguar
3 May	Cm	5 4/8	Killed by jaguar
3 May	Dc	10	Killed by jaguar – Tag #s VA2318 and VA2317 in RR and LR flippers, respectively
6 May	Cm	6 4/8	Killed by jaguar – observed jaguar feeding on kill
6 May	Cm	10	Killed by jaguar
9 May	Cm	10	Killed by jaguar
12 May	Cm	8	Killed by jaguar
12 May	Cm	13	Killed by jaguar
18 May	Cm	12	Killed by jaguar
18 May	Cm	12	Killed by jaguar
18 May	Cm	7 4/8	Killed by jaguar
21 May	Cm	10	Killed by jaguar
21 May	Cm	12 4/8	Killed by jaguar
24 May	Ei	13 4/8	Killed by jaguar – Tag # 110031 in LF flipper
27 May	Cm	9	Killed by jaguar
27 May	Cm	10 4/8	Killed by jaguar
30 May	Cm	8 4/8	Killed by jaguar
30 May	Cm	14 4/8	Killed by jaguar
02 June	Ei	12 4/8	Killed by jaguar

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

3.9 Environmental Education and Outreach Activities

3.9.1 Environmental Education Program

In 2010, Dagnia Nolasco was contracted part-time as the Outreach and Education Coordinator (OEC); she was responsible for supervising the development of an environmental education program and organizing outreach activities in the communities of Tortuguero and San Francisco.

A summary of the different environmental education activities conducted by the OEC and RAs during the 2010 Leatherback Program is shown in Appendix 2; there are also photographs of some of the events.

In total, 45 different educational activities were conducted during the 2010 Leatherback Program. For students at the high school the general theme was climate change; there was a presentation to introduce the topic and then a series of events during which they created posters to show the general effects of climate change, the impact of climate change in Tortuguero, global warming and greenhouse gases, and climate change relating to sea turtles. These posters were displayed to the general public as part of the community event organized for 23 May to celebrate World Turtle Day and International Biodiversity Day. Furthermore, STC signed an agreement with Tortuguero High School to facilitate the coordination of environmental education on the curriculum; this document was officially signed during the festivities on 23 May. As a result of this agreement the OEC was invited to be a member of the board of the 'Blue Flag' (Bandera Azul) committee at the high school; the Blue Flag program is a national initiative to make schools and other organizations more environmentally conscious and eco-friendly. The OEC also established weekly workshops for students that were part of the regular curriculum for students.

At the start of the season it was difficult to coordinate the activities at Tortuguero School; the school director made no effort to meet with the OEC to determine a schedule of activities. However, through persistence and interaction directly with the teachers it was possible to initiate the program. Several different campaigns were realized with the students: Reduce, Recycle, Reuse; Conserve Water and No to Contamination; Reduce Energy Use and Artificial Lights on the Beach; No to Plastic Bags. The objective behind these different campaigns was to teach the students about the different threats to the environment, to show them what they can do to make a difference, and to demonstrate how they can become actively involved in protecting their natural resources. The culmination of these activities was the celebration of World Turtle Day and International Biodiversity Day on 23 May; several student marches were organized, to raise awareness of the different campaigns throughout the members of the community.

Other programs conducted during the 2010 Leatherback Program included the establishment of an organic garden at the STC station for 2nd grade students at the school; they learned about organic farming and helped plant different vegetables from seed. This project was coordinated by Mónica Duarte.

3.9.1.1 Junior Research Assistant Program

The Junior Research Assistant Program (JRAP) ran for a third year in 2010 for students at Tortuguero High School. The program consisted of talks, night patrols, a visit to another turtle conservation project and participation in the student symposium/10 year anniversary of Ecology Project International (EPI).

To avoid problems with students missing classes as a result of participating in night patrols during the week, all patrols were limited to Friday and Saturday nights. Twenty-eight students took part in at least one of the program activities during the course of 2010. However, the program was not as successful as in previous years, and no-one completed all of the requirements to graduate.

During the 2010 Leatherback Program four returning JRAP students from 2009 were invited to participate in a visit to Pacuare Nature Reserve; they joined a group of high school students from the coastal province who were part of a program organized by EPI. To cover the costs of their board and lodging in Pacuare the students sold coconuts to tourists at the STC Visitor Centre;

they were able to raise \$180 towards their trip, and STC provided transportation to/from Pacuare. Only three of the students actually went to Pacuare; the fourth was not granted permission from his parents at the last moment.

In April 2010 a short documentary film was produced about the JRAP; it featured several of the participants. The aim of the documentary was to promote the JRAP by letting the students talk about their experiences with the STC turtle project, their opinions about conservation and their reasons for participating in the JRAP program. The documentary was showcased during the celebrations on 23 May to celebrate World Turtle Day and International Biodiversity Day, and can be accessed via the STC website: <http://www.conserveturtles.org/costarica.php?page=videos>.

9.1.2 EcoWallet Project

The EcoWallet project was established in April 2010 as part of the program of activities conducted at Tortuguero High School. The principal objectives of the project were to teach the students about recycling and to develop their manual skills, while at the same time searching for a sustainable way to obtain funds to support the education centre, by creating a product that could be sold to raise money.

Mónica Duarte developed the program, and conducted weekly workshops with interested students to teach them how to create EcoWallets from used Tetra Pak cartons (See Appendix 3 for photos of examples). STC donated the first set of materials, to initialize the project. The students, all girls from the high school, and a teacher received training from Mónica in how to make various different styles of wallets which were subsequently sold at various local festivals, artisan stalls in Tortuguero and at the STC Visitor Centre and the Barrier Island Centre in Florida. During 2010 the project raised approximately \$422.50; \$103.88 was reinvested into the project through the purchase of more materials, and \$99.44 was used to purchase a fan for one of the high school class rooms. The remaining \$219.18 will be used as needed in 2011.

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 2010. As in previous years the committee was comprised of representatives from STC, MINAET, ProParques (an environmental NGO based in San Jose) with support from local residents in Tortuguero and San Francisco. Veterinarian support is provided by the Humane Association for Animal Protection in Costa Rica (AHPPA).

Prior to the clinic two presentations were made to 2nd – 5th grade students at Tortuguero school, about the benefits of castration for domestic animals and to provide details of the clinic.

The fifth veterinary clinic took place 25-27 March, 2010. 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 2009, 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 13 summarizes the results of the clinics since 2008; in March, 2010 37 animals were castrated, bringing the total in the three years of the program to 294.

Table 13. Summary of veterinary clinics 2008 – 2010

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

4. Discussion

4.1 Preparations

In 2010, 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 in 2010; 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 mid-July; RAs encountered leatherbacks until 17 June. There was a peak in nesting observed in mid-April (See Figure 1) and then two further peaks in May and June. The three-day track surveys conducted by the FRC and RAs in 2010 covered the main nesting period for leatherbacks.

Unfortunately there was a slight decrease in the estimated number of leatherback nests laid in 2010 compared to 2009 (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 is a large discrepancy between the estimated number of nests (as determined from data collected during the weekly surveys) and the number of nests counted by the FRC and RAs during the three-day surveys (200 compared to 434, respectively). It would be interesting to do a comparative analysis of the two data sets over the last 14 years to obtain a clearer understanding of the status of the Tortuguero leatherback population. It is valuable, therefore, to continue to conduct the three-day surveys in future Leatherback Programs, to compare with results from the weekly surveys. 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 2010 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 13 to 20 (See Figure 3). As in 2009 there was also a small peak in activity at mile 1, which is interesting. As noted previously, highest nesting density occurs outside of Tortuguero National Park, in miles 19 and 20; these two miles accounted for 23.7% of all leatherback nesting recorded in 2010.

Unfortunately illegal poaching of turtle nests occurred throughout the 2010 Leatherback Program (See Table 1). The percentage of poached nests for leatherbacks was lower than that recorded in 2009 (14.8% compared to 17.7%, respectively). Poaching of green turtle nests was the same in 2010 as in 2009, and no hawksbill nests were reported as poached in 2008 (See Table 1). The spatial distribution of poaching was very 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 40% 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 might even be necessary to implement some kind of camouflage techniques to better protect the nests from poachers.

4.3 Tagging of Nesting Sea Turtles

The availability of additional volunteers and staff from GVI facilitated additional night patrols close to Jalova; this was reflected in the increased number of patrol hours logged in comparison to other years. Previously, patrols at the southern end of the beach have been limited to a single group of RAs covering four miles of beach; in 2010 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.

The return to a group of eight RAs and the additional patrols at Jalova meant that leatherback turtle encounters during night patrols in 2010 were higher than in 2009 (101 compared to 78, respectively). Furthermore, the number of green turtle encounters ($n = 60$) was much higher than typically observed during the leatherback nesting season; peak nesting for this species occurs later in the year, from June – November, although early nesting females are often observed, though in much lower numbers than those seen in 2010. The number of hawksbills ($n = 3$) encountered during night patrols was similar to that observed during previous leatherback nesting seasons. The encounter with an untagged loggerhead in April was unusual; this species nests only very sporadically at Tortuguero; a single tagged female has been encountered every three years or so, but this was a new individual suggesting that a very small population of this

species is using Tortuguero for nesting.

The proportion of new leatherback turtles (individuals that did not have tags when first encountered) observed during the 2010 season was much lower than observed in the last few years; this could indicate that there is reduced recruitment of sexually mature females into the population, or that new females are using other beaches in preference to Tortuguero. 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.

Over 70% of female leatherbacks encountered during 2010 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 three females with tags from Chiriquí Beach, Panama. An interesting encounter was with a female who was first tagged in Tortuguero in 1989; this was a new nesting history record of 21 years for a leatherback at Tortuguero. 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.

Final adjustments were made during 2010 to the cooperative agreement that will facilitate the proposed regional database for leatherback tagging information. It is hoped that this agreement between the different turtle conservation projects can be formalized for the database to be operational in 2011.

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, or between newly tagged and previously tagged turtles, thus data were combined to calculate the overall mean of 152.2cm (See Table 2), which is very similar to the mean for previous years. There was also a similar size diversity in the size of leatherback females encountered in 2010 to that seen during other nesting seasons; ranging from very small (135.4cm) to very large individuals (172.5cm). 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.

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

The precision of carapace measurements taken during the same encounter was the same for leatherbacks, green turtles and hawksbills in 2010 (0.4cm). However, for leatherbacks that were observed on more than one occasion throughout the nesting season the precision was low (more

than 2.5cm); for one leatherback there was a difference of 5.9cm 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 first time in 2010 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; 49 leatherback nests, plus 27 green turtle and two hawksbill nests. Marking nests at the southern end of the beach would allow an evaluation of nest survivorship and hatching success for the first time; and could provide data to do a comparative analysis with nests laid to the north. Unfortunately, sample sizes in 2010 were not sufficiently large enough to permit such analyses.

It was a little worrying to observe that of the 35 leatherback nests marked at the southern end of the beach data from 21 (60.0%) could not be included in the subsequent analysis as either the nests were not found at excavation, or the data were not recorded. In future years more care will be taken to conduct additional training sessions with all RAs and GVI staff and volunteers about the correct protocol for nest excavations and data recording.

Even with limited sample sizes it was interesting to note that there was an apparent difference in hatching success of undisturbed nests between the north and south ends of the beach (38.2% and 69.2%, respectively). It would be very interesting in future to continue to mark nests close to Jalova to investigate whether this was simply an anomaly due to small sample size for northern nests ($n = 3$) or whether there is a spatial variation in success of nests laid in different parts of the beach.

It was encouraging to observe that overall, more than 50% of leatherback nests for which the fate could be determined remained undisturbed during the incubation period. Mean hatching and emerging success in 2010 was lower than in 2009 (33.2% compared to 58.1%, respectively), but values were within the range observed previously for this species at Tortuguero.

Four of the 49 marked nests (8.2%) were poached; three of these were at the southern end of the beach, within TNP. Poaching is 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.

4.6 Physical Data Collection

As in 2009 the precipitation pattern observed during the 2010 Leatherback Program was different to that typically seen in Tortuguero; March was once again the wettest and coolest month (597.8mm total precipitation and 23.9°C average temperature). Data for June, July, August and September were included as several leatherback nests were still incubating during those months; the environmental conditions could influence the survival and/or hatching success

of those nests. Throughout the Leatherback Program the temperatures remained quite high, often reaching 31.0°C during the day. After an exceptionally wet month in May the following four months were very dry, and temperatures were high; often in June and July there is increased precipitation. It is important to maintain the daily record of precipitation and temperature in Tortuguero, as this is a long-term data base that is very useful for observing trends in rainfall and/or temperature patterns.

Unfortunately the problems with the data loggers persisted throughout 2010; financial conditions at the start of the season prohibited the purchasing of new data loggers to replace those lost in 2009; it is important that they are replaced as soon as possible, to not lose valuable data about beach conditions that could affect nest survival or hatching success.

4.7 Collection of Human Impact Data

Data from 2010 showed that the decline in tourist visitation to TNP first observed in 2009 continued for a second consecutive year; although the decrease was much smaller than that observed between 2008 and 2009. It was interesting to observe that while there were fewer international visitors entering TNP, the number of national tourists actually increased in 2010. However, it is still not clear whether ACTo is continuing to include tour guides and boat captains in this group; if so, then the actual decrease in tourism might be more pronounced.

For the third consecutive year there was a decrease in the number of tourists to the STC Visitor Centre; almost 3,000 fewer people were recorded in 2010 than in 2009. However, the entrance fee to the museum was increased from \$1 to \$2 and so the revenue from the centre actually increased in 2010. It is discouraging to observe that some tour guides would walk past the Visitor Centre, and actually use the information displayed outside to inform their tour groups about turtles, and yet not support the STC by bringing their groups inside the centre. Various tour guides have commented on the fact that the information video is outdated and that the centre offers nothing new for visitors to Tortuguero, and so plans were being reviewed during the 2010 Leatherback Program to change the layout of the Visitor Centre and also produce a new video, with up to date information about STC and the work it is doing in Costa Rica to protect sea turtles.

The negative impact of artificial lights to turtles and hatchlings on the nesting beach was one of the campaigns for students at the Tortuguero School during the 2010 Leatherback Program. As part of this campaign a petition was created that people were invited to sign during the community activity to celebrate World Turtle Day in May. It was encouraging to observe that more than 200 people signed the petition, which urged the Costa Rican electricity company (ICE) to reduce the number of lights that are visible on the beach in front of the village. Following the success of the petition, the OEC was in contact with ICE staff and they were incredibly enthusiastic about helping to find a viable solution to the light problem in Tortuguero. Working together with the OEC, problematic public street lights (which are the main cause of light pollution on the beach) in the village were covered. ICE were also interested in finding an alternative light bulb that could be used in all the public lights in the village; that would provide sufficient light for people, but would not impact nesting sea turtles, or hatchlings. The cooperation with ICE should definitely be continued in the future, to ensure that an effective long-term solution to the problem of artificial lights can be established. Also, STC should continue to work with the community to ensure that they are aware of the problems caused by artificial lights; to encourage people to cover or turn off their lights during turtle nesting season.

4.8 Dead Turtles

It was encouraging to observe that only one green turtle was recorded as poached during the 2010 Leatherback Program. However, the report of two green turtles stranded dead on the beach might suggest that turtles are being targeted offshore, as was observed in 2009. If this is the case, then STC would have no means of recording the level of take. It is imperative that MINEAT and/or the Costa Rica Coast Guard conduct marine patrols, to deter illegal fishing of turtles or other protected species within TNP.

A large number of turtles were recorded killed by jaguars during the 2010 Leatherback Program; 33 green turtles, three leatherbacks and two hawksbills. This is the second consecutive year in which leatherbacks have been prey to jaguars, typically it is the smaller species that are taken. Predation activity was reported throughout the program, and there was some indication of increased numbers of dead turtles reported in miles 8 4/8 and 10, although jaguars are known to occur along the entire length of the beach; footprints were observed on track surveys from close to Tortuguero village to Jalova lagoon. There were also numerous jaguar sightings by STC staff and RAs during the 2010 Leatherback Program; on several occasions people witnessed jaguars feeding on dead turtles. It is possible that the jaguar population within TNP is increasing, supported by the observation in May 2010 of a mother and cub resting on the beach, and that 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 turtle populations in TNP.

3.9 Environmental Education and Outreach Activities

The contracting of a part-time Outreach and Education Coordinator for the 2010 Leatherback Program, dedicated to developing and supervising the implementation of a structured environmental education program was very beneficial. Having a person focused on education and outreach, who can act as a crucial link between STC, the community and national park staff is key to raising awareness about the STC project in Tortuguero. Dagnia Nolasco was a good person to have in this role as she has worked with STC previously, and has a good relationship with many of the key leaders of the community. She worked extremely hard in 2010 to establish links with the school and high school in Tortuguero, and the school in San Francisco, to be able to conduct regular activities with students. At times the logistics were complicated by a lack of communication; on occasion STC staff and RAs arrived at the school or high school to find that classes had been cancelled without advising STC; however, overall, there was a significant interest on the part of the education centers to have STC conduct activities. This was manifest in a formal agreement between STC and Tortuguero High School, and the appointment of the OEC as a member of the board for the Blue Flag (Bandera Azul) project.

The different topics selected for education activities and the various campaigns that were conducted were all designed to raise awareness among the students, and members of the community, about issues such as climate change, conserving water and saving energy that have a direct impact on everyone in Tortuguero, as well as the natural resources upon which the area is dependent. The event to celebrate World Turtle Day in May was extremely successful, and while the participation of the adult members of the community could have been greater, there were over 100 children taking part in the different activities, protest marches and workshops. It was a good chance to show the community the work that STC is doing in the schools, and a chance to collaborate with staff from TNP. Hopefully in future years a similar program of activities can be conducted, to continue to raise local awareness about environmental issues, and

to encourage the younger generation to take a more active role in conservation, by demonstrating that each individual can make a difference to protect the environment.

The development of several new projects by Mónica Duarte, such as the organic garden and the EcoWallet project, were very well received by the students and teachers at the school and high school. Such projects allow STC to be involved more directly with the community, and to help students develop new skills that are not part of the regular school curriculum. The EcoWallet project was especially interesting as it provided the high school students with a sustainable way of raising funds to provide equipment to the school. Hopefully the students will retain their enthusiasm and the project can be continued in future years.

In 2010, STC continued to support the veterinary clinic in Tortuguero and San Francisco, working together with MINAET, ProParques and members of the community. The fifth veterinary clinic in March, 2010 was again well supported by local residents. However, throughout the Leatherback Program numerous dogs, occasionally in groups, were regularly observed unsupervised on the beach. It is important to work with MINAET and the community to ensure that everyone is aware of the continuing problem of domestic animals on the nesting beach, and also the threat to other wildlife or even people if the dog population in Tortuguero is not more effectively controlled, and if dog owners do not take more responsibility for their animals. The veterinary clinics should be continued, while alternative short-term, direct action solutions are discussed with the key stakeholder groups involved.

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6. Appendices

Appendix 1. Nightly sea turtle encounters for the 2010 Leatherback Program

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

Appendix 1. Continued

Date	Leatherback				Green				Hawksbill			
	New	REM	REN	Total	New	REM	REN	Total	New	REM	REN	Total
12-Apr	1	1		29	4			17				0
13-Apr		2		31	3			20				0
14-Apr				31	1			21				0
15-Apr	1	2		34	2			23				0
16-Apr	1	1		36	1			24				0
17-Apr	1			37	1	1	2	28				0
18-Apr		1	1	39	1			29				0
19-Apr	1	1		41	3			32				0
20-Apr			1	42	1	1		34				0
21-Apr		2		44				34				0
22-Apr	1		2	47				34				0
23-Apr				47	2			36				0
24-Apr	1	1	1	50	1		2	39				0
25-Apr		1		51			1	40		1		1
26-Apr	1	3	1	56				40				1
27-Apr		1		57				40				1
28-Apr		1	1	59			3	43				1
29-Apr		1		60	2			45				1
30-Apr	1	2	1	64				45				1
1-May				64				45				1
2-May				64				45				1
3-May		1		65	1		2	48				1
4-May		2	2	69	1			49				1
5-May	1	2	1	73			1	50				1
6-May		1		74				50				1
7-May			1	75				50				1
8-May			1	76				50				1
9-May				76				50				1
10-May		1		77	2		2	54				1
11-May			1	78	2			56				1
12-May				78				56				1
13-May			1	79				56		1		2
14-May				79				56				2
15-May			1	80				56	1			3
16-May		1	1	82	1			57				3
17-May		1	2	85			1	58				3
18-May		1		86				58				3
19-May		1		87	1			59				3

Appendix 1. Continued

Date	Leatherback				Green				Hawksbill			
	New	REM	REN	Total	New	REM	REN	Total	New	REM	REN	Total
20-May		1		88				59				3
21-May		1		89				59				3
22-May				89				59				3
23-May				89				59				3
24-May			1	90				59				3
25-May			1	91	1			60				3
26-May		1	1	93				60				3
27-May	2	2	1	98				60				3
28-May		1		99				60				3
29-May				99				60				3
30-May				99				60				3
31-May				99				60				3
1-Jun				99				60				3
2-Jun		1	1	101				60				3
Total	20	56	25	101	41	3	16	60	1	2	0	3
%	19.8	55.4	24.8	100	68.3	5.0	26.7	100	33.3	66.7	0.0	100

¹ On 12 April one newly tagged loggerhead was encountered

Legend

New = Turtles that had no tags on first encounter in 2010

REM = Remigrant; turtles that had tags from previous years/other projects on first encounter in 2010

REN = Renester; turtles that were encountered more than once during 2010

Appendix 2. Summary of environmental education activities conducted during the 2010 Leatherback Program

Date	Description of activity	Objectives	Student Group
25-Mar	Informative talk about 'Earth Hour'. Made posters and displayed them at various locations in the village.	To teach students about international activities that they can participate in. To introduce the topic of saving energy.	Tortuguero High School – all grades
25-Mar	Informative talk about 'Earth Hour'. Made posters and displayed them at various locations in the village.	To teach students about international activities that they can participate in. To introduce the topic of saving energy.	Tortuguero School – all grades
24-Mar	Introduction to the theme of climate change; Global warming and greenhouse gases; Global, regional and local effects of climate change; Climate change and sea turtles; What you can do to help reduce impacts of climate change.	To introduce the theme of environmental education activities for the Leatherback Program.	Tortuguero High School – all grades and Drew School Group
7-Apr	Preparation of posters about climate change.	To have a cultural exchange with foreign students. To work in groups to produce a poster related to one of the topics of climate change.	Tortuguero High School – all grades and Drew School Group
9-Apr	Beach clean-up.	To have a cultural exchange with foreign students. To teach students about the need to reduce waste on the beach.	Tortuguero High School – all grades and Drew School Group
23-Apr	Introductory talk about water use and the need to conserve water.	To introduce one of the campaigns for the Leatherback Program. To teach students about the negative impacts of uncontrolled water use. To raise awareness about the need to conserve water.	Tortuguero School – 4 th grade
26-Apr	Informative talk about the negative impacts of plastic bags on wildlife.	To introduce one of the campaigns for the Leatherback Program. To raise awareness about the environmental problems caused by plastic bags.	San Francisco School – 3 rd and 4 th grade

Appendix 2. Continued

Date	Description of activity	Objectives	Student Group
28-Apr	Informative talk about recycling, introducing the three R's – Reduce, Recycle, Reuse.	To introduce one of the campaigns for the Leatherback Program. To raise awareness of recycling and how to help reduce waste.	San Francisco School – 5 th and 6 th grade
28-Apr	Preparation of posters about climate change.	To work in groups to produce a poster related to one of the topics of climate change.	Tortuguero High School – all grades
4-May	Presentation about conserving energy and the negative impact of artificial lights on the nesting beach.	To introduce one of the campaigns for the Leatherback Program. To raise awareness about reducing energy use. To raise awareness about the problem of artificial lights for sea turtles.	Tortuguero School – 6 th grade
4-May	Informative talk about the negative impacts of plastic bags on wildlife.	To introduce one of the campaigns for the Leatherback Program. To raise awareness about the environmental problems caused by plastic bags.	Tortuguero School – 5 th grade
5-May	Completion of posters about climate change.	To review student knowledge of climate change. To finalize posters.	Tortuguero High School – all grades
7-May	Preparation of banners for a student march to promote the campaign “Reduce the use of Water and No to Contamination”.	To discuss with students the theme of conserving water and reduced contamination. To prepare materials for a student march.	Tortuguero School – 4 th grade
7-May	Preparation of materials for the Turtle Day event regarding saving energy and reducing artificial lights on the nesting beach. Preparation of a letter and petition to ICE asking for a reduction in lights in front of the beach.	To discuss with students the theme of saving energy. To prepare a petition to ICE to reduce artificial lights on the beach.	Tortuguero School – 6 th grade
10-May	Preparation of a stand for the Turtle Day event for the “Reduce, Recycle, Reuse” campaign.	To teach students about the importance of Reduce, Recycle, Reuse. To teach students how they can help reduce waste by separating their garbage.	Tortuguero School – 3 rd grade

Appendix 2. Continued

Date	Description of activity	Objectives	Student Group
10-May	Informative talk about the negative impacts of plastic bags on wildlife.	To introduce one of the campaigns for the Leatherback Program. To raise awareness about the environmental problems caused by plastic bags.	Tortuguero School – 5 th grade
11-May	Preparation of a stand for the Turtle Day event for the “Reduce, Recycle, Reuse” campaign.	To talk to students about the importance of recycling. To prepare materials to display to the public about reducing waste by separating garbage.	Tortuguero School – 3 rd grade
11-May	Preparation of banners and posters for the student march for the “No to Plastic Bags” campaign.	To raise awareness among students about the need to reduce the use of plastic bags. To teach students how to be proactive in conservation issues.	Tortuguero School – 5 th grade
13-May	Preparation of banners for a student march to promote the campaign “Reduce the use of Water and No to Contamination”.	To discuss with students the theme of conserving water and reduced contamination. To prepare materials for a student march.	Tortuguero School – 4 th grade
13-May	Preparation of materials for the “Reduce Energy Consumption and Reduce Artificial Lights on the Nesting Beach” campaign.	To discuss with students the importance of reducing energy consumption. To raise awareness about the impacts of artificial lights to turtles.	Tortuguero School – 6 th grade
14-May	Preparation of banners for a student march to promote the campaign “Reduce the use of Water and No to Contamination”.	To discuss with students the theme of conserving water and reduced contamination. To prepare materials for a student march.	Tortuguero School – 4 th grade
18-May	Preparation of materials for the “No to Plastic Bags” campaign.	To discuss with students the need to reduce the use of plastic bags. To teach students how to be proactive in conservation issues.	Tortuguero School – 5 th grade
19-May	Preparation of materials for the “Reduce Energy Consumption and Reduce Artificial Lights on the Nesting Beach” campaign.	To discuss with students the importance of reducing energy consumption. To produce materials to display to the public.	Tortuguero School – 6 th grade

Appendix 2. Continued

Date	Description of activity	Objectives	Student Group
19-May	Drawing competition – Theme ‘Biodiversity and Marine Turtles’	To teach students about the concept of biodiversity. To encourage students to participate in a competition.	Tortuguero School – 2 nd grade
19-May	Preparation of materials for the “No to Plastic Bags” campaign.	To discuss with students the need to reduce the use of plastic bags. To teach students how to be proactive in conservation issues.	Tortuguero School – 5 th grade
19-May	Preparation of a stand for the Turtle Day event for the “Reduce, Recycle, Reuse” campaign.	To talk to students about the importance of recycling. To prepare materials to display to the public about reducing waste by separating garbage.	Tortuguero School – 3 rd grade
20-May	Preparation of banners for a student march to promote the campaign “Reduce the use of Water and No to Contamination”.	To discuss with students the theme of conserving water and reduced contamination. To prepare materials for a student march.	Tortuguero School – 4 th grade
20-May	Preparation of a stand for the Turtle Day event for the “Reduce, Recycle, Reuse” campaign.	To talk to students about the importance of recycling. To prepare materials to display to the public about reducing waste by separating garbage.	Tortuguero School – 3 rd grade
20-May	Preparation of materials for the “Reduce Energy Consumption and Reduce Artificial Lights on the Nesting Beach” campaign.	To discuss with students the importance of reducing energy consumption. To produce materials to display to the public.	Tortuguero School – 6 th grade
20-May	Drawing competition – Theme ‘Biodiversity and Marine Turtles’	To teach students about the concept of biodiversity. To encourage students to participate in a competition.	Tortuguero School – 2 nd grade
21-May	Drawing competition – Theme ‘Biodiversity and Marine Turtles’	To teach students about the concept of biodiversity. To encourage students to participate in a competition.	Tortuguero School – 1 st grade
21-May	Preparation of banners for a student march to promote the campaign “Reduce the use of Water and No to Contamination”.	To discuss with students the theme of conserving water and reduced contamination. To prepare materials for a student march.	Tortuguero School – 4 th grade

Appendix 2. Continued

Date	Description of activity	Objectives	Student Group
23-May	Community event to celebrate International Biodiversity Day and World Turtle Day	<p>To organize a community event with Tortuguero National Park and community leaders.</p> <p>To raise community awareness about sea turtles and conservation issues.</p> <p>To teach the importance of conserving energy and water; reducing plastic bag usage and eliminating artificial lights on the nesting beach.</p> <p>To share with the community the results of the environmental education program.</p>	All students from Tortuguero School and High School; community members and tourists
27-May	Informative talk about conserving water and reducing contamination.	To discuss with students the need to conserve water and reduce contamination.	San Francisco School – 5 th and 6 th grade
31-May	Presentation about conserving energy and the negative impact of artificial lights on the nesting beach.	<p>To introduce one of the campaigns for the Leatherback Program.</p> <p>To raise awareness about reducing energy use.</p> <p>To raise awareness about the problem of artificial lights for sea turtles.</p>	San Francisco School – 5 th and 6 th grade
2-Jun	Preparation of banners and posters for the student marches for different campaigns.	<p>To discuss with students the need to reduce the use of plastic bags.</p> <p>To teach students how to be proactive in conservation issues.</p>	San Francisco School – 3 rd to 6 th grade
4-Jun	Celebration of World Environment Day	<p>To raise community awareness about the importance of conserving energy and water; reducing plastic bag usage and eliminating artificial lights on the nesting beach.</p> <p>To share with the community the results of the environmental education program.</p>	San Francisco School – all grades; community members

Appendix 2. Continued - Photographs of some of the environmental education activities conducted during the 2010 Leatherback Program



Students, STC staff and members of Tortuguero community participate in the celebration of World Turtle Day and International Biodiversity Day



Some of the JRAP participants display results of the study they conducted during an exchange visit to Pacuare Nature Reserve



Students march to raise local awareness about the “No to Plastic Bags” campaign

Appendix 2. Continued - Photographs of some of the environmental education activities conducted during the 2010 Leatherback Program



Students explain EcoWallet projects to tourists during the celebration of World Turtle Day and International Biodiversity Day



Example of an EcoWallet