

REPORT ON THE 2013 LEATHERBACK PROGRAM AT TORTUGUERO, COSTA RICA

**Submitted to
Sea Turtle Conservancy (Formerly the Caribbean Conservation Corporation)
and
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Executive Summary

Monitoring and Research Activities Conducted

- 1 A total of 26 track surveys were conducted between the Tortuguero river mouth and Jalova lagoon between 5 January and 29 June, 2013.
- 2 The first leatherback nest was reported on 2 March.
- 3 A total of 204 leatherback nests were estimated for the season.
- 4 The peak of nesting was recorded on 7 April when seven fresh leatherback nests were recorded from the previous night.
- 5 The Field Research Coordinator (FRC) and the Research Assistants (RAs) conducted a total of 23 additional track surveys between the Tortuguero river mouth and the Jalova Lagoon between 24 March and 29 May, 2013.
- 6 191 leatherback, 213 green turtle and 19 hawksbill nests were recorded during the track surveys of the entire 18 miles of beach.
- 7 Seven nests were reported as poached; two leatherback and five green turtle nests.
- 8 Only one green turtle was taken illegally during the 2013 Leatherback Program.
- 9 Forty-eight turtles were killed by jaguars during the 2013 Leatherback Program; 46 green turtles, one leatherback and one hawksbill.
- 10 A total of 72 encounters with nesting females were recorded during 983.2 hours of night patrols between 19 March and 31 May, 2013; 30 leatherbacks, 32 green turtles and five hawksbills.
- 11 Thirty different leatherback females were encountered; 13 were new females and 17 (56.7%) had tags from previous year or other nesting beaches.
- 12 Of the previously tagged leatherback turtles, 23.5% were originally tagged in Tortuguero (n = 4); the others were tagged in Caño Palma (n = 2), Moín (n = 6), Mondonguillo (n = 1) and Pacuare (n = 2).
- 13 Only one (8.3%) of the newly tagged leatherback turtles (n = 13) showed evidence of old tag holes or notches when encountered for the first time.
- 14 Most leatherback turtles nested in the open zone (77.2%, n = 27); 11.4% nested in the border zone (n = 4) and 11.4% did not lay eggs (n = 4).
- 15 No significant difference in carapace length (CCL_{min}) or clutch size was found between newly tagged and previously tagged turtles.
- 16 Mean curved carapace length (CCL_{min}) of leatherbacks was 151.8cm (n = 18); with a range of 130.5 – 167.4cm.
- 17 Mean clutch size for leatherbacks was 75.8 yolked and 23.3 yolkless eggs (n = 11).

- 18 Mean carapace length (CCLmin) for green turtles was 103.4cm (newly tagged) and 109.5cm (previously tagged). Mean clutch size for green turtles was 96.2 eggs (newly tagged) and 120 eggs (previously tagged).
- 19 Mean CCLmin for hawksbills was 96.0cm (newly tagged) and 97.9cm (previously tagged). Mean clutch size for hawksbills was 160.3 eggs (previously tagged).
- 20 Precision of the CCLmin measurement during the same encounter was relatively high in 2013; 0.5cm for leatherbacks, 0.4cm for green turtles and 0.3cm for hawksbills.
- 21 The mean precision of CCLmin measurements for leatherback turtles measured twice had a range of 0.7 – 1.3cm. The largest difference between the measurements of the two encounters was 1.6cm.
- 22 A total of 20 leatherback nests were marked for monitoring; 12 at the northern end of the beach and eight at the southern end close to Jalova.
- 23 Overall hatching success for monitored leatherback nests (n = 14) was 47.8% and overall emerging success was 45.5%.
- 24 The incubation period for leatherback nests for which emergence was observed (n = 5) ranged from 59-63 days, with a mean of 61 days.
- 25 Rainfall was heaviest in July (579.2mm), and April was the driest month (181.9mm).
- 26 Mean monthly air temperature during the 2013 Leatherback Program ranged from 19.5°C – 31.0°C.
- 27 Sand temperature in the vegetation zone ranged from 25.1 – 28.9°C and in the border zone it ranged from 24.5 – 33.9°C.
- 28 Visitation at the STC Visitor Center decreased by 566 people in 2013. A total of 24,674 visitors were registered for the year, an average of 68 visitors per day.
- 29 There was a decline in the number of artificial lights visible on the beach; but there are still many lights visible from Tortuguero village and several lodges and cabinas north of the village.

Conclusions

- 1 In 2013, leatherback nesting decreased slightly for another consecutive year, continuing the trend observed since 1995.
- 2 There were very few nests or turtles poached in 2013, in comparison with previous years, but there were no surveys conducted along the four miles of beach between miles 18 – 22, where the majority of poaching has been reported in the past.
- 3 The number of leatherback turtles encountered during nightly patrols (n = 30) was less than half the number encountered in 2012, but there was an increase in the number of new turtles (without tags) encountered.
- 4 Overall hatching and emerging success of leatherback nests was much higher in 2013 than in 2012, and there were very few disturbed nests.

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 STC should initiate night patrols in the section of beach between Jalova and Parismina to conduct a pilot study to investigate whether nest relocation or camouflaging of nests could be appropriate strategies to reduce poaching of critically endangered leatherback nests.
- 4 The marking and monitoring of leatherback nests to determine the survivorship of these nests, the threats they face and hatching and emerging success should be continued in future programs.
- 5 It is important to continue to collect physical data as a base line for environmental parameters at Tortuguero
- 6 STC should work together with the Costa Rica Energy Institute (ICE) to reduce artificial lighting on the beach, especially the public street lights that are the most problematic.
- 7 A full time Outreach and Education Coordinator should be contracted during future Leatherback Programs, to implement the education program and act as a liaison between STC, the National Park and the local community.

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 in 1997 and updated the protocol in 1998. The 2013 Leatherback Program represents the nineteenth consecutive leatherback program and the sixteenth year of implementing the new monitoring protocol.

The objectives of this report are to summarize the results of the 2013 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

There follows a detailed description of the monitoring protocol used during the 2013 Leatherback Program; this protocol was submitted as part of the research permit application to ACTo – MINAE on 12 December, 2012.

The permit application also included the protocol to conduct a pilot study to compare different treatment options for leatherback nests laid on the section of beach between Jalova and Parismina. High levels of nest poaching have been recorded on this stretch of beach in previous years and so the aim of the study was to see which treatment (relocation, camouflage or in situ) would be most useful to reduce the number of poached nests. Unfortunately, for internal reasons within ACTo regarding the jurisdiction of this section of beach, the 2013 research permit did not include any activities within these four miles of beach, either the pilot study or track surveys.

2.1 Preparations

Prior to the start of the 2013 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 2013 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 18 miles (29km) of beach between the Tortuguero and Jalova lagoon 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, every 4/8 mile between mile 5 and mile 15, then every 1/8 mile between miles 15 – 18 (Jalova lagoon). 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 river mouth and the Jalova lagoon, every three days during the 2013 Leatherback Program, following the completion of the RA orientation and training period. The beach was divided into three sections: Tortuguero river mouth - STC station (mile 2 5/8); STC station - Juana López trail (mile 15) and Juana López trail - Jalova lagoon (mile 18).

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 registered 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 15 (led by GVI staff).

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. Two people were required to take the measurements. 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 affect 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 15 – 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 pertinent observations about the nest contents were also noted.

2.6 Physical Data Collection

Throughout the 2013 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 2013 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 2013.

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.

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 2013 Leatherback Program. The additional personnel allowed for the continuation of extra monitoring patrols in the section of beach close to Jalova lagoon.

The FRC arrived in Tortuguero on 15 March to prepare for the 2013 Leatherback Program. Training and orientation sessions were conducted from 18-31 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. 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 2013 Leatherback Program; STC staff and RAs were assisted in this task by GVI staff and volunteers who painted the mile markers between miles 10 – 18.

3.2 Track Surveys

3.2.1 Weekly track surveys

A total of 26 weekly track surveys were conducted between 5 January and 29 June 2013, during which 32 leatherback nests and 15 false crawls were recorded by the track surveyor. The first leatherback nest was reported on 2 March, and the last nests were observed on 22 June. 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. Peak nesting occurred on 7 April when seven leatherback nests were recorded from the previous night. Using the methodology described in Troëng *et al.* (2004), extrapolation from the weekly track surveys suggests that 204 leatherback nests were laid between the Tortuguero river mouth and the Jalova lagoon during the 2013 nesting season.

The leatherback nesting trend at Tortuguero since 1995 can be seen in Figure 2. It is clear that in 2013 there was another slight decrease in the number of nests laid; since 1995, leatherback nesting has shown a decline of 85.3%. Using the estimations calculated from the weekly track survey data, in the last five years there has been an average of 223 leatherback nests laid each season.

3.2.2 Three-day track surveys

The FRC and RAs conducted 23 track surveys of the 18 miles of nesting beach from the Tortuguero river mouth to the Jalova lagoon between 24 March and 29 May, 2013. They recorded 191 leatherback, 213 green turtle and 19 hawksbill nests; in addition 86 leatherback, 175 green turtle and 10 hawksbill false crawls were also counted.

The temporal distribution of leatherback nesting (as determined from the from the 3-day surveys) was similar to that observed in previous years, with a peak in nesting observed in April (See Figure 3). The high level of nesting registered on 24 March was due to the fact that during this first survey all tracks were counted, since the beginning of the season. Peak nesting was seen on 14 April, when 24 nests were laid during the three previous nights. It is interesting to compare Figures 1 and 3, which show temporal distribution from the weekly and 3-day track surveys; the pattern of nesting is very similar in the two figures, with a very clear peak in leatherback nesting occurring in the middle of April.

The spatial distribution of leatherback nesting during the 2013 Leatherback Program is shown in Figure 4; it was different to that observed in previous years, with two peaks at the extremes of the beach, in miles 1 and 17. But, as in previous years, the majority of nesting was recorded in the southern half of the beach (beyond mile 9).

Figure 1. Temporal distribution of leatherback nesting activity during 2013, as determined during weekly track surveys

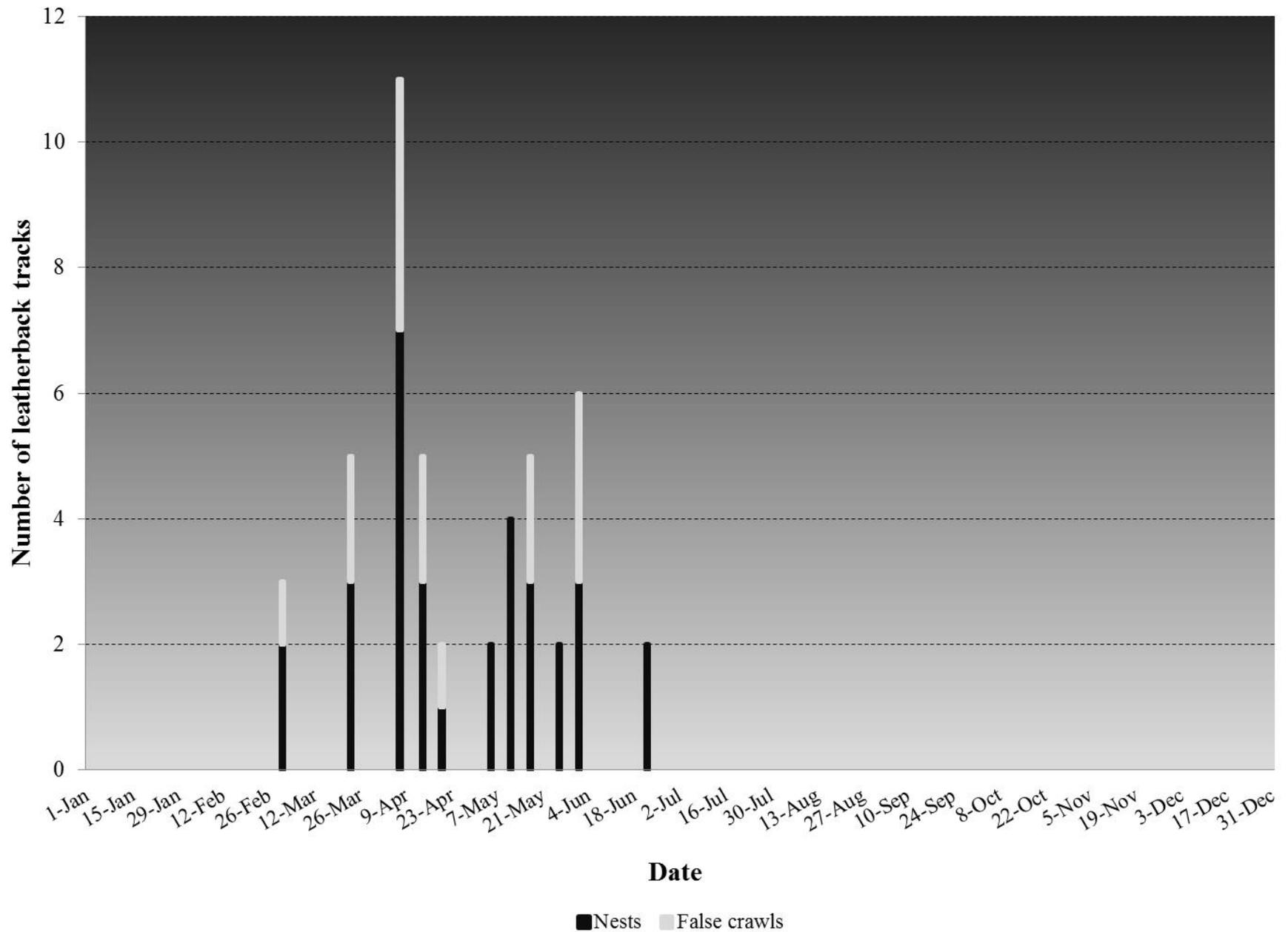


Figure 2. Leatherback nesting trend 1995 – 2013, determined from weekly track surveys

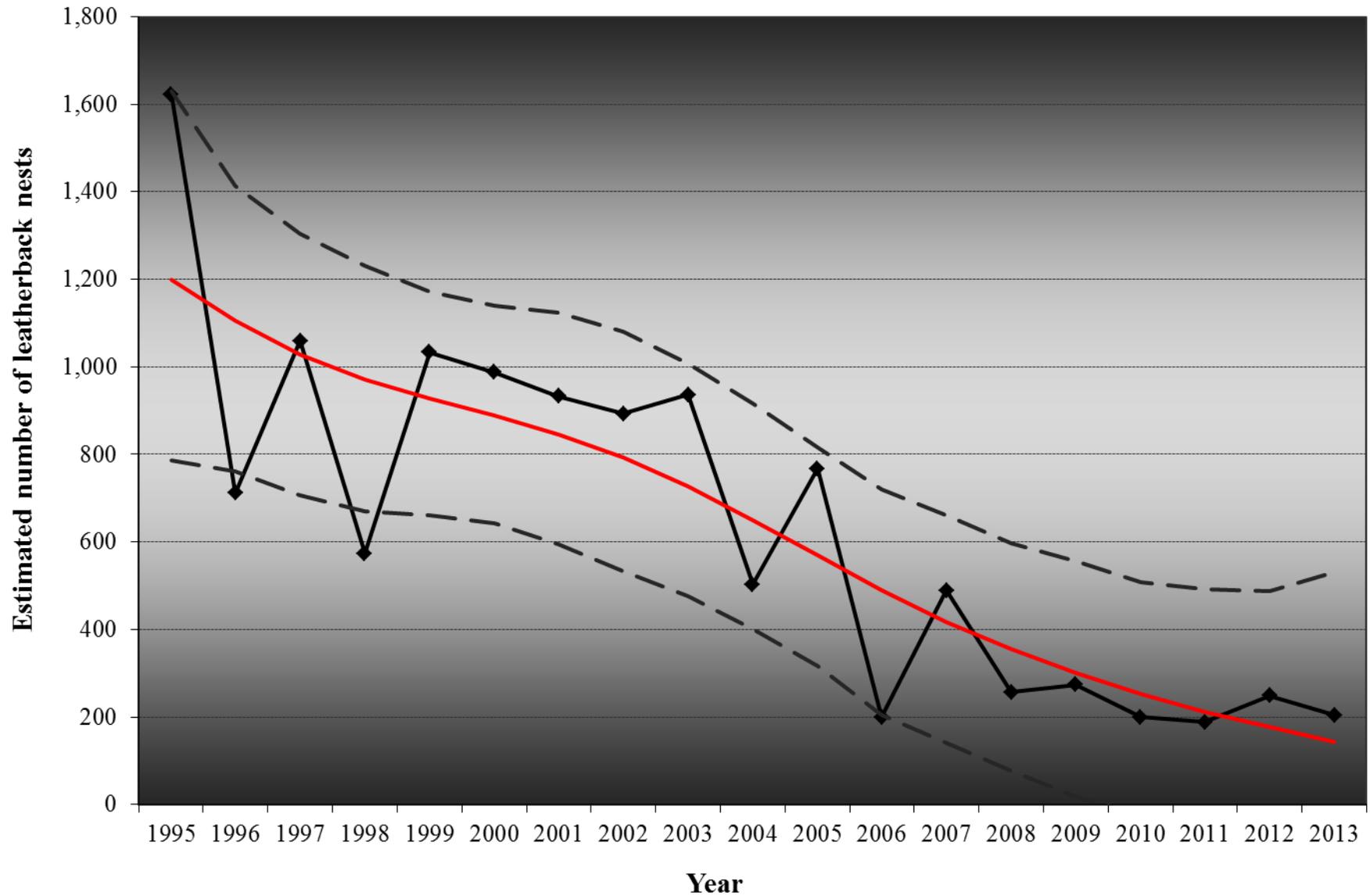


Figure 3. Temporal distribution of leatherback nests in 2013, as determined by three-day track surveys

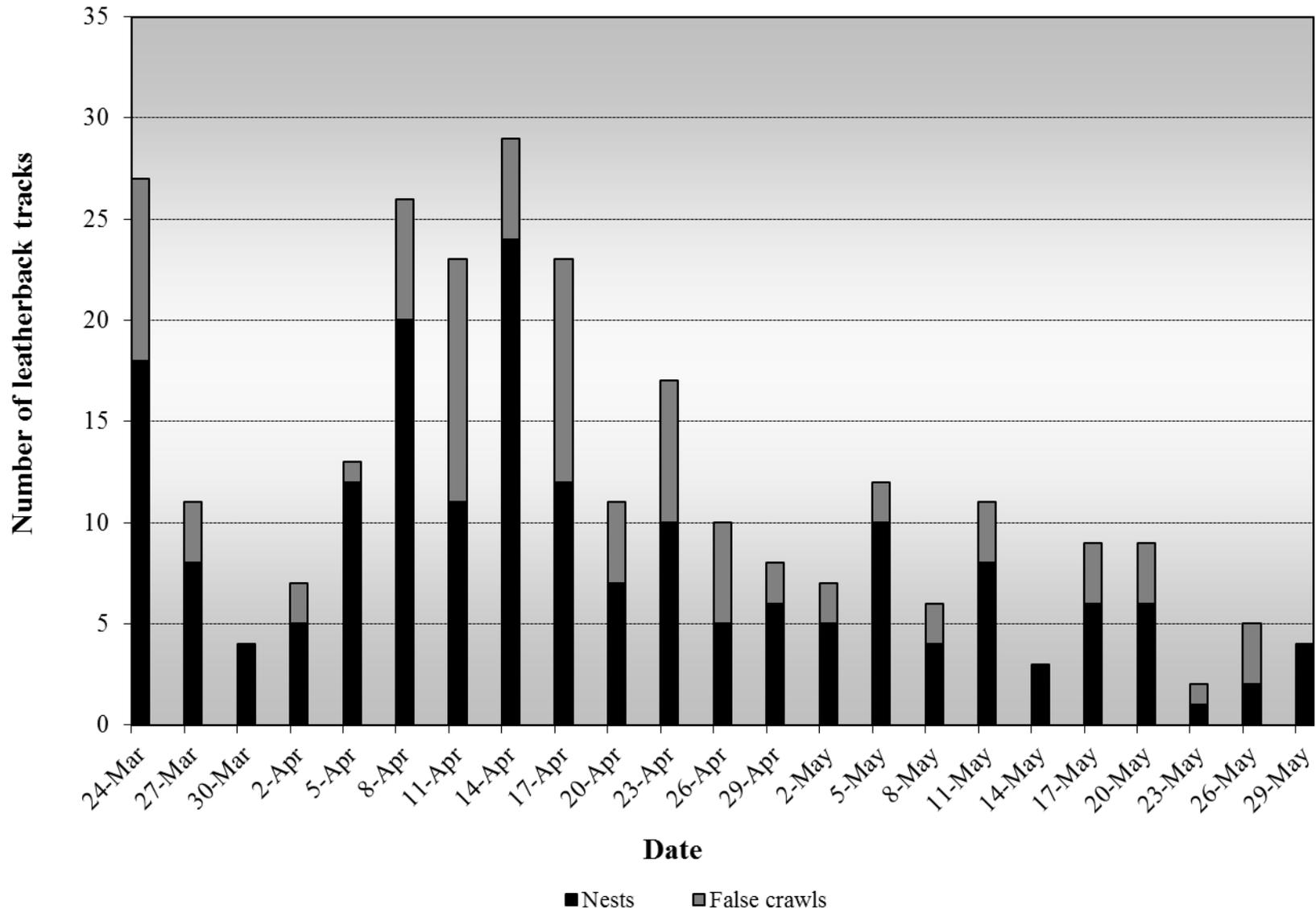
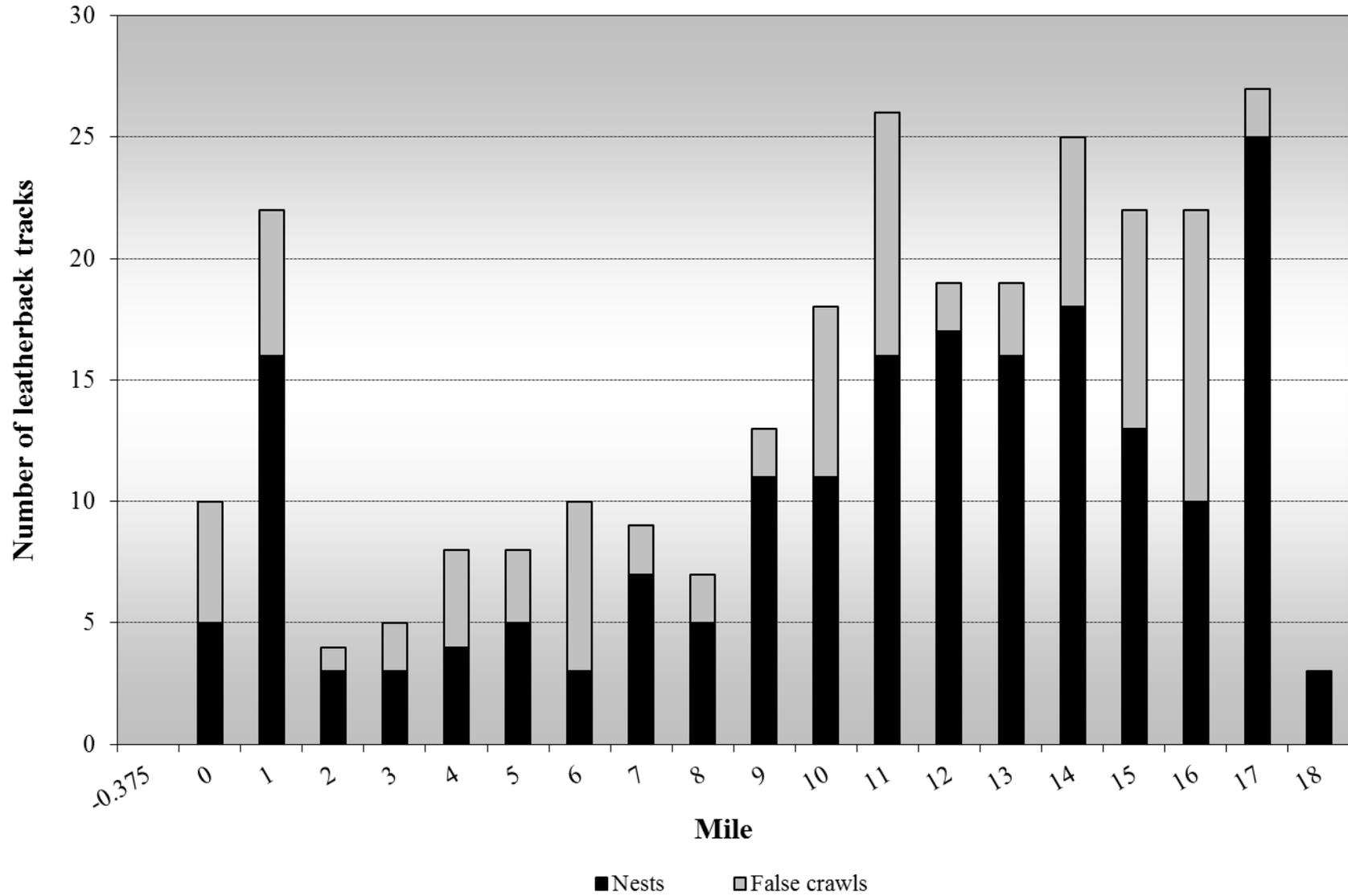


Figure 4. Spatial distribution of leatherback nesting in 2013; as determined by three-day track surveys



3.2.3 Illegal Take of Turtles and Nests

During the 2013 Leatherback Program seven nests were reported as poached; two leatherback and five green turtle nests (See Table 1). All the nests were taken within Tortuguero National Park (TNP). No hawksbill nests were poached. Only one turtle was registered as taken during the track survey conducted from March – May 2013; on 23 April two RAs found evidence that a hawksbill had been taken at mile 3 3/8.

Table 1. Incidence of poaching during the 2013 Leatherback Program

Date	Leatherback		Green Turtle	
	# nests	Mile	# nests	Mile
11 Apr	1	17 6/8	0	0
29 Apr	1	10	3	8 4/8
				9 4/8
				12 4/8
5 May	0	0	1	4 7/8
14 May	0	0	1	6
Total	2		5	

3.2.4 Dead Turtles

In addition to the turtle taken on 23 April, a total of 48 turtles were killed by jaguars during the 2013 Leatherback Program; 46 green turtles, one leatherback and one hawksbill (See Table 2). All jaguar predation occurred within TNP, between miles 4 5/8 and 17 2/8. Once again there was a report of a leatherback killed by jaguars, a phenomenon that has increased in recent years.

Table 2. Turtles killed by jaguars during the 2013 Leatherback Program

Date	Species	Mile	Comments
09 Feb	13	Cm	No tags
24 Mar	7 4/8	Cm	No tags
	8	Cm	No tags
	13 4/8	Dc	No tags
27 Mar	9 4/8	Cm	No tags
	11	Cm	Carcass of turtle not found
	13	Cm	No tags
	13 4/8	Cm	Carcass of turtle not found
30 Mar	11	Cm	No tags
02 Apr	11 4/8	Cm	Tags #104072 / 104129 – Tortuguero
05 Apr	8	Cm	No tags

Table 2. Continued

Date	Species	Mile	Comments
07 Apr	7 4/8	Cm	No tags
	11 4/8	Cm	No tags
	11 4/8	Cm	No tags
08 Apr	10	Cm	No tags
	10 4/8	Cm	No tags
11 Apr	7	Cm	No tags
	9	Cm	No tags
	17 2/8	Cm	No tags
15 Apr	7 4/8	Cm	No tags
	9 4/8	Cm	No tags
	9 4/8	Cm	No tags
17 Apr	9	Cm	Tags #CP1726 / CP1728 – Caño Palma
20 Apr	16 4/8	Cm	Tags #127032 / 127033 – Tortuguero
	12 4/8	Cm	No tags
	5 4/8	Cm	No tags
	7 4/8	Cm	No tags
23 Apr	13 4/8	Cm	No tags
26 Apr	13	Cm	No tags
29 Apr	10	Cm	No tags
02 May	8 4/8	Cm	No tags
	9	Cm	No tags
05 May	4 5/8	Cm	No tags
14 May	16 3/8	Cm	No tags
17 May	9 4/8	Cm	No tags
	12	Cm	No tags
20 May	14 4/8	Cm	No tags
23 May	6	Cm	Tags # 128010 / 128009 – Tortuguero
	7	Cm	Tag #128040 – Tortuguero
	10	Cm	No tags
	12	Cm	No tags
	8	Ei	No tags
26 May	8 4/8	Cm	No tags
	9 4/8	Cm	No tags
29 May	8	Cm	No tags
	11	Cm	No tags
	13 4/8	Cm	No tags
	13 4/8	Cm	No tags

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

3.3 Tagging of Nesting Sea Turtles

Tags used during the 2013 Leatherback Program were National Band & Tag Company Monel #49 tags VC1828-VC1830, VC1923-VC1927, VC4346-VC4373, VC4383-VC4391, and Inconel #681 tags 127026-127052, 128001-128047.

Nightly patrols were conducted between 19 March – 31 May 2012 (with the exception of 21, 23 and 24 March); up to five patrols were conducted per night in the different sections of beach. A total of 983.2 team patrol hours were logged; 234.8 were patrols conducted by GVI between mile 15 and the Jalova lagoon. During these patrols a total of 72 turtle encounters were recorded; 35 leatherbacks, 32 green turtles and five hawksbills (See Appendix 1). This is equal to an average of 0.04 leatherback, 0.03 green and 0.005 hawksbill turtles encountered per patrol hour.

The turtles encountered correspond to 30 individual female leatherbacks, 27 green turtles and four hawksbills. Although the majority (5% of leatherback females were already tagged when first encountered ($n = 17$), there were 13 individuals newly tagged during the 2013 season, which is a similar percentage to recent years (See Appendix 1).

Of the 17 previously tagged leatherback turtles encountered in 2013, only 23.5% had originally been tagged in Tortuguero ($n = 4$). The remainder were tagged by researchers at Caño Palma (north of the river mouth in Tortuguero; $n = 2$) and other nesting beaches on the southern Caribbean coast of Costa Rica, including Pacuare ($n = 2$), Mondonguillo ($n = 1$) and Moín ($n = 6$). There were two leatherbacks that the SD is trying to determine where they were tagged; she has consulted other turtle conservation projects on the Caribbean coast to get more information. Of the turtles tagged in Tortuguero, one was originally tagged 10 years ago in 2003. Two green turtles and one hawksbill were encountered with tags; all three were originally tagged in Tortuguero.

Evidence of holes or notches were found on only one (8.3%) of the newly tagged leatherback turtles checked for previous tagging ($n = 12$) when they were encountered for the first time during the 2013 Leatherback Program. The majority of leatherbacks nested in the open beach zone (77.2%, $n = 27$); 11.4% nested in the border zone ($n = 4$) and 11.4% did not lay eggs ($n = 4$).

3.4. Biometric Data Collection

Table 3 summarizes the biometric data collected from leatherback females. CCLmin measurements were taken for 28 of the 30 individual leatherback turtles encountered. Clutch size was taken for 12 individuals, but one female only laid 10 eggs and so this nest was excluded from the analysis. No turtles had their caudal projection classified as incomplete, so measurements from all turtles were analyzed together. Two analyses were conducted to see if there was a difference in either CCLmin or clutch size between newly tagged and previously tagged turtles. The results indicated that there was no significant difference between the two groups (CCLmin – Mann-Whitney test: $U = 71.0$, $p = 0.103$; Clutch size – Mann-Whitney test: $U = 9.0$, $p = 0.194$); therefore all the turtles were analyzed together. To ensure the independency of the data only one measurement or clutch count was used for each female. Mean CCLmin was 151.8cm and mean clutch size was 75.8 eggs (yolked) and 23.3 eggs (yolkless).

Table 3. Mean carapace length and clutch size of leatherback turtles encountered in 2013

CCLmin / cm			Clutch size / # of eggs				
n	$\bar{x} \pm \text{S.D.}$	Range	n	\bar{x} yolked $\pm \text{S.D.}$	Range	\bar{x} yolckless $\pm \text{S.D.}$	Range
28	151.8 \pm 8.8	130.5 – 167.4	11	75.8 \pm 17.0	49 - 98	23.3 \pm 13.2	10 – 54

Table 4 summarizes the biometric data collected for other species encountered during the 2013 Leatherback Program; separated for newly tagged and previously tagged individuals. Mean carapace length (CCLmin) was calculated for 26 newly tagged green turtles (103.4cm) and one female with tags (109.5cm). Six newly tagged green turtle clutches were counted and the average size was 96.2 eggs; the female with tags laid 120 eggs. The newly tagged hawksbill had a CCLmin of 96.0cm and the mean CCLmin of the three females with tags was 87.9cm. Three hawksbill clutches were counted, with a mean of 160.3 eggs.

Table 4. Mean carapace length and clutch size of green and hawksbill turtles

Species	Category	Carapace length / cm			Clutch size / # of eggs		
		n	$\bar{x} \pm \text{S.D.}$	Range	n	$\bar{x} \pm \text{S.D.}$	Range
Green	New	26	103.4 \pm 4.1	94.6 – 113.3	6	96.2 \pm 16.9	80 – 121
	With tags	1	109.5	-	1	120	-
Hawksbill	New	1	96.0	-	-	-	-
	With tags	3	87.9 \pm 1.3	86.8 – 89.3	3	160.3 \pm 21.2	136 – 175

The precision of the CCLmin measurements taken during 2013 was relatively high, and was very similar for all species encountered during the Leatherback Program; between 0.3 – 0.5cm (See Table 5).

Table 5. Precision of carapace measurements for the different species of turtle

Species	n	\bar{x} precision for CCLmin (cm) \pm S.D.	Range / cm
Leatherback	30	0.5 \pm 0.3	0.0 – 1.2
Green	32	0.4 \pm 0.3	0.0 – 1.0
Hawksbill	5	0.3 \pm 0.3	0.0 – 0.7

The precision of the CCLmin carapace measurements for turtles measured during more than one encounter is shown in Table 6. For the two leatherbacks measured twice, the precision was 0.7cm; for the five green turtles the precision was 1.1cm and for the one hawksbill it was 1.3cm. The biggest difference in measurements was 1.6cm (green turtle).

Table 6. Precision of carapace measurements for turtles encountered more than once during the 2013 Leatherback Program

Species	No. of encounters	n	\bar{x} precision for CCLmin (cm) \pm SD	Range / cm
Leatherback	2	2	0.7	0.4
Green turtle	2	5	1.1 \pm 0.3	0.8 – 1.6
Hawksbill	2	1	1.3	-

3.5 Determination of Nest Survivorship and Hatching Success

A total of 20 leatherback nests were marked between 25 March and 18 May, 2013; 12 in Tortuguero and eight in Jalova. Twelve green turtle and three hawksbill nests were also marked; these will be included in the analysis of nest survivorship and hatching success in the 2013 Green Turtle Program Report.

Of the 20 marked nests, six (30.0%) had to be removed from the analysis of survivorship and hatching success because they were not found at excavation; of these four were probably eroded. This left a total of 14 nests included in the subsequent analyses. The fate, hatching and emerging successes of 20 marked and monitored leatherback nests are shown in Table 7. Data from the nest excavations are summarized in Table 8; data are combined from both northern and southern ends of the beach.

Table 7. Fate, hatching and emerging success of marked leatherback nests

Fate	Tort	Jal	Total	% of nests	% Hatching success	% Emerging success
Undisturbed	6	4	10	71.4	66.9	63.7
Unhatched	1	0	1	7.2	0.0	0.0
Eroded	0	3	3	21.4	0.0	0.0
Total	7	7	14	100	47.8	45.5

Not included in analysis	Tort	Jal	Total
<i>Unknown – Possibly eroded</i>	4	0	4
<i>Unknown – Not found</i>	1	1	2
Total	5	1	6

Overall mean hatching success of leatherback nests was calculated at 47.8% and emerging success was 45.5%. These values were the mean of the 14 nests that were marked and the fate of the nest was determined (See Table 7). Obviously nests that were eroded had 0.0% hatching and emerging success as all eggs were lost; if these nests are eliminated from the calculations, undisturbed nests had a high hatching and emerging success; 66.9% and 63.7%, respectively, which is at the upper limit of the range normally observed for this species.

Table 8. Summary of data from nest excavations of marked leatherback nests during the 2013 Leatherback Program

Fate	n	Hatchlings		Empty shells	Pipped	Unhatched eggs			Predated eggs	Yolkless eggs	Total number of eggs
		Live	Dead			No embryo	Embryo	Full embryo			
Undisturbed	10	11	11	418	8	96	38	1	53	250	625
Unhatched	1	0	0	0	0	190	0	0	0	3	90
Total	11	11	11	418	8	186	38	1	53	253	715

Total = Total number of eggs (excluding yolkless eggs)

From Table 5 it can be seen that no nests were poached or depredated. The biggest problem was erosion of nests; seven nests in total (if the four that were probably eroded are included) were lost to high tides, at both extremes of the beach.

The incubation period for undisturbed leatherback nests for which emerging was observed (n = 5) varied between 59 - 63 days, with a mean of 61 days

The distance from the sand surface to the top egg for undisturbed and unhatched nests at excavation varied between 53 - 82 cm with a mean of 65.5cm (n = 11). The distance from the sand surface to the bottom of the egg chamber for the same nests varied from 70 - 101 cm, with a mean of 82.7cm.

Only one deformed embryo was recorded, corresponding to 0.14% of eggs encountered during nest excavations.

3.6. Physical Data Collection

Table 9 summarizes data collected for air temperature and rainfall from March – July; information for June and July are include as there were still leatherback nests incubating during those months.

Table 9. Air temperature and rainfall recorded from March – July 2013

Month	Average temperature / °C	Range of temperature / °C	Total rainfall mm / month	\bar{x} rainfall mm / 24hrs
March ¹	25.5	19.5 – 30.0	214.8	6.9
April ²	27.0	23.5 – 31.0	181.9	6.1
May ³	26.5	24.0 – 31.0	216.9	7.0
June ⁴	26.7	23.5 – 31.0	286.4	9.5
July ⁵	26.4	24.0 – 29.5	579.2	18.7

¹Information until 29 March; ²Information for 48 hours 2-3 and 5-6 April and until 23 April; ³Information for 48 hours 12-13 May and for 168 hours 24-30 May; ⁴Information for 48 hours 2-3 June and until 26 June;

⁵Information from 4 July and for 48 hours 5-6, 14-15, 21-22 and 25-26 July and until 26 July

Air temperature was very stable from May – July, when the monthly mean varied by just 0.3°C; March was the coolest month and April the warmest. Rainfall between March and July was very variable; ranging between 181.9mm (April) and 579.2mm (July). Daily rainfall, for a 24 hour period, ranged from 6.1mm in April to 18.7mm in July (See Table 9).

Table 10 shows mean monthly sand temperature from March – July 2013. Unfortunately there were no data loggers at any depth in the open zone or at 70cm in the vegetation zone during this time period. Data for June and July are included as there were still leatherback nests incubating during these months. For all months, and at all depths, the temperature in the vegetation zone was less than that in the border zone. In both zones, mean sand temperature did not drop below 26.5°C, and did not rise above 31.0°C. The temperature range in the vegetation zone was 25.1 – 28.9°C and in the border zone it was 24.5 – 33.9°C. Minimum sand temperature observed was 25.1°C (in the vegetation zone at 30cm); maximum temperature was 33.9°C (in the border zone at 30cm).

Table 10. Mean monthly sand temperature, March – July, 2013

Zone	Vegetation			Border			Open		
	\bar{x} temperature / °C			\bar{x} temperature / °C			\bar{x} temperature / °C		
Depth/ cm	30	50	70	30	50	70	30	50	70
March ¹	26.6	26.6	N/A	31.0	30.3	29.8	N/A	N/A	N/A
April	27.3	27.3	N/A	30.8	30.6	30.4	N/A	N/A	N/A
May	27.3	27.4	N/A	30.5	30.5	30.4	N/A	N/A	N/A
June	27.2	27.3	N/A	30.0	30.1	30.1	N/A	N/A	N/A
July	26.5	26.8	N/A	29.0	29.2	29.3	N/A	N/A	N/A
Minimum	25.1	25.6	N/A	24.5	26.5	27.0	N/A	N/A	N/A
Maximum	28.9	28.5	N/A	33.9	32.6	31.8	N/A	N/A	N/A
Mean	27.0	27.1	N/A	30.2	30.1	30.0	N/A	N/A	N/A

N/A = No data logger at that depth for that month; ¹From 16 March

3.7 Collection of Human Impact Data

3.7.1 Visitors to Tortuguero

The number of visitors registered at the STC Visitor Center decreased in 2013 to 24,674 visitors (See Table 11); 566 fewer visitors than in 2012.

Table 11. Visitors to the STC Visitor Center, January 2011 - December 2013

Month	2011		2012		2013	
	Total	\bar{x} / day	Total	\bar{x} / day	Total	\bar{x} / day
January	3,347	108	3,697	119	3,223	104
February	4,081	146	4,304	148	4,194	150
March	4,398	142	4,616	149	4,536	146
April	1,810	60	2,129	71	2,020	67
May	936	30	833	27	742	24
June	1,126	38	1,190	40	1,127	38
July	1,450	47	1,818	59	1,867	60
August	1,116	36	1,304	42	1,213	39
September	443	15	550	18	819	27
October	848	27	665	21	849	27
November	1,791	60	1,892	63	1,937	65
December	2,183	70	2,242	72	2,147	69
Total	23,529	64	25,240	69	24,674	68

Mean daily visitation at the center was 68 visitors, ranging from 24 (May) to 150 (February). The pattern of visitation was similar to that observed previously, with more visitors from January –

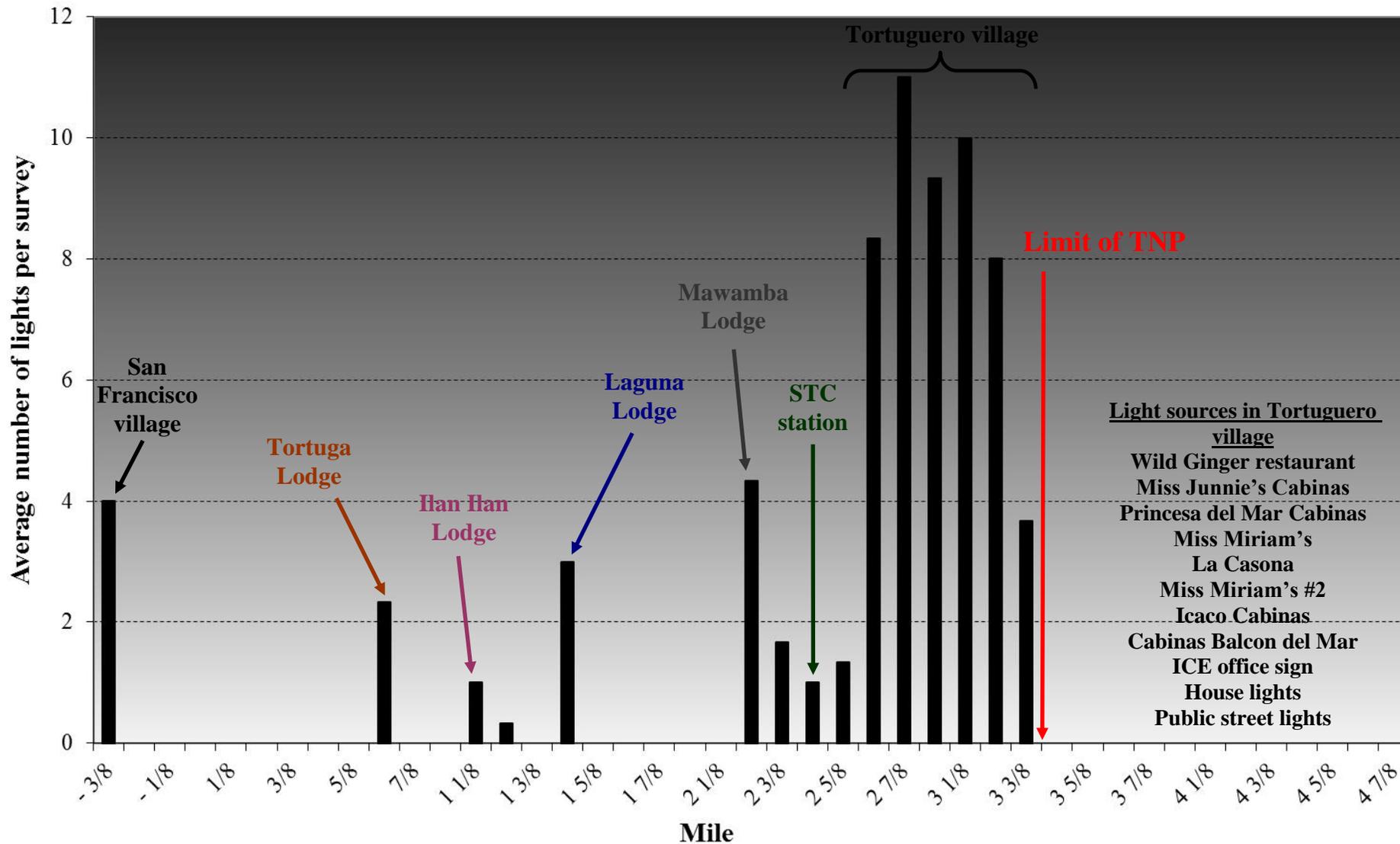
March, with a significant decline beginning in April. A slight increase was observed in July; coinciding with an increase in turtle nesting, which is the major attraction for tourists to the area. There was a dramatic decrease in September and October, when there were only 27 visitors per day (See Table 11).

3.7.2 Artificial lights

Light surveys were conducted in April and May during the 2013 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.

The average number of lights counted on each survey was 104 (range = 97 – 111). There was a decline in the number of visible lights, when compared to the same period in 2012. During each survey a mean of 72.5% of the lights were observed between miles 2 6/8 – 3 3/8; which corresponds to the section of beach in front of Tortuguero village. The limit of TNP is at mile 3 3/8; there were no lights observed within TNP (See Figure 5).

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



4. Discussion

4.1 Preparations

In 2013, 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 18 miles of nesting beach.

The two-week training and orientation program has become a compulsory component for the start of each Program to ensure that the RAs and GVI staff are sufficiently prepared to conduct all of the different activities of the protocol. They all received theoretical and practical session about the monitoring protocol, in addition to informative talks about TNP, and an introduction to the history and development of Tortuguero over the years.

4.2 Track Surveys

As in previous years leatherback nesting was observed during weekly track surveys from the beginning of March to June; however, one leatherback was encountered by RAs during a night patrol in July. There was a peak in nesting observed in April (See Figure 1); this is a typical nesting for this species in the Caribbean. But, it is interesting to compare the results of the weekly track surveys to those conducted every three days by the FRC and RAs; temporal distribution appeared to be a little different (see Figures 1 and 3). The three-day surveys provide a more complete data set showing the nesting level during the entire season.

The data from the track surveys in 2013 showed the continued negative trend for leatherback nesting (see Figure 2); in 2013 only 204 leatherback nests were estimated to have been laid, and this is similar to the number of nests counted during the three-day surveys ($n = 191$). This represents a decline of more than 85% in leatherback nesting since the Leatherback Program began in 1995, which is very worrying. However, it is important to remember that leatherback females use more than one nesting beach, so a regional evaluation of all the nesting beaches in Costa Rica, and including the Caribbean coast of Panama, can provide more information about the status of the leatherback nesting population overall. One suggestion would be to conduct aerial surveys of the entire coast to have a sample of nesting at each site; this type of survey was conducted in 2003 and 2004, therefore it would be possible to compare data from 10 years ago, to see if there has been a decline in the number of nests, or a change in their spatial distribution.

It was unfortunate that MINAE turned down the application to conduct a pilot study in the four miles of beach south of the Jalova lagoon, to see the impact of different management strategies for leatherback nests (relocation, camouflage and *in situ*), because results from monitoring conducted in previous years demonstrated that this stretch of beach had more nesting than other parts of the beach, but also, unfortunately, more poaching. Hopefully the internal discussion within ACTo will be resolved quickly so that this study can be realized in the future. A very basic study could be implemented that might increase the survivorship of nests laid in this section of the beach, but it is necessary to conduct the comparative study to determine which method would be most effective.

The spatial distribution of leatherback nests in 2013 was not the typical pattern observed in previous years. There was a 'peak' in nesting at the northern end of the beach (in mile 1) and another larger one at mile 17 (See Figure 4). As in other seasons, the majority of leatherback

nesting was in the southern part of the beach; there was an obvious increase in the number of nests per mile after mile 9.

The level of illegal poaching of turtle nests during the 2013 Leatherback Program was low; there were more nests poached than in 2012 (seven in total, of which only two were leatherback nests), but the problem of poaching (less than 1% of all nests) is still not comparable to that observed at other beach on the Caribbean coast, where a very high percentage of nests are taken by people. Also, only one green turtle was taken; this was the second consecutive season when there was only one report of a turtle being taken, which is encouraging to see.

For another year there were reports of leatherbacks killed by jaguars, and an increase in the number of green turtles killed; 48 dead turtles were reported, of which 46 were green turtles. Obviously the jaguar population in TNP is very healthy, and those individuals are now accustomed to killing and eating marine turtles. What is a little worrying is this relatively new behavior of killing leatherbacks; in previous seasons only green turtles or hawksbills were killed. This may be something to discuss with jaguar experts, to see if there is anything that can be done, considering that jaguars are also an endangered species.

4.3 Tagging of Nesting Sea Turtles

For financial reasons the 2013 Leatherback Program began a couple of weeks later than normal, in the middle of March. However, nesting levels during the first two weeks of the month were very low (See Figure 1), and so very few data were lost as a result of starting monitoring activities a little later. Furthermore, the period of tagging patrols from March to the end of May coincides with the period of heaviest leatherback nesting (See Figures 1 and 3) and it is suggested that night patrols be conducted during the same period in future years.

There was a dramatic decrease in the number of encounters recorded during night patrols in 2013 when compared with 2012; 72 and 98 encounters, respectively. Of these, only 30 were with leatherbacks; there was a lot of green turtle nesting during the first few months of the year in 2013, suggesting that the nesting season for this species had commenced earlier than typically seen in Tortuguero.

The proportion of new leatherback turtles (individuals that did not have tags when first encountered) observed during the 2013 season was much higher than that seen in 2012; 43.7% in comparison to ~30% of all individuals, respectively. It is encouraging to see an increase in the number of 'new' females, since they represent the future survival of the population. 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.

As in previous years, the majority of females seen in 2013 had tags when first encountered; from Tortuguero and other nesting beaches in the region. There were more records of turtles with tags from Moín; this beach is close to Limón and has a very high level of poaching of nests, and so a turtle conservation and monitoring program was initiated a few years ago at this site. These recaptures are very important, as they demonstrate to the Costa Rican authorities the importance of protecting all of the beaches along the coast, including those outside of designated protected areas, such as Moín, as they reveal that these animals are using many different locations.

It is always very encouraging to encounter females with tags from other nesting beaches, or from

previous seasons at Tortuguero, as it indicates that these individuals have managed to survive despite the numerous threats that they face while they migrate between nesting and foraging sites during the two/three period between nesting seasons.

4.4 Biometric Data Collection

No leatherback turtle had a caudal projection recorded as ‘incomplete’ and there was no difference in CCLmin or clutch size between newly tagged or previously tagged turtles, and so data for all females were analyzed together. Mean carapace length of leatherbacks (151.8cm) was similar to that calculated for this species in other seasons, and the range of measurements was also very typical, between 130.4cm – 167.4cm. This suggests that there is a mix of young and old turtles within the Tortuguero nesting population; a healthy nesting population should consist of individuals of different ages.

The precision of carapace measurements taken during the same encounter was high, and only varied by 0.2cm between the three species (0.3cm – hawksbills; 0.4cm – green turtle and 0.5cm – leatherback). For turtles that were observed on more than one occasion throughout the nesting season the precision was a little better than in other years. The difference between measurements for the same individual observed twice ranged from 0.7 – 1.6cm. There was a lot of emphasis during the RA training sessions on which were the correct points of reference to use when taken carapace measurements, to ensure less observer variability. Also, the Eco-Volunteer training was improved and everyone needed to complete an intensive practical session before measuring a turtle in the beach. These improvements were reflected in the high precision of measurements taken during the 2013 Leatherback Program.

4.5 Determination of Nest Survivorship and Hatching Success

In 2013 it was again 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. However, even with the additional night patrols close to Jalova it was only possible to mark 20 leatherback nests during the 2013 Leatherback Program; 12 in Tortuguero and eight in Jalova. Additionally, 15 green turtle and hawksbill nests were marked.

It was quite frustrating that six of the 20 nests could not be found during excavation; of these, four were probably eroded by high tides. As in previous years, it is necessary to emphasize to the RAs during the training period the importance of carefully reviewing the location of each marked nest during the daily nest check, until signs of emergence are observed. It was from these surveys that it was determined that the four nests had possibly been eroded, since they had been washed over and inundated by tides on various occasions during the incubation period.

The majority of the marked nests, 71.4%, for those for which the fate was determined, remained undisturbed during the incubation period. Mean hatching and emerging success (47.8% and 45.5%, respectively) for 2013 was much higher than that reported in previous seasons. These values represent the upper limit of the range observed previously for this species at Tortuguero. For the 10 undisturbed nests, hatching and emerging success was very high (66.9% and 63.7%, respectively); this is excellent for a species that typically has very low nesting success.

For another consecutive year, the most serious threat to marked nests in 2013 was erosion or

possible erosion by high tides; three nests were eroded in Jalova and the four not found during excavation were possibly also eroded. Of the eroded nests only one was laid close to the high tide line; the rest were laid at least 10m above the high tide line. Of the four that were probably eroded, one was close to the high tide line, but the rest were laid higher up the beach, away from the high tide line, so unfortunately, it is not possible to use the distance from the high tide line as a reliable indicator of the risk of inundation or erosion.

It is very important to continue the study of nest survivorship and hatching success as part of future Leatherback Programs. It is not enough to simply know how many nests are laid on the beach, it is also critical to have an idea about how many survive and how successful they are.

4.6 Physical Data Collection

In the last seven years there has been considerable variation in the pattern of rainfall observed at Tortuguero during the months of the Leatherback Program, with different months reported as the wettest month. Data on air temperature and rainfall were collected between March – July; covering the period of incubation of leatherback nests in 2013. July was the wettest month, with a total of 579.2mm of rainfall recorded, a daily mean of 18.7mm; this was more than double the amount of rain recorded for any other month. For another consecutive year, April was the driest month, with just 181.9mm of rain the entire month. This was reflected in a high air temperature during this month also. From May to July air temperature was very stable; it was strange that there did not appear to be an clear impact on temperature resulting from the high levels of rainfall observed in July.

There were days during the incubation period of leatherback nests when the sand temperature passed the maximum limit permitting embryo development; the maximum sand temperature recorded was 33.9°C. Unfortunately, these high temperatures were recorded in various months at the start of the season, therefore if eggs were developing at these depths it is likely that the embryos would not have survived. The climate in July (the wettest month) also affected sand temperatures; in both zones (vegetation and border) and at all depths, mean temperatures in July fell, in comparison with temperatures in June; the decline was between 0.6 – 1.0°C. These types of change can impact embryo development and possibly the proportion of males and females produced. For this reason, it is important to continue to collect physical data in future programs.

4.7 Collection of Human Impact Data

Visitation to the STC Visitors Center declined slightly in 2013; approximately 500 fewer people entered the center (See Table 11). Even with the changes to the exhibits and client service, there were many tourists who came to Tortuguero without knowing about the center. There are still some tour guides that use the information available outside the Visitor Center to teach their groups about sea turtles and their threats, but do not support STC by bringing their guests into the center. Our Education and Outreach Coordinator initiated a series of improvements to enrich the visitor experience, such as new interactive exhibit, but there is still more that can be done to take advantage of this contact with visitors, to teach them about sea turtles, the work of the STC and what each one of them can do to help conserve natural resources.

Unfortunately, the problem of artificial lights visible on the beach, continued in 2013; particularly in the sector in front of Tortuguero village. Public lights remain the most visible, due to the fact that they are the tallest and the brightest lights; however, the problem associated with the cutting of vegetation in front of many buildings meant that many lights from the village were

visible. This is a situation that STC has tried to address, by replanting trees in this area, but some people removed the new plants just days after they had been planted. STC and the Costa Rican Electricity Institute (ICE) have discussed on various occasions possible solutions to the problem and it is an issue that needs to be resolved in the most appropriate manner, involving TNP staff, as the authority responsible for the protection of natural resources in the area.

5. References

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6. Appendices

Appendix 1. Nightly sea turtle encounters for the 2013 Leatherback Program

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

Appendix 1. Continued

Date	Leatherback				Green				Hawksbill			
	New	REM	REN	Total	New	REM	REN	Total	New	REM	REN	Total
27-Apr	0	0	0	25	0	0	0	16	0	0	0	0
28-Apr	1	0	0	26	0	0	0	16	0	0	0	0
29-Apr	0	0	0	26	1	0	0	17	0	0	0	0
30-Apr	0	0	0	26	0	0	0	17	0	0	0	0
1-May	0	0	0	26	1	0	0	18	0	0	0	0
2-May	0	1	0	27	0	0	0	18	0	0	0	0
3-May	0	2	0	29	0	0	0	18	0	0	0	0
4-May	0	1	0	30	0	0	0	18	0	0	0	0
5-May	0	0	0	30	0	0	0	18	0	0	0	0
6-May	0	0	0	30	0	0	0	18	0	0	0	0
7-May	0	0	0	30	0	0	0	18	0	0	0	0
8-May	0	0	0	30	1	0	0	19	0	0	0	0
9-May	0	0	0	30	1	0	0	20	0	0	0	0
10-May	0	0	0	30	2	0	1	23	0	1	0	1
11-May	0	0	0	30	0	0	0	23	0	0	0	1
12-May	0	0	0	30	0	0	0	23	0	0	0	1
13-May	0	0	0	30	0	0	0	23	0	0	0	1
14-May	0	1	0	31	0	0	0	23	0	0	0	1
15-May	0	0	0	31	0	0	0	23	0	1	0	2
16-May	0	0	0	31	0	0	1	24	0	1	0	3
17-May	0	0	0	31	0	0	0	24	0	0	0	3
18-May	0	1	0	32	0	0	0	24	0	0	0	3
19-May	0	0	0	32	0	0	0	24	0	0	0	3
20-May	0	0	0	32	0	0	0	24	0	0	0	3
21-May	0	1	0	33	0	0	0	24	0	0	0	3
22-May	0	0	0	33	0	0	0	24	0	0	0	3
23-May	0	0	1	34	0	0	0	24	1	0	0	4
24-May	0	0	0	34	0	0	0	24	0	0	0	4
25-May	0	0	0	34	1	0	0	25	0	0	0	4
26-May	0	0	0	34	0	0	1	26	0	0	0	4
27-May	0	0	0	34	1	1	0	28	0	0	0	4
28-May	0	0	0	34	0	0	0	28	0	0	0	4
29-May	0	0	0	34	1	0	0	29	0	0	0	4
30-May	0	0	0	34	2	0	0	31	0	0	0	4
31-May	0	1	0	35	1	0	0	32	0	0	1	5
Total	13	17	5	35	26	1	5	32	1	3	1	5
%	37.1	48.6	14.3	100	81.3	3.1	15.6	100	20.0	60.0	20.0	100

Legend

New = Turtles that had no tags on first encounter in 2013

REM = Remigrant; turtles that had tags from previous years/other projects on first encounter in 2013

REN = Renester; turtles that were encountered more than once during 2013