REPORT ON
THE 2005 GREEN TURTLE PROGRAM
AT TORTUGUERO, COSTA RICA

Submitted to
Caribbean Conservation Corporation and
the Ministry of Environment and Energy of Costa Rica.
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by

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The 2005 Green Turtle Program was conducted under a research permit from the Tortuguero Conservation Area of the Ministry of Environment and Energy of Costa Rica, detailed in resolution Nº ACTo-GASP-PIN-003-05.

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EXECUTIVE SUMMARY

Monitoring and Research Activities Conducted

1. During 2005, a total of 50 track surveys were conducted along the entire 18 miles of beach between Tortuguero river mouth and Jalova lagoon.
2. Green turtle nesting was observed between 2 April and 3 December, 2005, with peak nesting recorded on 31 July when 4,071 nests were counted. A total of 16.0% of all green turtle nests recorded during track surveys were deposited between Tortuguero river mouth (mile –3/8) and mile 5, where all night patrols took place.
3. During daily track surveys conducted by research assistants between 20 June and 1 November, a total of 34,076 green turtle nests and 19,545 green turtle half-moons were recorded between the Tortuguero river mouth and the mile 5 marker.
4. The track surveyor recorded the illegal take of 32 nesting green turtles during five surveys in 2005. Green turtle nest poaching was recorded during six track surveys and a total of six green turtle nests were recorded as poached.
5. Jaguars killed a minimum of 24 green and one hawksbill turtles in 2005.
6. Hawksbill nesting density was very low throughout the season, with 0-2 nests/night recorded between May and October.
7. A total of 1,071 green turtles were newly tagged, 615 green turtles with tags from previous years and 508 renesters were recorded during 2,020 team hours of night patrols between 14 June and 30 October.
8. Nine green turtles from other projects were encountered nesting in 2005; four were tagged on the beach in Pacuare Nature Reserve, four were tagged in Parismina, and one was probably tagged in Gandoca, all located in Costa Rica.
9. Overall probability of within-season tag loss from first to last encounter was low at 0.030, and there was considerable variation between taggers and between months.
10. Newly tagged green turtles had evidence of old tag holes or notches in at least one front flipper in 12.6% of cases.
11. Tagging efficiency for night patrols varied from 0%-50%, with a mean of 4.1%, for nights preceding track surveys (n = 130).
12. Green turtles encountered during night patrols nested in the open zone in 29.5% of cases (n = 642), 53.2% (n = 1159) were located in the border zone and 7.0% (n = 153) in the vegetation zone. 10.3% of turtles were encountered during a half-moon (n = 225).
13. Five hawksbill turtles were newly tagged, and one previously tagged hawksbill was encountered during the 2005 Green Turtle Program.
14. Four of the hawksbill nests were laid in the open zone, one nested in the border zone and one hawksbill did not lay.
15. Three leatherback turtles were encountered during the 2005 Green Turtle Program; one was newly tagged and two were previously tagged females.
16. Mean carapace length for newly tagged green turtle females without evidence of previous tagging was 104.8 cm (CCLmin) and 98.7 cm (SCLmax); for newly tagged green turtle females with old tag holes or notches 105.6 cm (CCLmin) and 99.4 cm (SCLmax), and for previously tagged females 106.4 cm (CCLmin) and 100.1 cm (SCLmax). Mean clutch size for the same groups of females was 108 eggs, 109 eggs and 113 eggs, respectively.

17. Measurement precision of green turtles was the same for CCLmin than for SCLmax within a single encounter. For turtles encountered two to five times, the SCLmax measurements were more precise.
18. Mean carapace length for newly tagged hawksbill turtles was 90.4 cm (CCLmin) and 84.5 cm (SCLmax).
19. Mean carapace length of previously tagged leatherbacks was 145.2 cm (CCLmin).
20. A total of ten green turtles representing 4.7% of 211 carefully examined individuals were recorded as having fibropapilloma tumors. Tumors were less than 3.5 cm in size and were located on the neck and shoulder area (six turtles), on the front flippers (three turtles) and on the right rear flipper (one turtle).
21. A total of 213 green turtle nests were marked and the fate was determined for 189 nests. Overall hatching success is estimated at 70.7% (14,523 empty shells from 20,541 eggs) and overall emerging success at 68.1% (13,983 hatchlings from 20,541 eggs).
22. The biggest cause of nest loss was other nesting females digging up 18 nests (9.5%) and depredation affecting seven nests (3.7%). Poaching affected three nests (1.6%).
23. Data from the daily track surveys suggest that illegal take of eggs along the northern 5 miles of beach was greater during the first half of the nesting season.
24. Comparison between egg counts at excavation and the moment of oviposition showed a mean difference of 0.7 more eggs counted at the time of laying.
25. Mean depth for undisturbed green turtle nests (n=147) at excavation was 59 cm from the sand surface to the top egg and 73 cm to the bottom of the egg chamber.
26. The mean incubation period for undisturbed green turtle nests (n=28) was 57 days.
27. A total of five albino, one twin, one triplet and twelve deformed embryos were observed in unhatched eggs in undisturbed, flooded and unhatched nests, accounting for 0.11% of eggs.
28. Three hawksbill nests were monitored and their fate determined. Overall hatching success was 32.0% (121 empty shells from 378 eggs) and overall emerging success was 32.0 % (121 emerged hatchlings from 378 eggs).
29. Mean depth for undisturbed hawksbill nests (n=1) at excavation was 29 cm from the sand surface to the top egg and 51 cm to the bottom of the egg chamber.
30. November was the wettest month of the 2005 Green Turtle Program (674.3 mm) and June was the month with least rain (128.6 mm).
31. Mean monthly sand temperatures were highest in June and lowest in November.
32. A total of 28,252 persons visited the CCC Natural History and Visitors Center in 2005.
33. Tourist visitation to Tortuguero National Park (TNP) increased in 2005, to 87,083 paying visitors. Entrance fees to Tortuguero Conservation Area (TNP and Barra del Colorado Wildlife Refuge) raised a total of ¢185,347,680 (~ US$387,933).
34. The capacity of hotels and cabinas in the Tortuguero area decreased to 583 rooms (but bed capacity increased to 1,495 beds) in 2005 as a result of more cabina owners renting their rooms to locals.
35. A total of 36,856 tourists were issued permits to go on guided turtle walks in 2005. A new visitation system, began as a pilot project in 2004, was implemented during the first part of the 2005 nesting season.
36. Most of the lights visible on the beach were from house and street lights in Tortuguero village, between miles 2 6/8 – 3 3/8. Numerous lights from cabinas, lodges, houses and the CCC station that are located behind the beach, north of the village, were also visible

as well as lights from houses and street lights in San Francisco, and Tortuga Lodge on the other side of the river.

37. The mean angular range of green turtle hatchlings crawling from the nests was 41° if outliers were excluded and 47° if outliers were included.
38. Several environmental education activities were carried out during the 2005 Green Turtle Program. A puppet show and drawing class were organized for the children at the Tortuguero kindergarten. A storytelling session was held for the youngest students at the school and a workshop to prepare letters and drawings for a school in the USA was organized for the high school students.

Conclusions

1. The vast majority of green turtle nesting was observed between 15 June and 1 November.
2. Daily track surveys conducted by the research assistants are essential to evaluate the effectiveness of the management actions aimed at reducing the impact of tourism visitation.
3. The high nesting levels recorded in 2005 meant that absolute nest densities were high along the entire beach.
4. Daily track surveys showed that illegal take of green turtle eggs continued throughout the nesting season although the levels of take appeared greater during the first part of the season.
5. The number of green turtles killed by jaguars is very small in comparison to the number of nesting green turtles and is not likely to represent a serious survival threat to the Tortuguero green turtle population.
6. For green turtles measured on two or more occasions, SCLmax had greater precision than the CCLmin measurements.
7. The frequency of albinism, twins, triplets and deformed embryos was higher than normal in 2005.
8. The continued implementation of the new turtle-tour visitation system, began as a pilot project in 2004, has been successful in reducing the impact on nesting turtles.
9. In terms of environmental education activities, interactive sessions have proven to be much more popular with school children in Tortuguero than traditional classroom activities.

Recommendations

1. It is strongly suggested that daily track surveys by the research assistants be continued.
2. Increased marine patrols by park rangers and foot patrols along the northern 5 miles of beach during the beginning of the green turtle nesting season may be a good way to reduce illegal take of nesting turtles and eggs.
3. To ensure increased hawksbill nesting in the future any action aimed at protecting nesting females, nests or females in the internesting habitat should be encouraged.
4. CCC should conduct analyses to quantify tag loss and survival probabilities on an annual basis.
5. There is a need for increased coordination of sea turtle conservation and monitoring activities in Caribbean Costa Rica.
6. Properly functioning tag pliers are a must and any set of pliers that is not in perfect condition should immediately be discarded.
7. Training in the collection of carapace measurement data may be repeated during the green turtle program to make sure measurements are recorded accurately.
8. SCLmax should remain the standard Tortuguero green turtle carapace measurement.
9. A detailed study, including the collection and analysis of tissue samples from turtle tumors, would clarify if the tumors are indeed correctly identified.
10. Additional effort should be invested to reduce the number of monitored green turtle nests with unknown fates.
11. Additional awareness activities and park ranger patrols would help to reduce the number of green turtle hatchlings excavated by tour guides.
12. The CCC Natural History and Visitors Center urgently needs new and more varied displays to attract more visitors.
13. It is suggested that the new visitation system be continued and that monitoring to evaluate its success be maintained.
14. It would be desirable to establish a sustainable funding mechanism to ensure the new visitation system can be implemented throughout the green turtle nesting season, such as a fee for each person participating in the turtle-tours.
15. Hotel and beach front property owners should be encouraged to maintain or replant native vegetation to reduce light pollution. The street lights in front of the village should be covered up to further reduce light pollution.
16. It would be desirable to expand the environmental education activities during future programs.

INTRODUCTION

Dr. Archie Carr began studies of green turtles (*Chelonia mydas*) in Tortuguero in 1954 (*Carr et al.* 1978). Since 1959, the Caribbean Conservation Corporation (CCC) has implemented the annual green turtle program. In preparation for the 1998 nesting season, CCC staff and the Scientific Advisory Committee revised the Green Turtle Program monitoring protocol. The new protocol defines that the Green Turtle Program is conducted in order to fulfill CCC's scientific mission in Tortuguero: "*CCC will provide the scientific information necessary to conserve the populations of sea turtles that nest at Tortuguero, Costa Rica, so that they fulfill their ecological roles*". The 2005 Green Turtle Program represents the eighth consecutive year of implementing the revised monitoring protocol.

The objectives of this report are to summarize and discuss the 2005 Green Turtle Program results and provide recommendations for future sea turtle programs, conservation efforts and research activities in Tortuguero.

2. METHODS

2.1 Preparations

The research assistants (RA's) arrived in Tortuguero on 14 June, 2005. The Program commenced with a week of training. The training included theoretical sessions on sea turtle biology and nesting behavior, and a comprehensive review of the monitoring protocol. The training also included practical sessions in nest marking, tagging and biometric data collection during daytime and night-time patrols between the Tortuguero river mouth and the mile 5 marker.

During the first week of the program the mile markers on the beach between the Tortuguero river mouth and the mile 5 marker were replaced and/or repainted as necessary, to ensure that there were three markers at each 1/8 of a mile. These markers were put in the same locations as those positioned during the 2005 Leatherback Program.

The RA's were familiarized with Tortuguero village, and were introduced to key persons in the Tortuguero community, including the school director and teachers. They were also introduced to park rangers at the station at Cuatro Esquinas, in order to facilitate co-operation during nightly beach patrols.

2.2 Track Surveys

Track surveys were carried out approximately weekly during the entire green turtle program. The track surveyor conducted surveys between the Tortuguero river mouth (mile -3/8) and Jalova lagoon (mile 18). The surveys commenced at dawn (4:30-5:00 AM) at the Tortuguero river mouth, or at Tortuguero village, and finished between 9:30 AM -12:00 PM at Jalova lagoon. If the survey started at the village, and the section between Tortuguero river mouth and the village had not been surveyed in the morning, the same person surveyed that beach section upon completing the other part of the survey. Only tracks from

the previous night were recorded and for each track the following information was recorded: species, mile section, nest or false crawl, if the nest or turtle was poached or if the turtle was depredated. 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. Dead turtles were considered depredated by jaguars (*Panthera onca*) when they were surrounded by jaguar tracks or showed characteristic jaguar injuries.

2.3 Tagging of Nesting Sea Turtles

Tagging teams patrolled the beach every night between 14 June – 30 October (except for 16 June, 24 September, 14, 15 and 27 October). The northern part of the beach was divided into two sections: mile -3/8 to the field station (at mile 2 5/8) and the field station to the mile 5 marker. Separate teams patrolled each section during two shifts: 8 PM-12 AM and 12-4 AM, when the number of station residents allowed.

Every turtle encountered after she had finished egg-laying was checked for old tags. Turtles without old tags were tagged in each front flipper, axillary, proximal to the first scale. Species, mile section, tagger, nest zone (open, border, vegetation, or did not lay) and special characteristics or injuries were noted for each tagged turtle.

Tags used during the 2005 Green Turtle Program include National Band&Tag Company (NBTC) Inconel #681 tags no. 101023-101025, 101062-101075 and 101089-103998, and Monel #49 tags no. VA3095-VA3096.

2.3.1 Green turtles

Inconel #681 tags were used to tag a minimum sample of 1,000 green turtles not carrying old tags. Every effort was made not to mix Inconel and Monel tags on the same individual. Thus, if a turtle was encountered carrying one Monel tag this was removed and two Inconel tags were applied. However, in some cases, it was not possible to remove the Monel tag and so a new Monel tag was applied to the other flipper.

The probability of tag loss was calculated for green turtles tagged with two Inconel #681 tags that were subsequently encountered with one or two tags. The probability of tag loss is:

$$1 - K_i = 1-((2r_{di})/(r_{si} + 2r_{di}))$$

where K_i is the probability of retaining a tag during the interval i, r_{di} is the number of turtles encountered carrying two tags at interval i, and r_{si} is the number of turtles encountered carrying one tag at interval i (Wetherall 1982). Probability of tag loss was estimated for the first-to-last encounter.

2.3.2 Hawksbill turtles

Hawksbill turtles (*Eretmochelys imbricata*) were tagged with Inconel #681 tags. A disposable sterile scalpel or a biopsy punch was used to collect tissue samples from all hawksbills encountered, when possible. The samples were kept in ethanol until a CITES permit is obtained and the samples are sent for analysis to Dr. Peter Dutton of the National

Marine Fisheries Service. The tagging team always remained with the hawksbill until it had returned to the sea and then they thoroughly erased its track afterwards.

2.3.3 Leatherback turtles

Leatherback turtles (*Dermochelys coriacea*) were tagged in the rear flippers using Monel #49 tags.

2.4 Biometric Data Collection

2.4.1 Green turtles

Biometric data were collected from a sample of nesting green turtles. An attempt was made to count one or two clutches per night as the eggs were laid. The person counting the eggs wore a plastic glove so as not to contaminate the nest. Eggs were counted using an egg counter.

All tagged turtles were measured after they had finished nesting, if time allowed. Curved carapace length minimum (CCLmin), from where the skin meets the carapace by the nuchal notch to the posterior notch between the supracaudals, along the midline, was determined to the closest millimeter using a fiberglass measuring tape. Straight carapace length maximum (SCLmax), from the anteriormost edge of the carapace to the posterior tip of the longest supracaudal, was determined, to the closest millimeter, using a set of calipers. Both CCLmin and SCLmax measurements were taken three times by the same person, whose name was recorded in the field book, in order to determine the precision of the measurements. Precision is defined as the difference in cm between the longest and the shortest of the three measurements.

2.4.2 Hawksbill turtles

CCLmin and SCLmax measurements were taken for all hawksbills encountered during nightly tagging work. As for green turtles, the same observer measured the turtle three times for each measurement, to allow the precision to be calculated. The clutch was counted, if the hawksbill had not already started to lay eggs at the time of encounter.

2.4.3 Leatherback turtles

For leatherbacks, CCLmin (from where the skin meets the carapace by the notch of the neck to the posterior end of the caudal projection, next to the central ridge) was measured using a 300 cm fiberglass measuring tape. Each turtle was measured three times to determine an average CCLmin. No SCLmax measurements were taken as the calipers were not sufficiently large enough to measure a leatherback turtle.

2.5 Fibropapilloma Assessment

2.5.1 Green turtles

For a minimum sample of 100 green turtles, those for which clutches were counted, an examination for fibropapilloma was also conducted. All soft body parts, including the cloacal region, were inspected for tumors, using a flashlight with a red filter. The absence

or presence of fibropapillomas, location and size of fibropapilloma tumors, and the names of the persons examining the turtle were recorded.

2.6 Determination of Nest Survivorship and Hatching Success

A sample of green turtle and hawksbill nests was marked during oviposition. These nests were all located between Tortuguero river mouth (mile – 3/8) and the mile 5 marker. The nests were marked using three pieces of flagging tape that were attached to vegetation behind the nest. The distance from the centre of the egg chamber to each of these tapes was measured, to the nearest cm, whilst the turtle was still laying eggs. When it was time to excavate the nest, triangulation of these three measurements was used to indicate the location of the egg chamber, at the site where the three lines crossed. Three marker tapes were used to compensate for the loss of any tapes as a result of camouflaging turtles, insects or persons removing the tapes intentionally. If one marker tape was lost it was still possible to locate the nest using the other two tapes. The distance to the most recent high tide line was also recorded at the time the nest was marked.

Marked nests were inspected daily at 6:00 AM. It was recorded if the nest was poached, predated (if possible, the type of animal was identified), dug up by another turtle or lost due to beach erosion. If evidence of hatching was observed, the date was noted and the nest was excavated two days later. If no depression or hatchling tracks were recorded, the nest was excavated after approximately 65 days. Daily inspection was terminated and the marker tapes were removed from those nests when it was determined with certainty that it had been poached, completely depredated or dug-up, or that had washed away. Monitoring of partially depredated or dug-up nests continued as normal until they were excavated, though the date of disturbance was recorded.

After 65 days, or sooner if signs of emergence had been recorded, the nests were excavated, once the distances from the marker tapes had been re-measured to confirm that it was the original nest. Nests that had no obvious depressions were located by probing for soft sand using a wooden stick (only after 65 days, when it was presumed that hatching and emergence had occurred), and this technique greatly aided in locating several of the marked nests. Nests were not excavated if the excavator encountered a large number of hatchlings in the nest. In such cases the hatchlings were re-buried and the nest excavated at a later date. If a few hatchlings were encountered, they were placed in a shallow hole close to the nest site and covered with sand so that they could reach the sand surface and emerge the following night.

For each excavated nest the name of excavators, nest code, mile section, date laid, date hatched (if available), date excavated, distance from sand surface to top egg, distance from sand surface to bottom of egg chamber were documented. To determine hatching and emergence success the number of empty shells (if it was more than 50% of the egg), live hatchlings, dead hatchlings, unhatched eggs with no embryo, unhatched eggs with visible embryo (all stages before fully developed), unhatched eggs with full embryo (ready to hatch but not yet pipped), pipped eggs, depredated eggs, destroyed eggs and yolkless eggs were also recorded. Notes were also kept on the number of albino, twin and deformed embryos encountered during excavations.

If a nest could not be found when excavated, an attempt was made to determine the fate of the nest. Nests were considered poached if an empty egg chamber was encountered. Nests were assumed dug-up by another turtle if broken eggshells and a new bodypit were encountered where the nest was supposed to be located. Nests were considered depredated if a large number of opened eggshells were found in close proximity to the location of the marked nest. If human footprints and digging was observed at the location of the nest, the nest was considered dug-up by tour guides or other persons to show the hatchlings to tourists. Nests for which the fate could not be determined with certainty or which were not excavated entirely were excluded from the sample.

2.7 Physical Data Collection

2.7.1 Rainfall

Rainfall (to the closest mm) was recorded daily at 9:00 AM at John H. Phipps Biological Field Station.

2.7.2 Sand temperature

Sand temperature was measured using data-loggers located at 30, 50 and 70 cm depth in the open, border and vegetation zones of the beach in front of the field station. These data-loggers recorded sand temperatures once an hour.

2.8 Collection of Human Impact Data

2.8.1 Visitors to Tortuguero

The number of visitors to the CCC Natural History and Visitors Center was estimated from the number of paying tourists that entered the center. The number of tourists visiting Tortuguero National Park was estimated from the number of visitors that paid the entrance fee at the National Park offices at Cuatro Esquinas and Jalova.

2.8.2 Capacity of hotels and cabinas

CCC Station Manager Sergio Campos, Field Coordinator Andrea de Haro and Scientific Director Sebastian Troëng requested information on the room and bed capacity from cabina owners and hotel managers in Tortuguero during the 2005 Green Turtle Program.

2.8.3 Turtle walks

The number of tourists going on guided turtle walks during the Green Turtle Program was estimated from the permits issued to tour guides by Tortuguero Conservation Area (ACTo). The Tortuguero Tour Guide Association recorded the money raised from the voluntary contributions from tour guides, money that is designated for use in community projects in the village. In 2005, the pilot project aimed at reducing the impact of tourism visitation on sea turtle nesting, first implemented in 2004, was extended to the entire beach from the Tortuguero river mouth to the mile 5 marker for a large part of the nesting season. Funds from hotel and cabina owners were used to employ thirteen local turtle spotters. The turtle spotters reported when and where sea turtles were ready to lay eggs, and tourists and guides walked to the location using a path behind the beach instead of walking along the beach.

Unfortunately, not all hotel owners fulfilled their promises of donating funds and the pilot project had to be discontinued earlier than planned due to lack of funds.

2.8.4 Artificial lights

The presence of artificial lights on Tortuguero beach was monitored along the northern 5 2/8 miles of beach, from the Tortuguero river mouth to the mile 5 marker. Once a month light surveys were conducted on nights close to the new moon, when natural light was minimal. The date and name of observers were recorded, as was the mile section, light source (if possible to determine) and location (beach side or river side) for each artificial light visible from the beach.

2.8.5 Hatchling orientation

Hatchling orientation was determined for a sample of nests from which hatchlings were known to have emerged the previous night. For each nest the observer, mile section, distance from the nest to the most recent high tide line (m) and the approximate number of tracks were recorded. In addition, at a distance of 10m from the nest, the angular range of all tracks (^{o}), the angular range of tracks minus any outliers (^{o}) and the modal direction of tracks were determined using a compass held at waist-height above the nest.

2.9 Environmental Education Activities

Talks and slide shows about sea turtle biology, conservation and environmental economics were given opportunistically to groups staying at or passing by the John H. Phipps Biological Station. In addition, the 2005 Green Turtle Program team implemented a series of environmental education activities at the Tortuguero village kindergarten, school and high school.

3. RESULTS

3.1 Track Surveys

3.1.1 Green turtles

Nesting of green turtles was observed from April - December, with more than 50 nests/night recorded between 18 June – 22 October (Figure 1). From the weekly track surveys, peak nesting was observed on 31 July when 4,071 nests were recorded in a single night (Figure 1). Using the methodology of Troëng & Rankin (2005), it is estimated that 148,378 green turtle nests were laid during the 2005 nesting season (Figure 11b).

During daily track surveys conducted by research assistants between 20 June and 1 November, a total of 34,076 green turtle nests and 19,545 green turtle half-moons were recorded between the Tortuguero river mouth and the mile 5 marker (Figure 2).

Green turtle nesting density was found to be highest in the centre of the beach, between miles 5 - 11, with the highest density occurring in mile 10 (Figure 3). Those nests laid between the Tortuguero river mouth and mile 5 marker, where night-time beach patrols were regularly conducted, made up 16.0% of nests laid on the entire beach (Figure 3).

The track surveyor recorded illegal take of nesting green turtles during five surveys from mid-August to early October 2005 (Figure 4). At least 32 green turtles were recorded as poached during these five surveys. Nest poaching was recorded during six track surveys and a total of six green turtle nests were recorded as poached. Additional observations on illegal take are summarized in Appendix 2.

Between April and October, the track surveyor reported a total of 11 freshly killed green turtles (Figure 5). Park rangers and research assistants reported another 13 green turtles and a hawksbill killed by jaguars in 2005. The field coordinator and a research assistant encountered a jaguar during a track surveys in 2005.

3.1.2 Hawksbill turtles

Very low levels of hawksbill nesting activity (0-2 nests/night) were recorded between May – October (Figure 6, Appendix 1).

3.1.3 Leatherback turtles

Leatherback nesting as recorded from track surveys was observed from January - July, with peak nesting occurring on 9 April when 16 nests were recorded (Figure 7, Appendix 1).

3.2 Tagging of Nesting Sea Turtles

3.2.1 Green turtles

A total of 1,071 newly tagged, 615 previously tagged and 508 renesting green turtles were encountered by researchers during 2,020 team hours of night patrols between 14 June and 30 October 2005 (Appendix 1).

Nine green turtles tagged at other nesting beaches were encountered during the 2005 Green Turtle Program. Four were tagged in the Pacuare Nature Reserve and four were tagged by the Parismina project. The ninth non-Tortuguero green turtle was probably tagged in Gandoca. All these projects are located in Costa Rica, to the south of Tortuguero National Park.

Of 1,058 newly tagged green turtles, 133 (12.6%) were recorded as having evidence of old tag holes or notches in at least one front flipper when encountered the first time during the 2005 Green Turtle Program.

Tagging efficiency for green turtles emerging (nests and half-moons) between the Tortuguero river mouth and the mile 5 marker on nights before track surveys (n = 130) ranged from 0% to 50% with an overall mean of 4.1%.

Green turtles encountered during night patrols nested in the open beach zone in 29.5% of cases (n = 642), 53.2% (n = 1159) were located in the border zone and 7.0% (n = 153) in the vegetation zone. 10.3% of turtles were encountered during a half-moon (n = 225).

From Table 1 it can be seen that of 226 turtles tagged with two tags and seen again during the 2005 Green Turtle Program, 13 were reported to have lost one tag, resulting in a within-season probability of tag loss of 3.0%. There were considerable differences in the probability of tag loss between researchers, ranging from 0% to 10%. Differences were also observed between months, with the lowest tag loss observed in October, and the highest in June (0% and 12% respectively).

Table 1. Probability of within-season tag loss from first-to-last encounter

a) By tagger

Tagger	r_{di}	r_{si}	$1\text{-}K_i \pm 95\%$ CL
RA1	23	0	0 ± 0
RA2	20	0	0 ± 0
RA3	16	0	0 ± 0
FC	15	0	0 ± 0
RA4	12	0	0 ± 0
RA5	9	0	0 ± 0
RA6	5	0	0 ± 0
RA7	5	0	0 ± 0
RA8	4	0	0 ± 0
RA9	4	0	0 ± 0
RA10	3	0	0 ± 0
RA11	3	0	0 ± 0
RA12	3	0	0 ± 0
SD	1	0	0 ± 0
RA13	1	0	0 ± 0
RA14	24	2	0.040 ± 0.057
RA15	15	2	0.063 ± 0.088
RA16	33	5	0.070 ± 0.063
RA17	9	2	0.100 ± 0.141
RA18	0	1	N/A
Mixed taggers	8	1	0.059 ± 0.117
TOTAL	**213**	**13**	**0.030 ± 0.016**

b) By month

Month	r_{di}	r_{si}	$1\text{-}K_i \pm 95\%$ CL
June	11	3	0.120 ± 0.138
July	99	3	0.015 ± 0.0.17
August	66	6	0.043 ± 0.035
September	36	1	0.014 ± 0.027
October	1	0	0 ± 0
TOTAL	**213**	**13**	**0.030 ± 0.016**

FC = Field Coordinator, SD = Scientific Director, RA = Research Assistant, Mixed taggers = Two RA's tagged the same turtle, r_{di} = Number of green turtles encountered with two tags, r_{si} = Number of green turtles encountered with one tag, $1\text{-}K_i$ = Probability of tag loss, 95% CL = 95% confidence limits

3.2.2 Hawksbill turtles

Six different hawksbill turtles were encountered during the 2005 Green Turtle Program; five were newly tagged, and one was previously tagged (Appendix 1). None of the newly tagged hawksbill turtles (n = 5) showed evidence of previous tags.

Four of the hawksbill turtle observed during night patrols nested in the open zone (66.7%, n=4), one nested in the border zone (16.7%, n = 1), and one did not lay (16.7%, n = 1).

3.2.3 Leatherback turtles

A total of three leatherback encounters were logged at the beginning of the 2005 Green Turtle Program; one was newly tagged and two were previously tagged turtles. All three leatherback turtles observed during night patrols deposited their nests in the open zone (n = 3).

3.3 Biometric Data Collection

3.3.1 Green turtles

Table 2 shows the mean carapace length and clutch size of green turtle females. The mean carapace length of newly tagged individuals with no evidence of previous tagging was slightly smaller than the mean carapace length of newly tagged females with old tag holes or notches, and that of previously tagged females. Clutch size was very similar for newly tagged females with no signs of previous tagging and for newly tagged individuals with evidence of previous tags but on average was slightly larger for previously tagged females (Table 2).

Table 2. Mean carapace length and clutch size of green turtles

	CCLmin (cm)		SCLmax (cm)		Clutch size (eggs)	
Sample	**n**	**$\bar{x}$ ± ST.D.**	**n**	**$\bar{x}$ ± ST.D.**	**n**	**$\bar{x}$ ± ST.D.**
Newly tagged females - no OTH/OTN	925	104.8 ± 4.9	925	98.7 ± 4.4	102	108 ± 25
Newly tagged females - with OTH/OTN	131	105.6 ± 4.6	152	99.4 ± 4.5	15	109 ± 27
Previously tagged females	587	106.4 ± 4.8	579	100.1 ± 4.4	26	113 ± 25

OTH = Old tag hole, OTN = Old tag notch

For green turtles, both curved carapace length (CCLmin) and straight carapace length (SCLmax), were measured with a higher degree of precision by research assistants than by participants (Table 3a). CCLmin and SCLmax measurements during one encounter were equally precise (Table 3a). For individuals measured two or more times during the season the SCLmax measurements had a higher level of precision than the CCLmin measurements (Table 3b).

Table 3. Precision of carapace measurements for green turtle females

a) During the same encounter

	CCLmin (cm)			SCLmax (cm)		
Observer	**n**	**$\bar{x}$ ± ST.D.**	**Range**	**n**	**$\bar{x}$ ± ST.D.**	**Range**
Research Assistants	1060	0.3 ± 0.2	0 - 2.4	1142	0.3 ± 0.3	0 – 2.2
Participants	1050	0.5 ± 0.5	0 - 5.1	934	0.5 ± 0.4	0 - 3.5
TOTAL	**2110**	**0.4 ± 0.4**	**0 - 5.1**	**2076**	**0.4 ± 0.4**	**0 - 3.5**

b) Between encounters

Encounters	CCLmin (cm) n	CCLmin (cm) $\bar{x}$ ± ST.D.	CCLmin (cm) Range	SCLmax (cm) n	SCLmax (cm) $\bar{x}$ ± ST.D.	SCLmax (cm) Range
2	290	1.3 ± 0.9	0.1 - 5.3	285	0.9 ± 0.6	0.2 - 3.9
3	57	1.9 ± 1.0	0.4 – 5.2	57	1.2 ± 0.6	0.4 – 2.8
4	13	1.6 ± 0.9	0.2 – 3.0	10	1.2 ± 0.5	0.6 – 2.2
5	1	1.5 ± N/A	N/A	1	0.6 ± N/A	N/A
6	1	4.9 ± N/A	N/A	1	5.6 ± N/A	N/A
7	1	3.6 ± N/A	N/A	1	1.6 ± N/A	N/A

3.3.2 Hawksbill turtles

Newly tagged hawksbill females had a mean CCLmin of 90.4 cm and a mean SCLmax of 84.5 cm (Table 4). No hawksbill clutches were counted during the 2005 Green Turtle Program.

The precision of CCLmin measurements was greater for green than for hawksbill turtles but the precision of the SCLmax measurements were the same for both species (Table 3a and Table 5).

Table 4. Mean carapace length and clutch size of hawksbill females

Sample	CCLmin (cm) n	CCLmin (cm) $\bar{x}$ ± ST.D.	SCLmax (cm) n	SCLmax (cm) $\bar{x}$ ± ST.D.
Newly tagged - no OTH/OTN	5	90.4 ± 4.7	5	84.5 ± 4.3
Previously tagged females	1	82.7 ± N/A	1	81.7 ± N/A

Table 5. Precision of carapace measurements for hawksbill females

Sample	CCLmin (cm) n	CCLmin (cm) $\bar{x}$	CCLmin (cm) Range	SCLmax (cm) n	SCLmax (cm) $\bar{x}$	SCLmax (cm) Range
Females	6	0.8	0 - 3.2	6	0.4	0.1-0.7

3.3.3 Leatherback turtles

The mean carapace length (CCLmin) of the two previously tagged leatherback turtles encountered during the 2005 Green Turtle Program was 145.2 cm and the newly tagged leatherback measured CCLmin 141.7 cm (Table 6). The only counted clutch contained 67 eggs and 4 yolkless eggs (Table 6). See de Haro *et al*. (2006) for an analysis of the precision of CCLmin measurements for leatherbacks turtles.

Table 6. Mean carapace length of leatherbacks

Sample	n	CCLmin (cm) $\bar{x}$ ± ST.D.	Clutch size (eggs + yolkless eggs)
Newly tagged - no OTH/OTN	1	141.7 ± N/A	
Previously tagged	2	145.2 ± 5.7	67 + 4

3.4 Fibropapilloma Assessment

3.4.1 Green turtles

A total of 211 green turtles were subject to a thorough examination for the presence of fibropapilloma tumors; ten individuals (4.7%) were recorded to be affected. One of the ten was checked twice and only once recorded as being affected. Tumors were less than 3.5 cm in size and were located on the neck and shoulder area (six turtles), on the front flippers (three turtles) and on the right rear flipper (one turtle). Six of affected turtles were newly tagged (two of these had evidence of prior tagging) and four were previously tagged turtles.

3.5 Determination of Nest Survivorship and Hatching Success

The mammal predators observed disturbing nests or taking hatchlings during the 2005 Green Turtle Program, include coatis (*Nasua narica*), domestic dogs (*Canis familiaris*) and humans (*Homo sapiens sapiens*).

The bird predators observed include black (*Coragyps atratus*) and turkey vultures (*Cathartes aura*) that were seen depredating eggs and hatchlings from nests that had been opened by other predators or nesting turtles. The vultures also depredated inactive hatchlings if they emerged during the day.

In addition, ghost crabs (*Ocypode quadrata*) were observed depredating hatchlings and fly larvae (*Megaselia scalaris*) were observed depredating eggs, pipped hatchlings and hatchlings in the nest.

3.5.1 Green turtles

A total of 213 green turtle nests were marked during the 2005 Green Turtle Program. Of these, all three marker tapes were lost for seven nests (some were lost due to cutting of vegetation between Laguna Lodge and the airstrip), two nests still contained hatchlings at the end of the Program, and the fate of 15 nests could not be determined with certainty. These 24 nests were excluded from subsequent analysis, leaving a sample of 189 green turtle nests monitored from the date of oviposition until their fates could be determined (Table 7).

Almost 80% of nests remained undisturbed during incubation (n = 151). Of those that were disturbed, depredation accounted for 3.7% of disturbances and nesting turtles partially destroyed another 9.5% of nests. Poaching resulted in the loss of a further three nests (1.6%).

Data from the daily track surveys to mile 5 indicate that illegal take of eggs occurred along the northern 5 miles of beach and was greater during the first half of the nesting season (Figure 8a, Figure 8b).

The results of the excavations of the 189 green turtle nests monitored through incubation are shown in Tables 8a and 8b. Overall hatching and emerging success was calculated, based on the assumption of a mean number of 107.9 eggs per marked nests unless the fate category indicated otherwise (Table 8b). The estimated total number of eggs in monitored

nests equals 20,541 eggs (177 nests x 107.9 eggs + 3 nest x 123.7 eggs + 4 nests x 146.5 eggs + 5 x 112 eggs + three nests x 123.7 eggs to account for nests that were dug up together with other nests – fate category 7). Overall hatching success is estimated at 70.7% (14,523 empty shells from 20,541 eggs) and overall emerging success at 68.1% (13,983 hatchlings from 20,541 eggs).

Most of the marked green turtle nests were deposited either in the border (n = 106) and open (n=70) zones, and few were laid in the vegetation (n = 13). Nests laid in the border zone were less likely to be disturbed than nests deposited in the open and vegetation zones (18% compared to 23% and 23%, respectively).

Table 7. Fate of marked green turtle nests

Fate	Public n	Park n	Total n	% of total
Undisturbed				
1. Undisturbed	95	56	151	79.9
Disturbed				
2. Poached	0	3	3	1.6
3. Depredated by dogs	1	1	2	1.1
4. Depredated	2	3	5	2.6
5. Dug up by nesting turtle	10	5	15	7.9
6. Two nests together	1	2	3	1.6
7. Flooded	0	4	4	2.1
8. Unhatched	0	5	5	2.6
9. Depredated after hatching	1	0	1	0.5
TOTAL	**110**	**79**	**189**	**100**
Not included in analysis				
(10. Hatchlings still in nest on 1 December	1	1	2	
11. All three marker tapes lost	6	1	7	
12. Undetermined	8	7	15)	

Table 8. Results of green turtle nest excavations

a) Raw data from excavations

				Hatchlings		Unhatched eggs				
Fate	Nests n	Empty shells	Pipped eggs	Live	Dead	No embryo	Embryo	Full embryo	Depredated	Destroyed
1	151	13489	35	246	136	1221	493	105	944	4
2	3	11	0	0	0	2	0	0	0	0
3	2	0	0	0	several	0	1	0	23	0
4	5	18	5	0	3	71	97	7	308	0
5	15	365	3	12	29	60	18	3	27	0
6	3	416	1	0	1	33	16	0	272	0
7	4	224	68	1	112	72	97	1	7	0
8	5	0	0	0	0	161	335	39	20	0
9	1	0	0	0	0	0	0	0	0	0
ALL	**189**	**14523**	**112**	**259**	**281**	**1620**	**1057**	**155**	**1601**	**4**

For fate categories see Table 7

b) Hatching and emerging success of excavated green turtle nests

Fate	Nests n	$\bar{x}$ clutch size	Hatching success (%)	Emerging success (%)
1	151	107.9	82.8	80.5
2	3	N/A	3.4	3.4
3	2	N/A	N/A	0
4	5	N/A	3.3	2.8
5	15	N/A	22.6	20.0
6	3	123.7	56.4	56.2
7	4	146.5	47.8	23.7
8	5	112	0	0
9	1	N/A	N/A	N/A
Total	**189**	**N/A**	**70.7**	**68.1**

For fate categories see Table 7

A comparison between egg counts at the time of oviposition and at excavation for a sample of undisturbed nests (n = 99) shows a mean of 0.7 more eggs (range: +77 to -63 eggs, st.dev. = 22 eggs) counted at the time of oviposition.

The distance between the sand surface and the top eggshell at the time of excavation for undisturbed nests (n = 147) ranged between 18 and 105 cm with a mean of 59 cm. The distance between the sand surface and the bottom of the egg chamber varied between 30 and 123 cm with a mean of 73 cm.

The incubation period for undisturbed nests for which emerging was observed (n = 28) ranged from 49 to 65 days with a mean of 57 days.

Unhatched eggs that contained albino, twin, triplet and deformed embryos accounted for 0.11 % of eggs in undisturbed, flooded and unhatched nests (Table 9).

Table 9. Incidence of albinism, twins and deformed embryos in green turtle nests

	n	% of total eggs
Albinos	5	0.029
Twins	1	0.006
Triplet	1	0.006
Deformed embryos	12	0.069
TOTAL	**3**	**0.110**

3.5.2 Hawksbill turtles

Three hawksbill nests were marked at the time of oviposition, and the results of the excavations of these nests are shown in Table 10. Of these three nests, one was undisturbed, one was dug up by a nesting turtle and one did not hatch.

Overall hatching and emerging success for hawksbill nests (n = 3) was 32.0% (121 empty shells and 121 emerged hatchlings from 378 eggs).

The distance between the sand surface and the top eggshell at the time of excavation for the undisturbed hawksbill nest (n = 1) was 29 cm. The distance between the sand surface and the bottom of the egg chamber was 51 cm.

Table 10. Results of hawksbill nest excavations

						Unhatched eggs						
		Empty	Pipped	Hatchlings						Total	Hatching success	Emerging success
Fate	n	shells	eggs	Live	Dead	No embryo	Embryo	Full embryo	Depred.	eggs	(%)	(%)
1	1	121	0	0	0	4	0	1	0	0	96.0	96.0
5	1	0	0	0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	53	0	0	0	0	0	0
ALL	**3**	**121**	**0**	**0**	**0**	**57**	**0**	**1**	**0**	**0**	**32.0**	**32.0**

For fate categories see Table 7
[a]Assuming mean nest size of 126 eggs

3.5.3 Leatherback turtles

For more information about the leatherback hatching success in Tortuguero in 2005, please consult de Haro *et al*. (2006).

3.6 Physical Data Collection

3.6.1 Rainfall

During the 2005 Green Turtle Program, which ran from mid-June to the end of November, November was the wettest month, with 674.3 mm of rain recorded (Table 11). June was the driest month of the Program with only 128.6 mm of rain recorded for the month.

Table 11. Rainfall, January-December 2005

Month	Total rainfall (mm/month)	$\bar{x}$ rainfall (mm/24hrs)*
January	1187.2	39.6
February	305.9	10.5
March	153.2	4.9
April	488.8	16.3
May	375.7	12.1
June	128.6	4.3
July	525.2	16.9
August	369.1	11.9
September	329.2	11.0
October	521.5	16.8
November	674.3	22.5
December	603.5	18.3

*Data for 31 January included in February total
*Data for 48 hours for 31 January-1 February
*Data for 360 hours for 19 December-2 January
*Data for 1-2 January 2006 included in December total

3.6.2 Sand temperature

Mean sand temperatures are shown in Table 13. At all depths, temperatures were greater in the open zone and lower in the vegetation zone (Table 13). During the Green Turtle

Program, the month with the highest sand temperatures, was June. November was the month with the lowest sand temperature (Table 13).

Table 13. Mean monthly sand temperatures.

Zone	_ Open × temp (ºC)			_ Border × temp (ºC)			_ Vegetation × temp (ºC)		
Depth (cm)	*30*	*50* [a]	*70*	*30*	*50* [b]	*70*	*30*	*50* [c]	*70*
January	N/A	N/A	25.8	N/A	N/A	25.2	N/A	N/A	23.8
February	N/A	N/A	26.9	N/A	N/A	26.7	N/A	N/A	24.3
Retrieval depth (cm) 5 Feb	*N/A*	*N/A*	*75*	*N/A*	*N/A*	*69*	*N/A*	*N/A*	*70*
Depth (cm) 5 Feb	*N/A*	*N/A*	*70*	*N/A*	*N/A*	*70*	*N/A*	*N/A*	*70*
March	N/A	31.7	30.9	N/A	30.4	30.1	N/A	N/A	26.8
April	N/A	30.8	30.4	N/A	29.3	29.3	N/A	N/A	26.7
May	N/A	31.8	31.4	N/A	30.0	30.0	N/A	N/A	27.3
June	N/A	32.6	32.1	N/A	30.6	30.6	N/A	N/A	27.8
Retrieval depth (cm) 24 June	*N/A*	*51*	*71*	*N/A*	*56*	*66*	*N/A*	*N/A*	*70*
Depth (cm) 24 June	*N/A*	*50*	*70*	*N/A*	*50*	*70*	*N/A*	*50*	*70*
July	N/A	31.8	31.6	N/A	30.0	30.1	N/A	27.5	27.7
August	N/A	31.8	29.3	N/A	N/A	28.5	N/A	26.5	26.7
September	N/A	31.1	30.6	N/A	N/A	30.9	N/A	26.8	27.0
October	N/A	31.4	30.9	N/A	29.8	29.9	N/A	26.4	26.8
November	N/A	27.9	27.4	N/A	26.4	26.5	N/A	24.8	25.0
December	N/A	29.5	28.8	N/A	27.2	27.0	N/A	25.2	25.4

[a] Data from 5 February
[b] Data for 5 February-21 August and from 22 September
[c] Data from 24 June

Figure 9a, 9b and 9c show the sand temperatures during the 2005 Green Turtle Program (14 June to 30 November), in the open, border and vegetation zones, respectively. A similar pattern was observed for all three beach zones, with sand temperatures peaking in June and dropping dramatically in early November. There was much more variation in sand temperatures in the open zone (which received no shading) than in the border and vegetation zones (which were partially and fully shaded, respectively).

3.7 Collection of Human Impact Data

3.7.1 Visitors to Tortuguero

The number of visitors paying to enter the CCC Natural History and Visitor Center in Tortuguero is shown in Table 14. In 2005, visitation decreased to less than the recorded number of visitors for 2003 and 2004.

The number of paying visitors to Tortuguero National Park, both Costa Rican nationals and foreign tourists, continues to increase and reached 87,083 visitors in 2005, an increase of over 5,000 people from 2004 (Table 15). In 2005, the income generated from the entrance fees to Tortuguero National Park and Barra del Colorado Wildlife Refuge totaled ¢185,347,680 (~ US$387,933). It is interesting to note that paying visitors to Barra del Colorado Wildlife Refuge have declined considerably since 1998, from over 23,000 paying visitors to less than 250 in 2005 (Table 15).

Table 14. Number of visitors to the CCC Natural History and Visitors Center

Month	2003 Total	2003 $\bar{x}$ Per Day	2004 Total	2004 $\bar{x}$ Per Day	2005 Total	2005 $\bar{x}$ Per Day
January	2220	72	2814	91	2503	81
February	2855	102	3648	126	3662	131
March	2921	94	3924	127	3841	124
April	2591	86	2940	98	2390	80
May	1410	45	1497	48	1187	38
June	1575	53	2089	70	1605	54
July	3272	106	3106	100	2523	81
August	3864	125	3415	110	3001	97
September	1779	59	1502	50	1509	50
October	1791	58	1482	48	1335	43
November	2453	82	1995	67	2344	78
December	2372	77	2205	71	2352	76
TOTAL	**29103**	**80**	**30617**	**84**	**28252**	**77**

Table 15. Number of paying visitors to Tortuguero National Park

Year	Tortuguero National Park CR Visitors	Tortuguero National Park Foreign Visitors	Tortuguero National Park Total Visitors	Barra del Colorado Wildlife Refuge Total Visitors	Tortuguero National Park and Barra del Colorado Wildlife Refuge Total Fees Raised
1996	1,287	7,766	9,053		
1997	2,274	10,757	13,031		
1998	4,284	12,550	16,834	23,256	¢23,990,280
1999	5,767	32,863	38,630	3,650	¢69,641,550
2000	5,543	36,354	41,897	2,639	¢71,409,282
2001	6,175	39,057	45,232	2,941	¢76,556,437
2002	5,745	44,594	50,339	3,999	¢98,495,745
2003	8,643	59,026	67,669	386	¢143,715,204
2004*	9,545	71,912	81,457	190	¢178,313,657
2005*	9,292	77,791	87,083	241	¢185,347,680

*adjusted 2004 and 2005 data were provided by ACTo in March 2006

3.7.2 Capacity of hotels and cabinas

The number of hotel rooms in Tortuguero continued to increase in 2005 but the number of rooms available in the cabinas decreased in 2005 (Table 16). There are currently less than 600 rooms for rent in the village and surrounding area, comprising a total of 1495 beds. Almost 80% of the capacity is within the larger hotels and lodges, as opposed to the smaller cabinas in the village (Table 16).

Table 16. Room and bed capacity of the hotels and cabinas in the Tortuguero area.

Hotels/Lodges	Rooms	Beds	Cabinas	Rooms	Beds
Evergreen	30	60	All Rankin Lodge	7	31
Hotel Vista del Mar	20	50	Aracari	12	30
Ilan-Ilan	24	71	Cabinas Evelyn******	5	15
Jungle	44	87	Casa Marbella	5	13
Laguna	95	285	La Casona**	4	16
El Manati******			Jumanji***	12	41
Mawamba	54	135	Ella y Yo*		
Pachira	80	166	La Espiga de Oro*		
Samoa Lodge*****	20	40	Hostel el Icaco	6	11
Tortuga	27	80	Joruki*		
Tortuga Verde****	32	64	Lapa Verde*		
Turtle Beach Lodge	30	89	Meryscar	18	40
Total – Hotels	*456*	*1127*	Miss Miriam	6	18
			Miss Miriam #2	8	24
			Miss Junnie Hotel	12	36
			Princesa	8	24
			Sabina*		
			Tortuguero	11	27
			Pisulin/Tropical Lodge	6	10
			(CCC	7	32)
			Total – Cabinas	*127*	*368*
	TOTAL	**583 Rooms**	**1495 Beds**		

* Now rented to locals, **Two rooms were converted to an internet café, ***Jumanji previously known as Chanu, **** Extension of Pachira Lodge, ***** Samoa Lodge previously known as Caribbean Magic, ****** El Manati was closed for remodeling in 2005, ****** Only open for tourists during high season

3.7.3 Turtle tours

In 2005, the pilot project aimed at reducing the impact of tourism visitation on green turtle nesting was extended to the National Park section of the beach. 13 local turtle spotters were hired with funds from the Tortuguero hotel and cabina owners. The turtle spotters would find green turtles ready to nest and inform guides and tourists who would then walk on a path behind the beach and enter the beach as close as possible to the nesting turtle. This reduced the amount of time tourists and guides were on the beach.

Table 17. Number of tourists paying to go on turtle tours in 2005

Month	Public beach (mile -3/8 to 3 3/8)	Park (mile 3 3/8 to 5)	Total	Tour guide nights
March	11	48	59	7
April	576	228	804	106
May	751	165	916	127
June	1163	1748	2911	406
July	6840	3188	10028	1178
August	7909	4601	12510	1402
September	4104	1496	5600	717
October	2174	1854	4028	527
November	0	0	0	0
TOTAL	**23528**	**13328**	**36856**	**4470**

Data from ACTo

A total of 36,856 tourists paid to go on a guided turtle tour during the official 2005 nesting season, which ran from March until the end of October (Table 17). Peak tourist visitation occurred in August (Table 17). More tourists visited the public beach, north of mile 3 3/8, than the beach within the national park.

3.7.4 Artificial lights

Results from four light surveys conducted roughly once a month from July to October (Figure 12). Most of the lights visible on the beach were from house and street lights in Tortuguero village, between miles 2 6/8 – 3 3/8 (Figure 12). However, numerous lights from cabinas, lodges, houses and the CCC station that are north of the village were also visible. The majority of lights were located on the beach side of the river, although those of houses and street lights in San Francisco, and of Tortuga Lodge were visible from the other side of the river. There are no artificial lights in the National Park.

3.7.5 Hatchling orientation

Green turtle hatchlings orientation results are summarized in Table 18. The mean angular range of green turtle hatchlings crawling from the nests was 41° if outliers were excluded and 47° if outliers were included in the measurements (Table 18)

Table 18. Green turtle hatchling orientation

Fate of nest	n	No. hatchling tracks $\bar{x}$ ± ST.D.	Angular range (°) $\bar{x}$ ± ST.D.	Angular range including outliers (°) $\bar{x}$ ± ST.D.	No. of circlers $\bar{x}$ ± ST.D.
Undisturbed	70	58 ± 22	41 ± 17	47 ± 24	0.13 ± 0.45

3.8 Environmental Education Activities

Several environmental education activities were carried out during the 2005 Green Turtle Program. A puppet show and drawing class were organized for the children at the Tortuguero kindergarten. A storytelling session was held for the youngest students at the school and a workshop to prepare letters and drawings for a school in the USA was organized for the high school students. The high school students also visited the CCC Field Station and received general environmental education information.

4. DISCUSSION

4.1 Track Surveys

4.1.1 Green turtles

Green turtle nesting was observed from April to December with the main nesting season extending from 15 June to 1 November. Green turtle nests laid before 15 June and after 1 November only amounted to 0.4 % of all counted nests in 2005.

The daily track surveys conducted between the Tortuguero river mouth and the mile 5 marker by the research assistants required considerable efforts on part of the 2005 Green Turtle Program team. The results of the surveys are essential to evaluate the effectiveness of

the management actions aimed at reducing the impact of tourism visitation on green turtle nesting. It is strongly suggested that these surveys be continued.

Green turtle nesting between the Tortuguero river mouth and the mile 5 marker represented 16.0% of all green turtle nesting between the river mouth and Jalova lagoon. The greatest nesting density, however, was between miles 5-11. The high nesting levels recorded in 2005 meant that absolute nest densities were high along the entire beach.

Illegal take of nesting green turtles was recorded by the track surveyor from mid-August to early October. Also, the daily track surveys showed that illegal take of green turtle eggs continued throughout the nesting season although the levels of take appeared greater during the first part of the nesting season. Increased marine patrols by park rangers and foot patrols along the northern 5 miles of beach during the beginning of the green turtle nesting season may be a good way to reduce illegal take of nesting turtles and eggs during future green turtle programs and should be encouraged.

The jaguars continue to kill nesting green turtles and many tour guides and Tortuguero villagers report having seen jaguars swimming across the river, particularly in the Caño Negro area. Fortunately, the number of green turtles killed is very small in comparison to the number of nesting green turtles and is not likely to represent a serious survival threat to the Tortuguero green turtle population.

4.1.2 Hawksbill turtles

The very low levels of hawksbill nesting observed at Tortuguero in 2005 are discouraging. To ensure increased hawksbill nesting in the future any action aimed at protecting nesting females, nests or females in the internesting habitat should be encouraged. Hawksbill nesting at Tortuguero are now at such low levels that every female and nest are important (Troëng *et al.* 2005).

4.1.3 Leatherback turtles

A comprehensive discussion of leatherback nesting at Tortuguero in 2005 can be found in de Haro *et al.* (2006).

4.2 Tagging of Nesting Sea Turtles

4.2.1 Green turtles

The goal of 1,000 newly tagged green turtles was successfully achieved in 2005. More green turtles could have been tagged if more tags had been available. Large numbers of previously tagged green turtles (n=615) were also recorded during the night patrols. These data are very useful in terms of estimating tag loss and annual survival probabilities, the latter through open robust design models. It is suggested that CCC conduct such analyses on an annual basis in order to detect any decrease in the survival probabilities.

The observation of nine green turtles tagged at nearby nesting beaches in Costa Rica demonstrates that green turtles can change nesting beaches. Although the vast majority of green turtles nest at Tortuguero, the nine females with non-Tortuguero tags emphasize the

need of coordination of conservation and monitoring activities in Costa Rica. It should also be noted that no green turtle with Tortuguero tags has ever been recorded nesting outside of Costa Rica.

The daily track surveys conducted by the research assistants to evaluate tourism visitation impact, also increased the sample size for tagging efficiency estimates.

Overall within season tag loss was low in 2005, at 3.0%. Tagloss varied with tagger and was much higher during the first month (June) of the program than during the rest of the program. Faulty tag pliers were most likely the reason for the initially high tag loss. Once these pliers had been replaced, and the research assistants had acquired more experience in applying tags, tag loss decreased considerably. Properly functioning tag pliers are a must and any set of pliers that does not appear to be in perfect condition should immediately be discarded to reduce tag loss during future programs. National Band & Tag Company which manufactures the tags and tag pliers have been informed of the faulty pliers and it is hoped that future purchases will not include problem pliers.

4.2.2 Hawksbill turtles

The very few hawksbill turtles encountered during the 2005 program is a discouraging sign. It may be that the conservation efforts on the Tortuguero beach are insufficient to recover the very reduced population given the persistence of in-water threats to Tortuguero hawksbill turtles on their foraging grounds (Troëng *et al.* 2005).

4.2.3 Leatherback turtles

de Haro *et al*. (2006) includes a detailed review of the tagging of leatherback turtles at Tortuguero in 2005.

4.3 Biometric Data Collection

4.3.1 Green turtles

Mean carapace measurements of previously tagged females were greater than those of newly tagged females with evidence of old tag holes or notches and those recorded for newly tagged green turtle females with no such evidence.

Participants had very similar precision to the researcher assistants for both CCLmin and SCLmax measurements. It is important to ensure that research assistants and program participants, receive adequate training prior to measuring nesting turtles. Such training may have to repeated during the program to make sure measurements are recorded as well as possible.

For green turtles measured on two or more occasions, SCLmax had greater precision than the CCLmin measurements. SCLmax should remain the standard Tortuguero green turtle carapace measurement.

4.3.2 Hawksbill turtles

The precision of the SCLmax measurements for hawksbills was the same as for green turtles but the CCLmin measurements were less precise for hawksbill than for green turtles.

4.3.3 Leatherback turtles

de Haro *et al*. (2006) contains information about biometric data collection from leatherback turtles nesting in Tortuguero in 2005.

4.4 Fibropapilloma Assessment

4.4.1 Green turtles

Few (4.7%) of the carefully examined green turtles were recorded as having fibropapillomas and affected turtles had few and small tumors. It is important to continue to collect information on fibropapillomas in Tortuguero green turtles. The collected data provide a baseline should fibropapillomas become more frequent in the future. It should also be recognized that the tumors recorded as fibropapillomas by research assistants may in fact be other tumors or tissue abnormalities. A detailed study, including the collection and analysis of tissue samples from tumors, would clarify if tumors are indeed correctly identified.

4.5 Determination of Nest Survivorship and Hatching Success

4.5.1 Green turtles

The sample size of marked green turtle nests was large in 2005 and mean hatching success was relatively high at 70.7%. Still, the fate of more than 10% of the marked nests could not be determined with certainty. This introduces uncertainty in the results and it is suggested that additional effort be invested in future program to reduce the number of nests with unknown fates. Training in nest marking is one important aspect but it is also important that RAs carefully inspect nests on a daily basis to identify predation and other mortality factors as well as making repeated attempts to locate nests when it is time for excavations.

The frequency of albinism, twins, triplets and deformed embryos was higher than normal. Continued monitoring should help determine if this is a beginning of a trend or just one unusually high value.

4.5.2 Hawksbill turtles

It is encouraging that none of the three marked hawksbill nests were poached or depredated.

4.5.3 Leatherback turtles

No leatherback nests were marked during the 2005 Green Turtle Program, however, information on leatherback nest survivorship and hatching success can be found in de Haro *et al*. (2006).

4.6 Physical Data Collection

4.6.1 Rainfall

Rainfall during the 2005 Green Turtle Program was unusual in that the rainy period which normally begins in June, did not really start until July. Also, rainfall during the June-August period was lower than normal. Rainfall during the late October-end of December period was also lower than normal.

4.6.2 Sand temperature

Rainfall influences sand temperature and ultimately affects hatchling sex ratio. It is likely that the lower than normal rainfall resulted in higher sand temperatures and hence a larger proportion of female hatchlings than normal. The higher than normal sand temperatures during June are particularly noteworthy.

4.7 Collection of Human Impact Data

4.7.1 Visitors to Tortuguero

The decrease in visitation to the CCC Natural History and Visitors Center is worrisome, especially as tourism visitation to Tortuguero National Park as a whole continues to grow and reached over 87,000 visitors in 2005. It is clear that the CCC Natural History and Visitors Center urgently needs new and more varied displays to attract more visitors. Poor management on behalf of the Visitor Center Administrator can not be ruled out and the hiring of a new Visitor Center Administrator, from Tortuguero village, in December 2005 appears to have been a very wise move.

4.7.2 Capacity of hotels and cabinas

The reason for the overall capacity of the cabinas decreasing in 2005 is because more cabina owners choose to rent rooms to locals rather than to tourists. Although this is likely to increase the occupancy of local cabinas and reduce the time the owner has to invest in managing the cabinas, it may also be a consequence of the hotels controlling most visitation to Tortuguero and the increased need for housing for people moving to the Tortuguero area.

4.7.3 Turtle tours

The continued implementation of the new turtle-tour visitation system, began as a pilot project in 2004, has been successful in reducing the impact on nesting turtles (de Haro *et al.* in press). The next, crucial, step is to establish a sustainable funding mechanism to ensure the system can be implemented throughout the green turtle nesting season. In 2005, the system had to be terminated early due to a lack of funds, stemming from the fact that some hotel owners went back on their word and did not contribute funds for the second half of the nesting season. This shows the urgent need to find other permanent funding mechanisms, such as a fee for each person participating in the turtle-tours.

The pilot project created thirteen seasonal job positions for Tortuguero villagers (six more than during 2004), paid for by the hotel and business owners, which must been seen as very positive.

It is suggested that the new visitation system be continued and that monitoring to evaluate its success be maintained.

4.7.4 Artificial lights

Near beach vegetation continues to be cleared in front of the village, in front of hotels and at the southern end of the airstrip. Hotel and beach front property owners should be encouraged to maintain or replant native vegetation to reduce light pollution. Vegetation has the added benefit of providing protection against the corrosion of roofs and other metal building materials.

4.7.5 Hatchling orientation

Data on hatchling orientation were collected in 2005 and represents important baseline information. If artificial lights continue to increase to the point where orientation is compromised, we should be able to detect changes in the overall hatchling orientation.

4.8 Environmental Education Activities

The many joint events undertaken by the CCC and the Tortuguero school and high school were educational both for the school children and for the research assistants. It would be desirable to expand the environmental education activities during future programs. Also, it should be noted that innovative and interactive sessions have proven to be much more popular with the school children than traditional classroom activities.

5. REFERENCES

Carr, A., Carr, M.H., Meylan, A.B. 1978. The ecology and migrations of sea turtles, 7. The west Caribbean green turtle colony. *Bull. Amer. Mus. Nat. Hist.* 162, 1-46.

de Haro, A., Troëng, S., Harrison, E., Silman, R., Rodríquez, D., Obando E. In press. Evaluation of new turtle-tour visitation system at Tortuguero, Costa Rica. Proceedings of the 26th Annual Symposium on Sea Turtle Biology and Conservation, April 2006, Crete, Greece.

de Haro, A., Troëng, S., Antman, P., Castillo, V., Garcés, P., Frohlich, C., Marín, A., Palomares, I., Reinhold, L., Sagone, A. 2006. Report on the 2005 Leatherback Program at Tortuguero, Costa Rica. Unpublished reported presented to Caribbean Conservation Corporation, the Ministry of Environment and Energy of Costa Rica. 25 pp.

Troëng, S., Rankin, E. 2005. Long-term conservation efforts contribute to positive green turtle *Chelonia mydas* nesting trend at Tortuguero, Costa Rica. *Biol. Conserv.* 121, 111-116.

Troëng, S., Dutton, P., Evans, D. 2005. Migration of hawksbill turtles *Eretmochelys imbricata* from Tortuguero, Costa Rica. *Ecography* 28(3), 394-402.

Wetherall, J.A. 1982. Analysis of double-tagging experiments. *Fish. Bull.* 80, 687-701.

Figure 1. Seasonal distribution of green turtle nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18)

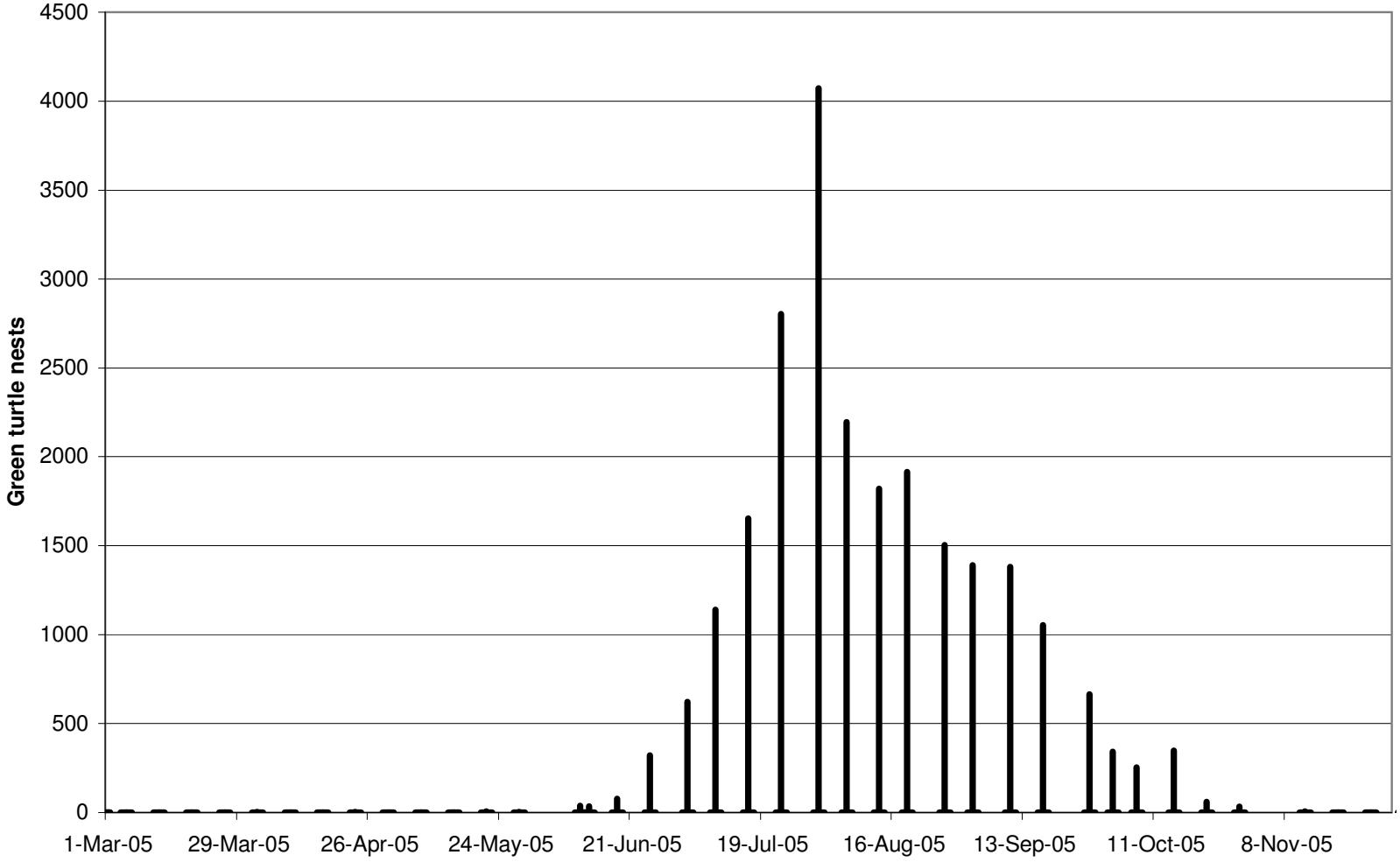


Figure 2. Seasonal distribution of green turtle nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to the mile 5 marker.

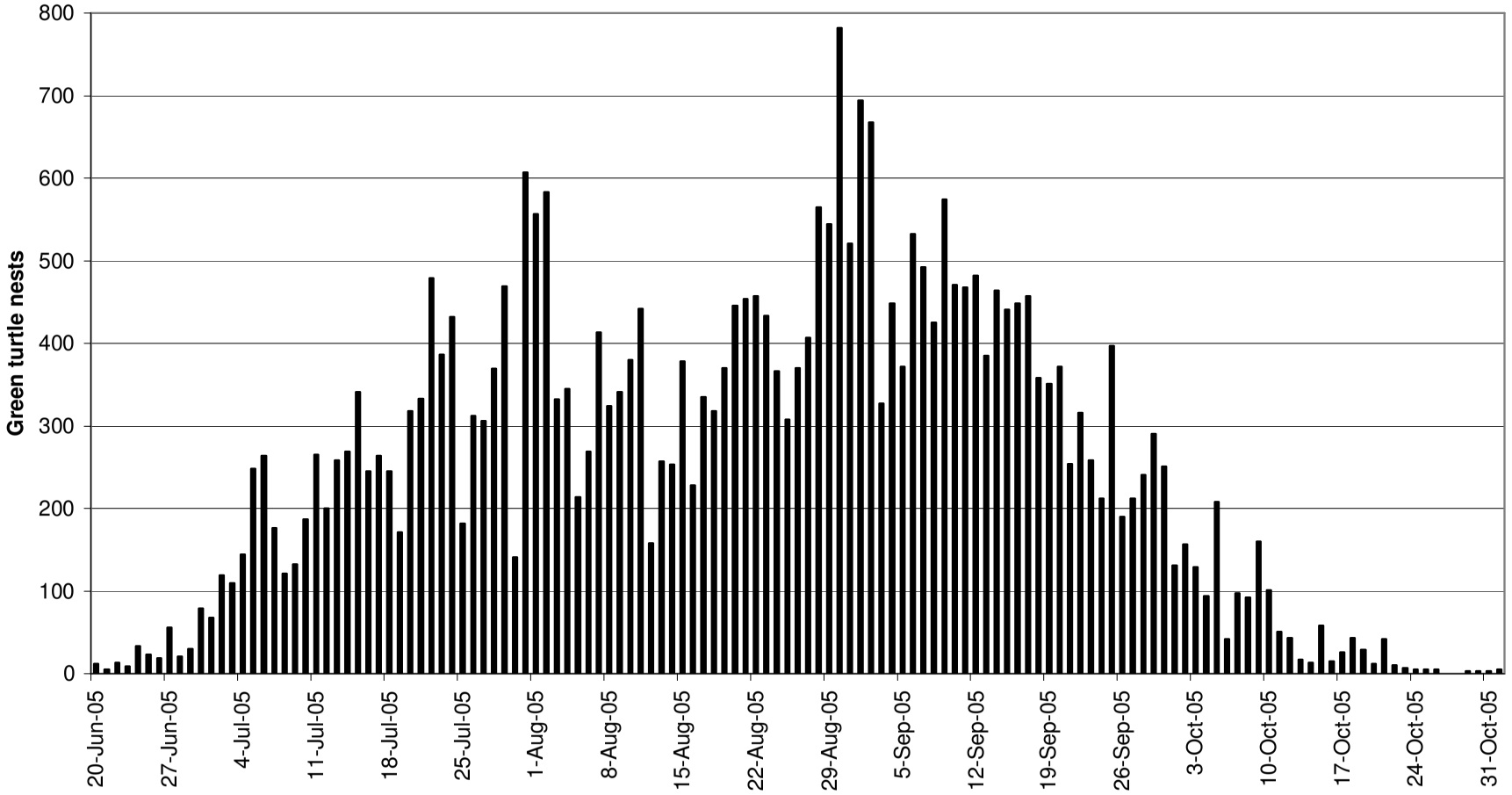


Figure 3. Spatial distribution of green turtle nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

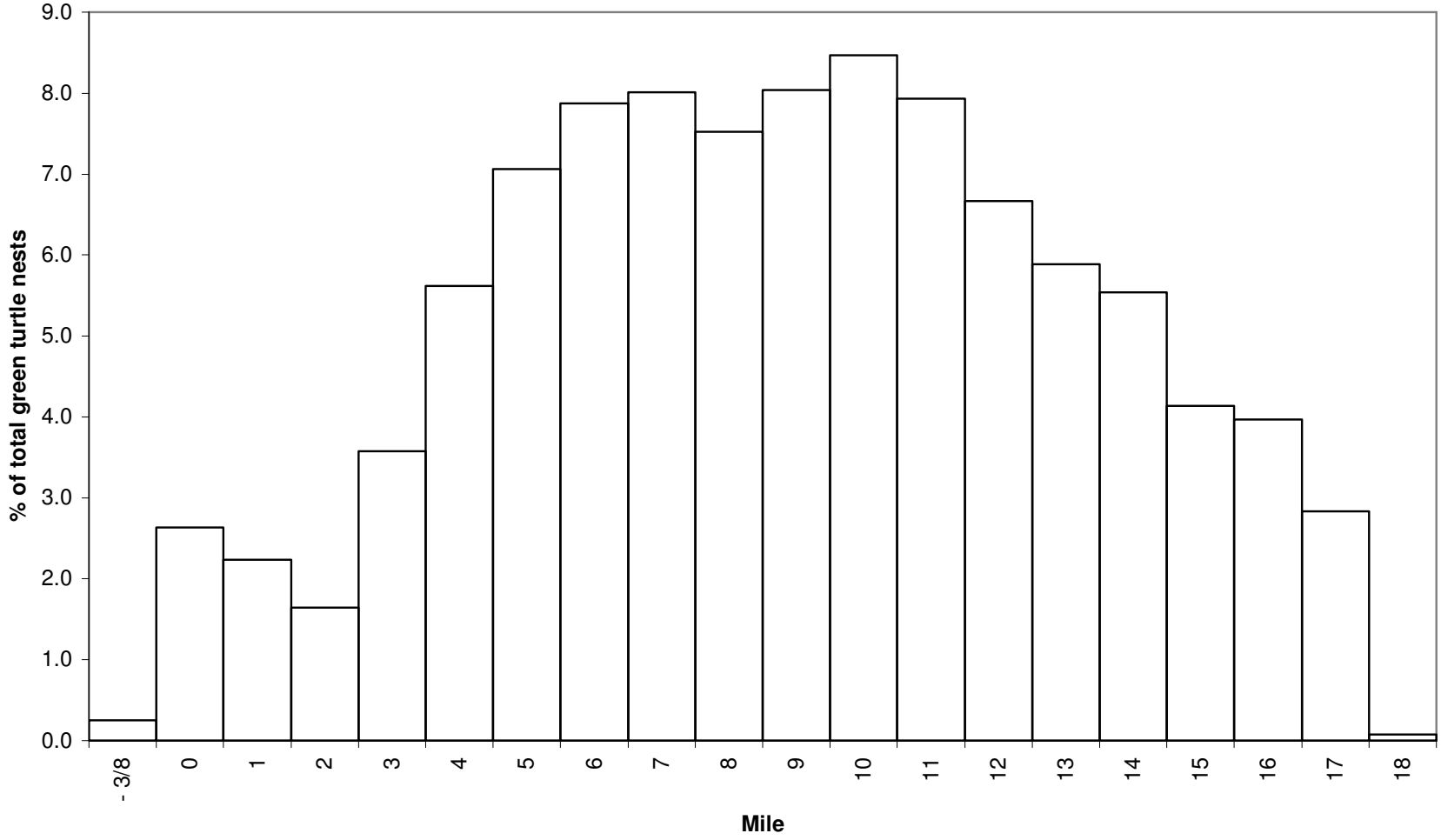


Figure 4. Illegal take of green turtles as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

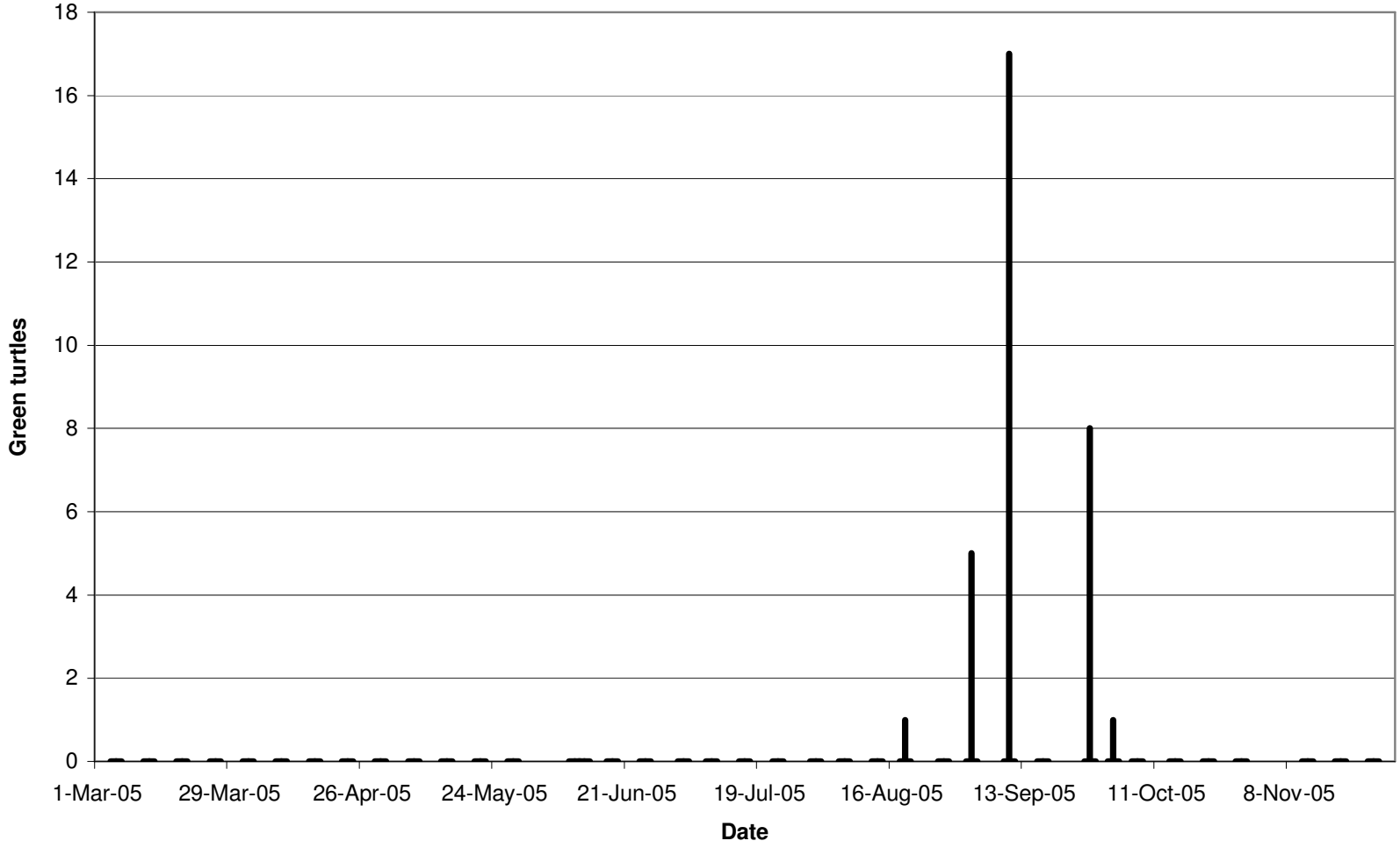


Figure 5. Green turtles killed by jaguars from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

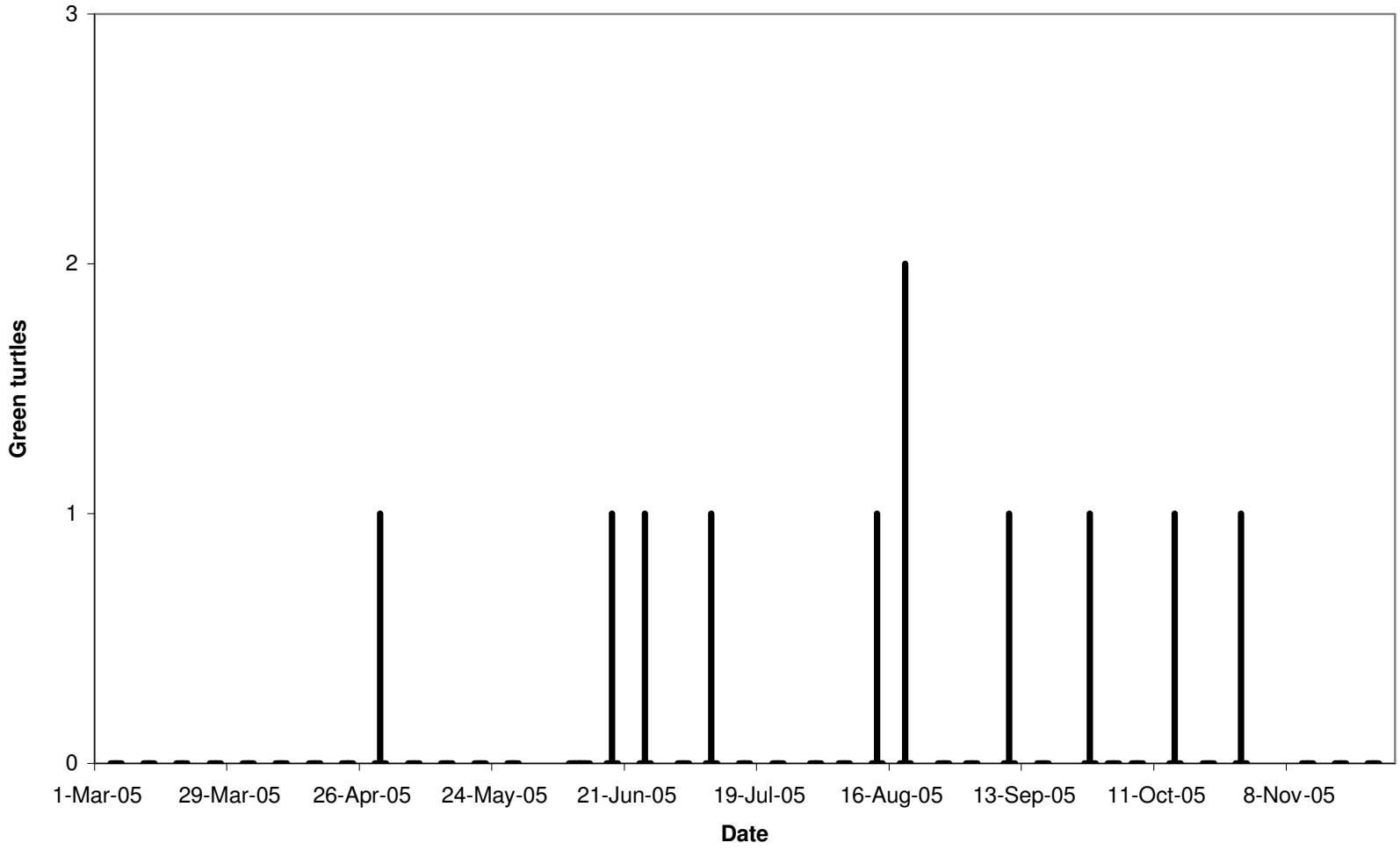


Figure 6. Seasonal distribution of hawksbill nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

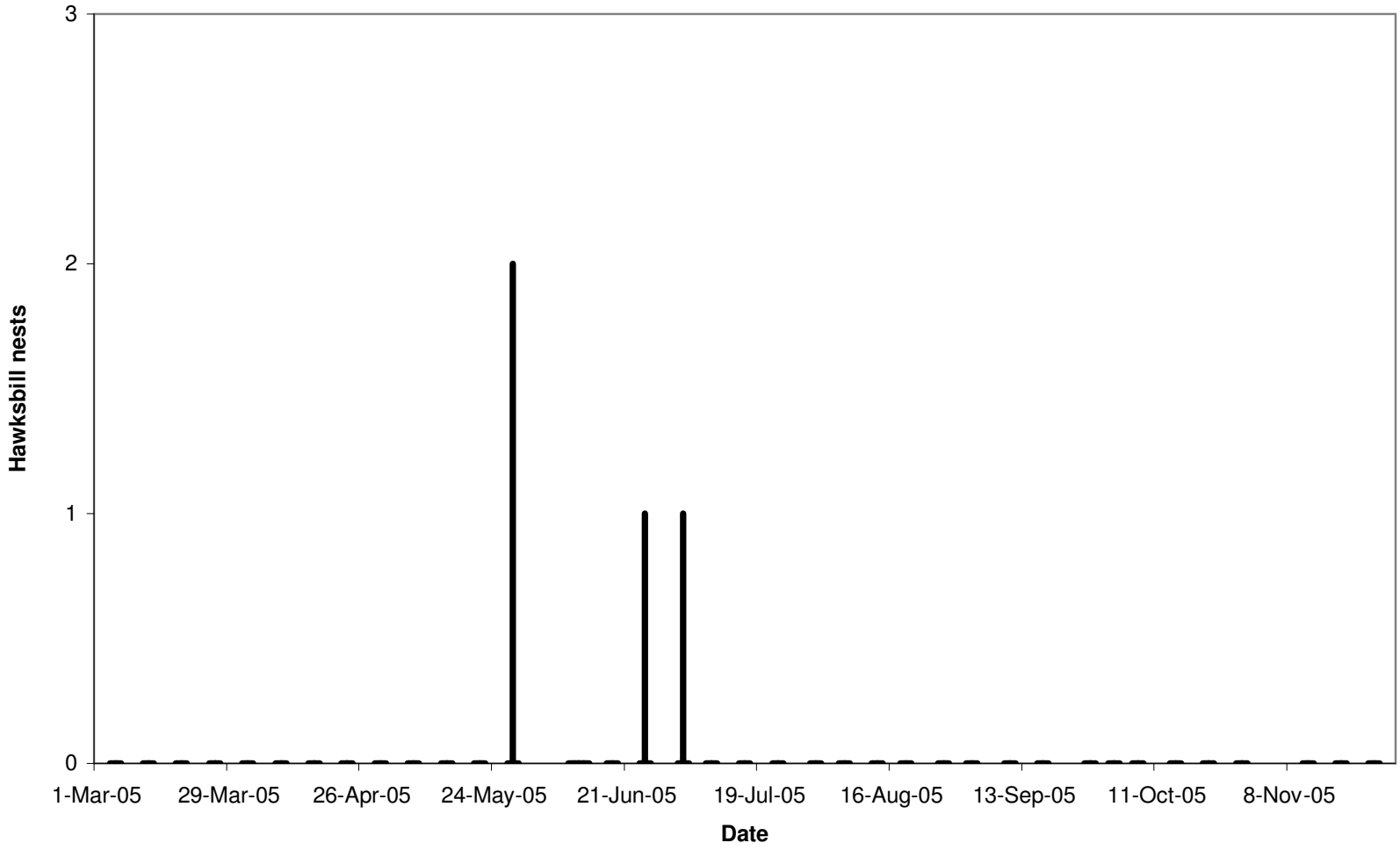


Figure 7. Seasonal distribution of leatherback nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

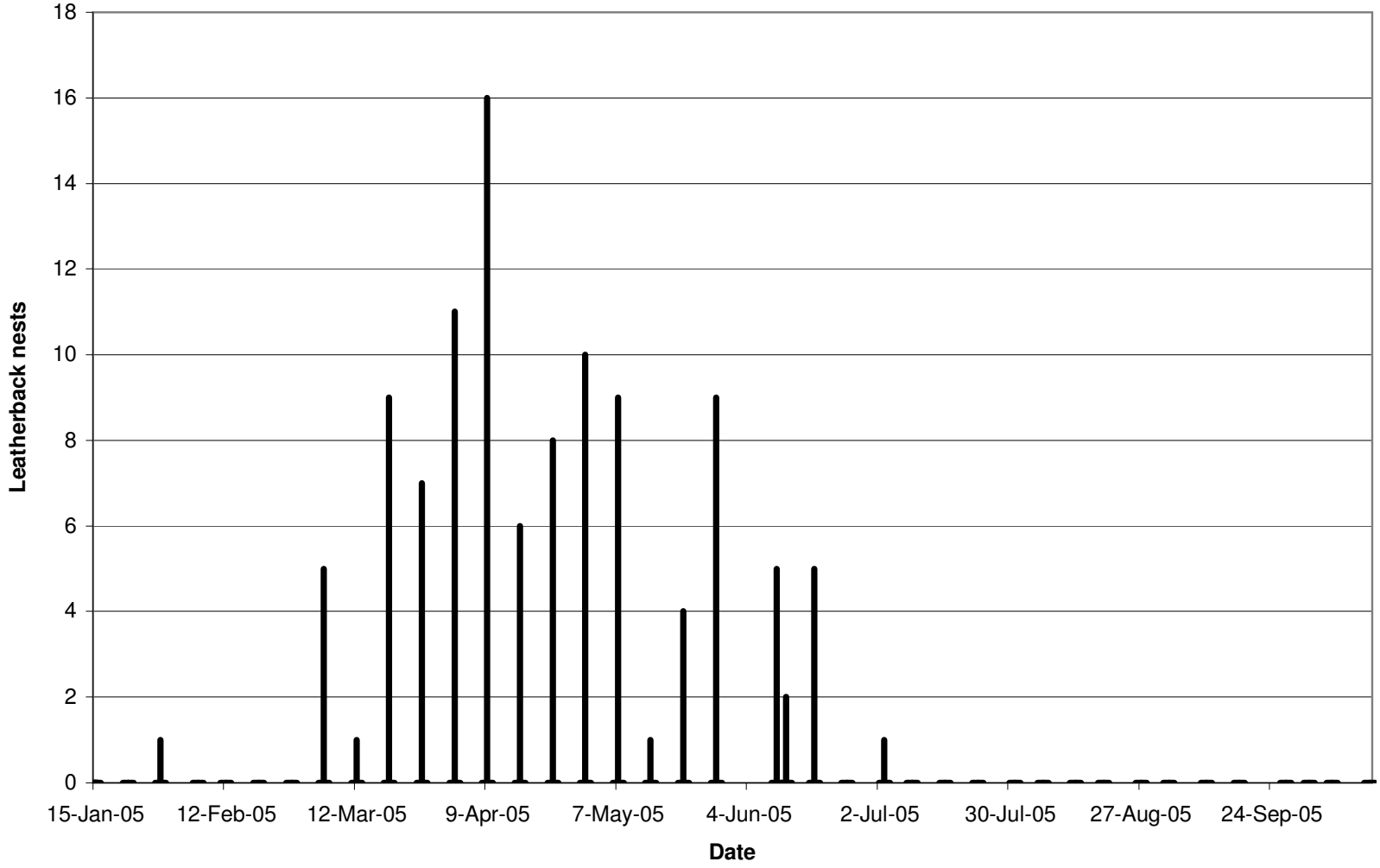


Figure 8a. Spatial distribution of illegal egg take.

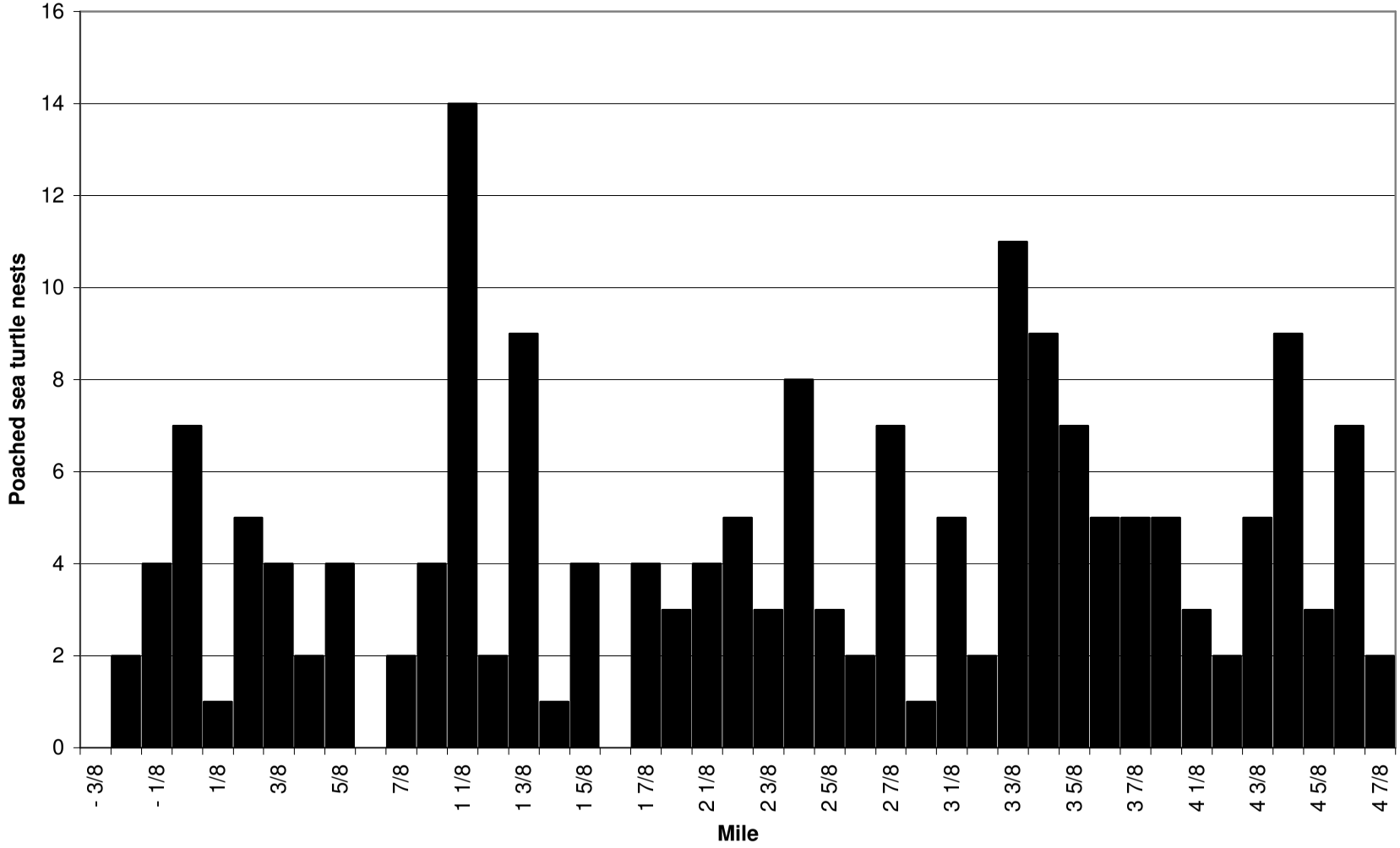


Figure 8b. Temporal distribution of illegal egg take.

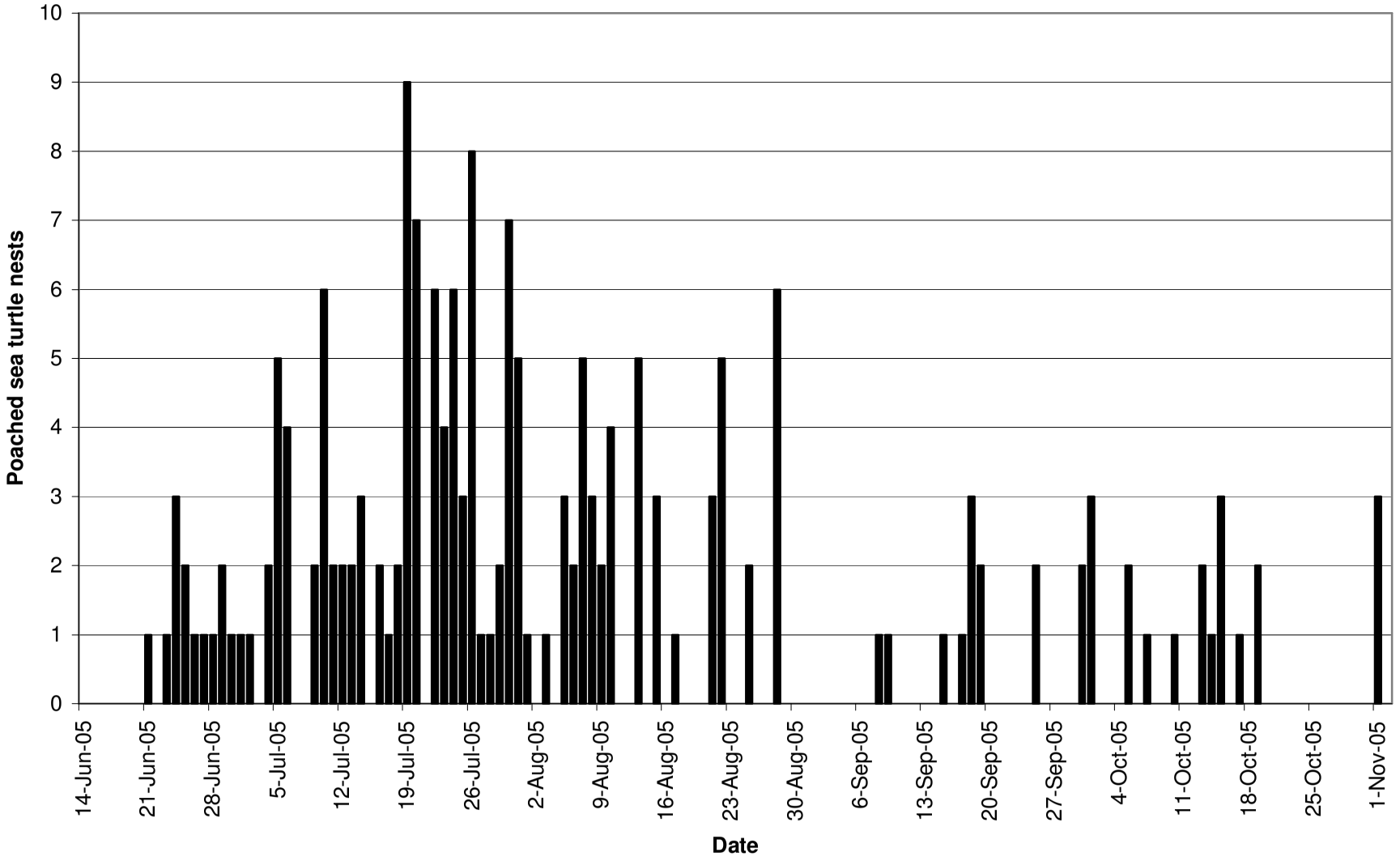


Figure 9. Sand temperatures.

Figure 9a. Temperature at 70 cm depth, open zone.

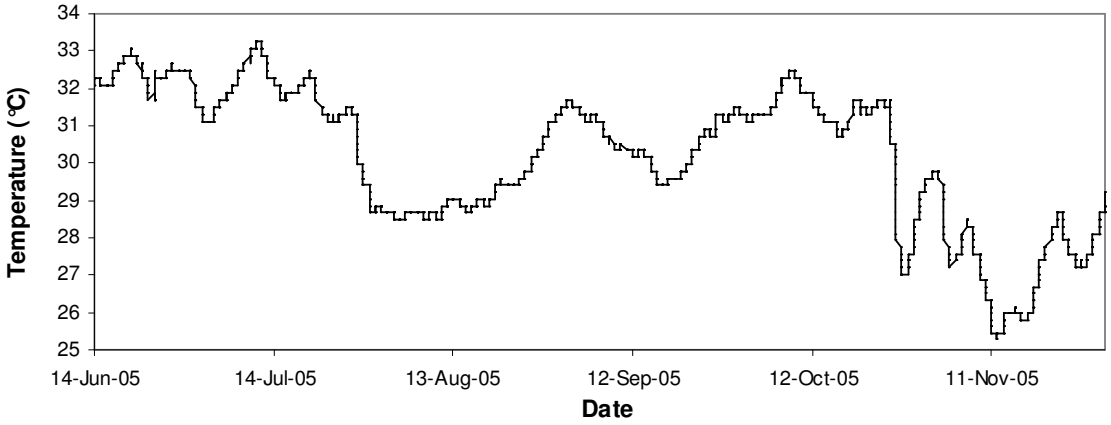


Figure 9b.Temperature at 70 cm depth, border zone.

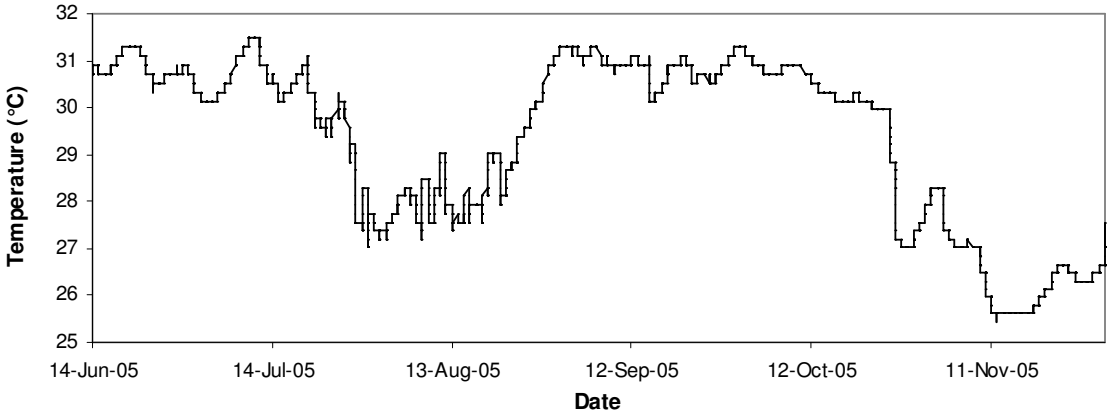


Figure 9c.Temperature at 70 cm depth, vegetation zone.

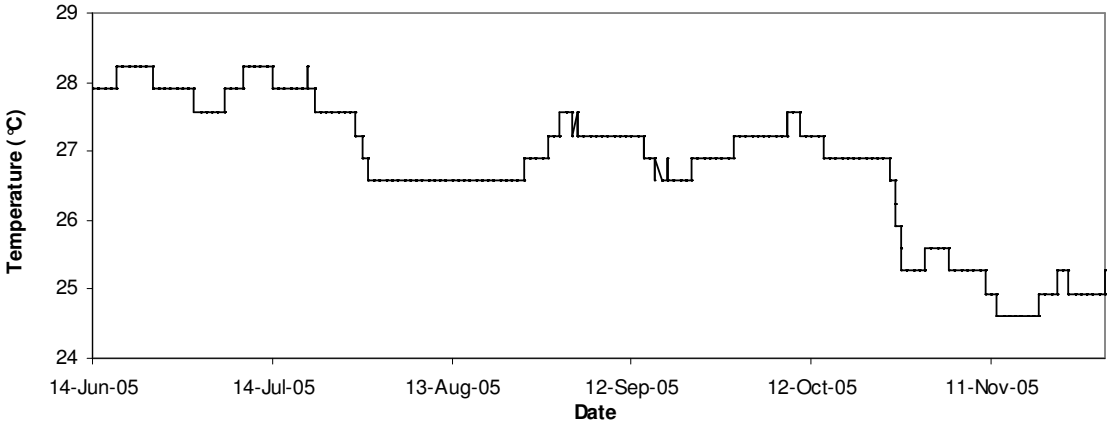


Figure 10. Recaptures of green turtles tagged at Tortuguero, by country.

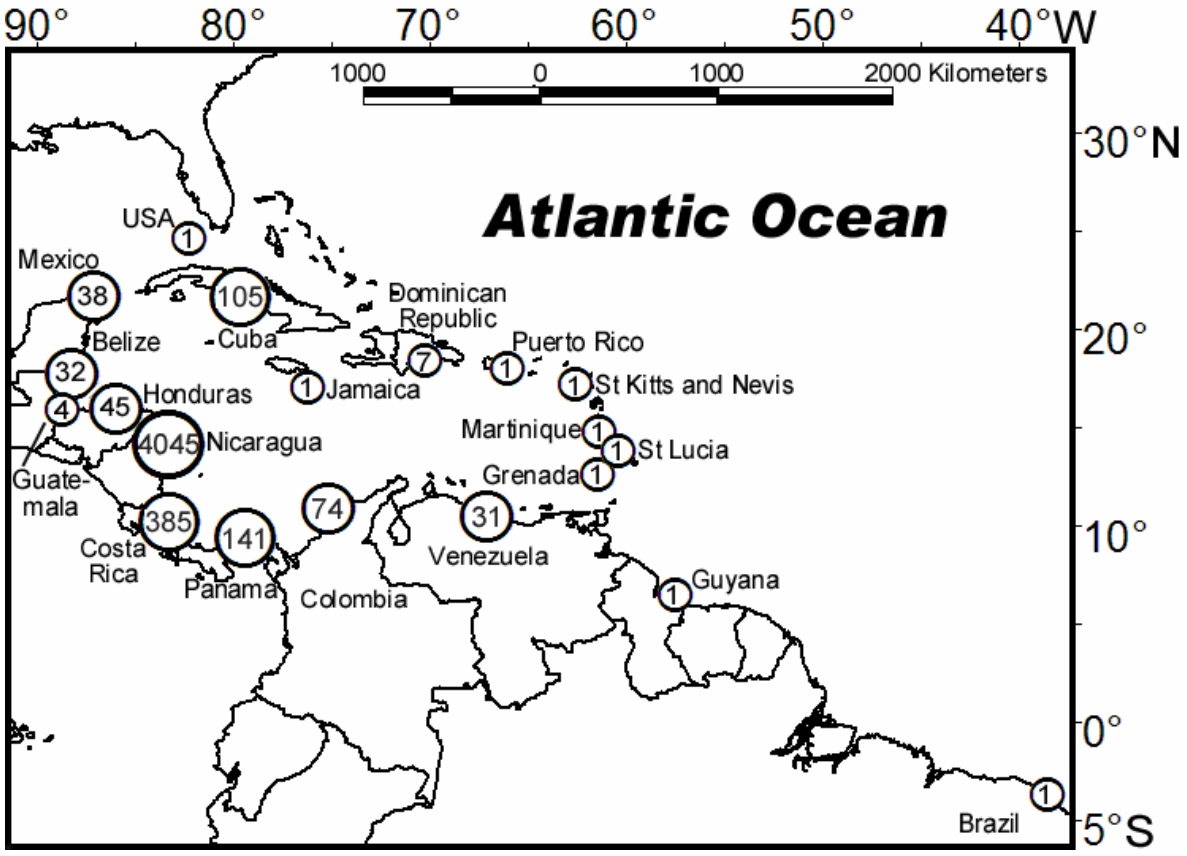
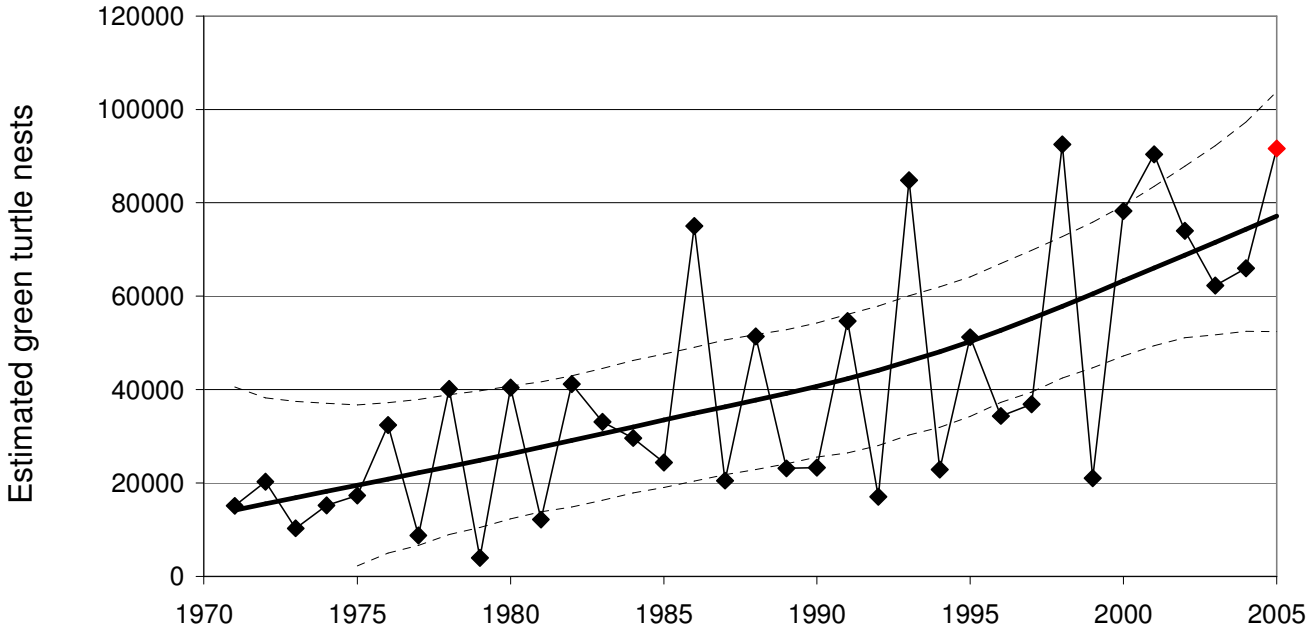


Figure 11. Green turtle nesting trend at Tortuguero.

For analysis methodology consult Troëng & Rankin (2005).

11a. Northern 18 km



11b. Entire beach

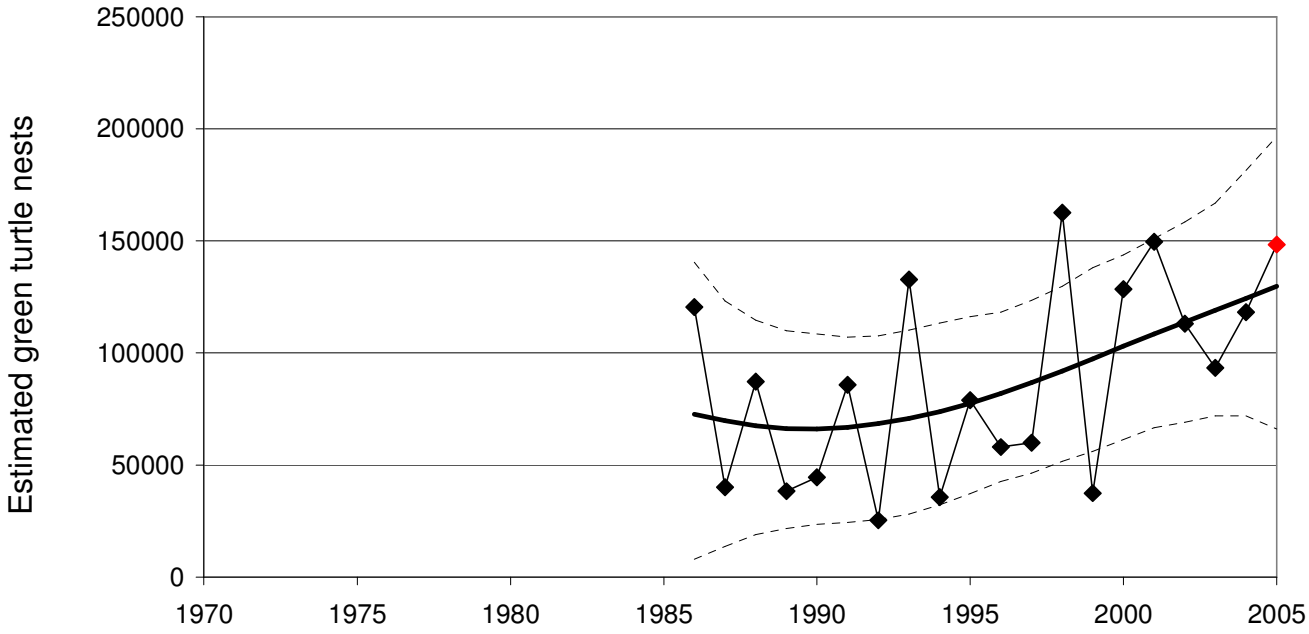
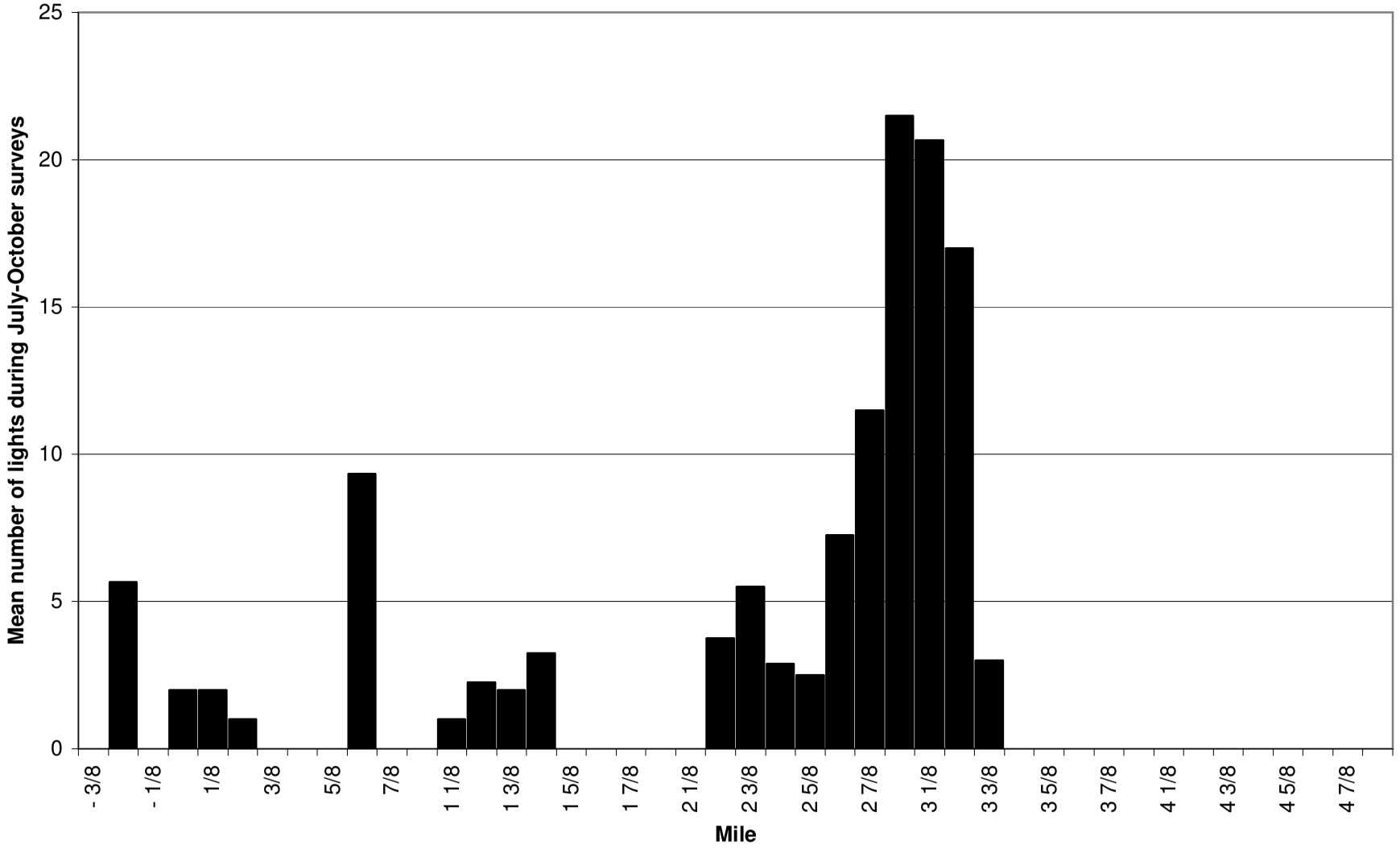


Figure 12. Results of light surveys between Tortuguero river mouth and mile 5 marker.



APPENDIX 1. Sea Turtle Encounters During Regular Night Patrols

	Green turtles				Leatherback turtles				Hawksbill turtles			
Date	Newly tagged	Previously tagged	Renester	Total	Newly tagged	Previously tagged	Renester	Total	Newly tagged	Previously tagged	Renester	Total
8-Jun-05			0	0				0				0
9-Jun-05			0	0				0				0
10-Jun-05			0	0				0				0
11-Jun-05			0	0				0				0
12-Jun-05			0	0				0				0
13-Jun-05			0	0				0				0
14-Jun-05			1	1				0				0
15-Jun-05			0	1				0				0
16-Jun-05			0	1				0				0
17-Jun-05	1		0	2				0	1			1
18-Jun-05	2	1	0	5				0				1
19-Jun-05	2	1	0	8				0				1
20-Jun-05	2	2	0	12				0				1
21-Jun-05	4		0	16		1		1				1
22-Jun-05	4	3	0	23				1				1
23-Jun-05	11	3	1	38				1				1
24-Jun-05	11	3	0	52				1			1	2
25-Jun-05	4	3	0	59	1			2				2
26-Jun-05	9	7	1	76				2				2
27-Jun-05	5	3	1	85				2				2
28-Jun-05	6	3	0	94				2				2
29-Jun-05	5	7	0	106				2				2
30-Jun-05	7	5	0	118				2				2
1-Jul-05	12	6	1	137				2				2
2-Jul-05	11	3	1	152				2	2			4
3-Jul-05	10	5	0	167				2				4
4-Jul-05	15	4	1	187				2				4
5-Jul-05	15	1	1	204				2				4
6-Jul-05	9	3	1	217		1		3				4
7-Jul-05	12	5	3	237				3				4
8-Jul-05	10	4	0	251				3				4
9-Jul-05	15	4	0	270				3				4
10-Jul-05	12	6	2	290				3				4
11-Jul-05	16	4	1	311				3				4
12-Jul-05	16	6	2	335				3				4
13-Jul-05	11	5	1	352				3				4
14-Jul-05	16	8	0	376				3				4
15-Jul-05	15	2	1	394				3				4
16-Jul-05	18	5	1	418				3				4
17-Jul-05	14	9	2	443				3				4
18-Jul-05	13	5	4	465				3				4
19-Jul-05	9	6	4	484				3				4
20-Jul-05	25	8	7	524				3				4
21-Jul-05	18	16	3	561				3				4
22-Jul-05	17	9	4	591				3				4
23-Jul-05	25	4	3	623				3				4

24-Jul-05	8	3	2	636		3		4
25-Jul-05	13	5	3	657		3		4
26-Jul-05	13	4	2	676		3		4
27-Jul-05	8	3	5	692		3		4
28-Jul-05	9	7	7	715		3		4
29-Jul-05	9	7	4	735		3		4
30-Jul-05	20	11	7	773		3		4
31-Jul-05	10	7	5	795		3		4
1-Aug-05	16	8	3	822		3		4
2-Aug-05	10	5	8	845		3		4
3-Aug-05	13	4	3	865		3		4
4-Aug-05	11	7	2	885		3		4
5-Aug-05	14	5	5	909		3		4
6-Aug-05	16	10	1	936		3		4
7-Aug-05	15	7	3	961		3		4
8-Aug-05	10	9	5	985		3		4
9-Aug-05	16	7	7	1015		3		4
10-Aug-05	13	6	10	1044		3		4
11-Aug-05	9	5	4	1062		3		4
12-Aug-05	12	5	2	1081		3		4
13-Aug-05	21	5	6	1113		3		4
14-Aug-05	19	9	6	1147		3		4
15-Aug-05	14	7	4	1172		3		4
16-Aug-05	23	6	7	1208		3		4
17-Aug-05	14	7	5	1234		3		4
18-Aug-05	21	3	12	1270		3		4
19-Aug-05	15	4	6	1295		3		4
20-Aug-05	18	7	7	1327		3		4
21-Aug-05	10	6	3	1346		3		4
22-Aug-05	14	6	6	1372		3		4
23-Aug-05	13		4	1389		3		4
24-Aug-05	11	2	7	1409		3		4
25-Aug-05	10	7	6	1432		3		4
26-Aug-05	12	5	4	1453		3		4
27-Aug-05	14	5	6	1478		3		4
28-Aug-05	13	6	6	1503		3		4
29-Aug-05	8	4	3	1518		3		4
30-Aug-05	7	7	1	1533		3		4
31-Aug-05	10	4	3	1550		3		4
1-Sep-05	8		4	1562		3		4
2-Sep-05	9	2	2	1575		3		4
3-Sep-05	8	4	6	1593		3		4
4-Sep-05	9	7	9	1618		3		4
5-Sep-05	18	3	7	1646		3	1	5
6-Sep-05	14	2	8	1670		3		5
7-Sep-05	14	8	4	1696		3		5
8-Sep-05	11	9	4	1720		3		5
9-Sep-05	4	13	8	1745		3		5
10-Sep-05	3	10	5	1763		3		5
11-Sep-05	4	6	12	1785		3		5
12-Sep-05	3	10	2	1800		3		5

13-Sep-05	4	7	11	1822			3				5
14-Sep-05	4	7	7	1840			3				5
15-Sep-05	3	9	8	1860			3				5
16-Sep-05	5	9	11	1885			3				5
17-Sep-05	2	12	12	1911			3				5
18-Sep-05	4	8	15	1938			3				5
19-Sep-05	2	15	8	1963			3				5
20-Sep-05	3	7	6	1979			3				5
21-Sep-05	1	12	14	2006			3				5
22-Sep-05	2	5	7	2020			3				5
23-Sep-05	4	4	2	2030			3				5
24-Sep-05			0	2030			3				5
25-Sep-05	3		6	2039			3				5
26-Sep-05	1	5	7	2052			3				5
27-Sep-05	2	2	7	2063			3				5
28-Sep-05	2	4	5	2074			3				5
29-Sep-05	2	4	3	2083			3				5
30-Sep-05	2	3	2	2090			3				5
1-Oct-05	1	6	8	2105			3				5
2-Oct-05		2	2	2109			3				5
3-Oct-05		1	5	2115			3				5
4-Oct-05		5	5	2125			3				5
5-Oct-05			2	2127			3				5
6-Oct-05		3	1	2131			3				5
7-Oct-05		2	8	2141			3				5
8-Oct-05		2	2	2145			3				5
9-Oct-05		2	7	2154			3				5
10-Oct-05		3	3	2160			3				5
11-Oct-05		2	3	2165			3				5
12-Oct-05		1	3	2169			3				5
13-Oct-05			3	2172			3				5
14-Oct-05			0	2172			3				5
15-Oct-05			0	2172			3				5
16-Oct-05			4	2176			3				5
17-Oct-05		2	7	2185			3				5
18-Oct-05		2	0	2187			3	1			6
19-Oct-05			1	2188			3				6
20-Oct-05			2	2190			3				6
21-Oct-05			1	2191			3				6
22-Oct-05		1	1	2193			3				6
23-Oct-05			0	2193			3				6
24-Oct-05			0	2193			3				6
25-Oct-05			0	2193			3				6
26-Oct-05			0	2193			3				6
27-Oct-05			0	2193			3				6
28-Oct-05			1	2194			3				6
29-Oct-05			0	2194			3				6
30-Oct-05			0	2194			3				6
Total	**1071**	**615**	**508**	**2194**	**1**	**2**	**0**	**3**	**5**	**1**	**0**	**6**

APPENDIX 2. Notes and Anecdotal Information on Illegal Take of Turtles

CCC personnel recorded numerous poaching incidents during the 2005 Green Turtle Program. The large number of poaching incidents recorded in 2005 is more likely a result of increased survey effort due to the daily track surveys conducted by the research assistants than caused by an increase in the illegal take of eggs in Tortuguero. The poaching of ten green turtles, 184 green turtle nests, and one hawksbill nest were recorded by the 2005 Green Turtle Program team.

In addition, the CCC track surveyor recorded the poaching of 32 green turtles and six green turtle nests during the weekly 18-mile surveys.