



REPORT ON THE 2004 GREEN TURTLE PROGRAM AT TORTUGUERO, COSTA RICA

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EXECUTIVE SUMMARY

Monitoring and Research Activities Conducted

1. During 2004, a total of 52 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 28 February and 27 November, 2004, with peak nesting recorded on 4 September when 3,102 nests were counted. A total of 13.5% of all green turtle nests recorded during track surveys were deposited between Tortuguero river mouth (mile -3/8) and mile 5, where most night patrols take place.
3. During daily track surveys conducted by research assistants between 21 June and 31 October (with the exception of 27 August and 16 October), a total of 12,442 green turtle nests and 16,896 green turtle half-moons were recorded between the Tortuguero river mouth and the mile 5 marker.
4. The track surveyor did not record the illegal take of nesting green turtles in 2004. Green turtle nest poaching was recorded during 12 track surveys and a total of 232 green turtle nests were recorded as poached.
5. Jaguar predation continued, with a minimum of 48 turtles killed during the 2004 Green Turtle Program.
6. Hawksbill nesting density was very low throughout the season, with 0-1 nests/night recorded between April and October.
7. A total of 1,099 green turtles were newly tagged, 374 green turtles with tags from previous years and 403 renesters were recorded during 1,689 team hours of night patrols between 14 June and 29 October.
8. Three green turtles from other projects were encountered nesting in 2004; two were tagged on the beach in Pacuare Nature Reserve and one in Parismina, in Costa Rica.
9. Overall probability of within-season tag loss from first to last encounter was high at 0.083, 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 12.5% of cases.
11. Tagging efficiency for night patrols varied from 0%-50%, with a mean of 10.3%, for nights preceding track surveys (n = 125).
12. Green turtles encountered during night patrols nested in the open zone in 38.7% of cases (n = 723), 39.8% (n = 744) were located in the border zone and 12.4% (n = 232) in the vegetation zone. 9.1% of turtles were encountered during a half-moon (n = 170).
13. Three hawksbill turtles were newly tagged, and one renester were encountered during the 2004 Green Turtle Program.
14. Two of the hawksbill nests were laid in the border zone and one in the vegetation.
15. Two leatherback turtles were encountered during the 2004 Green Turtle Program; one with tags from another beach and one renester.
16. Mean carapace length for newly tagged green turtle females without evidence of previous tagging was 104.1 cm (CCLmin) and 98.1 cm (SCLmax); for newly tagged green turtle females with old tag holes or notches 105.2 cm (CCLmin) and 98.9 cm (SCLmax), and for previously tagged females 105.4 cm (CCLmin) and 99.3 cm (SCLmax). Mean clutch size for the same groups of females was 111 eggs, 108 eggs and 111 eggs, respectively.

17. Measurement precision of green turtles was the same for CCLmin than for SCLmax within a single encounter. For turtles encountered three or four times SCLmax measurements were more precise.
18. Mean carapace length for newly tagged hawksbill turtles was 86.1 cm (CCLmin) and 82.7 cm (SCLmax).
19. Mean carapace length of previously tagged leatherbacks was 156.2 cm (CCLmin).
20. A total of five green turtles representing 3.1% of 159 carefully examined individuals were recorded as having fibropapilloma tumors. All affected turtles had tumors (2-6 cm in size) on the shoulder and neck area, and two had tumors in the front flippers.
21. A total of 184 green turtle nests were marked and the fate of 144 determined. Overall hatching success was 56.5% (8,269 empty shells from 14,623 eggs) and overall emerging success was 55.3% (8,089 emerged hatchlings from 14,623 eggs).
22. The biggest cause of nest loss was other nesting females destroying 26 nests (18.1%) and depredation affecting 12 nests (8.3%). Poaching affected 9 nests (6.3%).
23. Comparison between egg counts at excavation and the moment of oviposition showed a mean difference of 6.9 more eggs counted at the time of laying.
24. Mean depth for undisturbed green turtle nests (n=80) at excavation was 56 cm from the sand surface to the top egg and 71 cm to the bottom of the egg chamber.
25. The mean incubation period for undisturbed green turtle nests (n=54) was 56 days.
26. A total of two albino and deformed embryos were observed in unhatched eggs in undisturbed nests and unhatched nests, accounting for 0.02% of eggs.
27. Two hawksbill nests were monitored and their fate determined. Overall hatching success was 37.2 % (119 empty shells from 320 eggs) and overall emerging success was 36.6 % (117 emerged hatchlings from 320 eggs).
28. Mean depth for undisturbed hawksbill nests (n=2) at excavation was 36 cm from the sand surface to the top egg and 54 cm to the bottom of the egg chamber.
29. November was the wettest month of the 2004 Green Turtle Program (842.3 mm) and September was the month with least rain (22.4 mm).
30. The sand temperature data loggers were stolen in August and new data loggers were buried on 24 August. Mean monthly sand temperatures for months with data were highest in September and lowest in December.
31. Ground water levels monitoring was discontinued as the PVC pipes used to measure ground water level kept get washed out or filled with sand.
32. A total of 30,617 persons visited the CCC Natural History and Visitors Center in 2004.
33. Tourist visitation to Tortuguero National Park (TNP) increased in 2004, to 80,319 paying visitors. Entrance fees to Tortuguero Conservation Area (TNP and Barra del Colorado Wildlife Refuge) raised a total of ¢181,222,983 (~ US\$423,700).
34. The capacity of hotels and cabinas in the Tortuguero area increased to 599 rooms (1,365 beds) in 2004.
35. A total of 31,655 tourists were issued permits to go on guided turtle walks in 2004.
36. Many artificial lights are still visible on the beach. The majority of lights are from the village, between mile 2 3/8 – 3 3/8. Some lights are also visible from several of the bigger hotels located north of Tortuguero village. Clearing of vegetation in front of Mawamba Lodge in June 2004 increased the visibility of lights from the beach. The Costa Rican Electricity Institute (ICE) replaced three Tortuguero village street lights with low pressure sodium lights.

Conclusions

1. The majority of green turtle nests (99.8%) recorded during track surveys were laid between 15 June and 31 October.
2. These results of the daily track surveys conducted by the Green Turtle Program team are essential to evaluate the impact of tourism visitation on green turtle nesting.
3. Studies focusing on density dependence are best conducted between miles 6 and 12 but most other types of studies can be conducted between the Tortuguero river mouth and the mile 5 marker.
4. The levels of illegal take of nesting turtles was very low in 2004, possibly as a result of increased marine patrols by park rangers during the beginning of the season that acted as a deterrent to poachers.
5. Jaguar predation and encounters were reported frequently, but at present does not represent a significant threat to the green turtle population.
6. The level of hawksbill nesting at Tortuguero was very low in 2004.
7. The goal of 1,000 newly tagged green turtles was achieved quite late during the 2004 Green Turtle Program, due to relatively low nesting levels during the first months of the Program.
8. The observation of three green turtles tagged at nearby nesting beaches demonstrate that green turtles can move between nesting beaches in Costa Rica.
9. Daily track surveys conducted by the Green Turtle Program team to evaluate tourism visitation impact, also provided data which allowed for a better estimate of tagging efficiency.
10. Overall within season tag loss was high in 2004, at 8.3%. Faulty tag pliers may have been the reason for the high tag loss.
11. Mean carapace measurements of previously tagged females and newly tagged females with evidence of old tag holes or notches were greater than those of newly tagged green turtle females.
12. Participants showed slightly lower precision than researchers for both CCLmin and SCLmax measurements.
13. For green turtles measured on three or four occasions, SCLmax had greater precision than the CCLmin measurements.
14. The precision of CCLmin measurements for hawksbills was the same as for green turtles.
15. Few (3.1%) of the carefully examined green turtles had any evidence of fibropapillomas.
16. Green turtle hatching and emergence success was relatively low at 56.5% hatching and 55.3% emerging success.
17. The excavation of nests by other turtles can not realistically be avoided but dog and human predation can be controlled. Veterinarians from the Human Society of the United States began the process of reducing the Tortuguero dog population in 2004.
18. The destiny of more nests (n=36) than normal could not be determined with certainty. It is unclear if this affected the hatching and emergence success estimates.
19. It is positive that the frequency of albinism, twins and deformed embryos was very low in 2004.
20. It is encouraging that none of the two marked hawksbill nests were poached or depredated.

21. Heavy rainfall coupled with rough seas and high tides eroded much of the beach during the first part of the Green Turtle Program.
22. The high rainfall resulted in low mean minimum air temperatures, particularly in June and July.
23. The theft of the data loggers in early August resulted in the loss of sand temperature data from mid/late June until late August.
24. The severe erosion meant that the PVC tubes used to measure ground water levels were frequently washed out or filled with sand.
25. Tourism visitation to Tortuguero National Park continues to grow rapidly and reached over 80,000 visitors in 2004.
26. The capacity of hotels and cabinas in the Tortuguero area are increasing. It is encouraging to see local cabinas increasing as this may indicate that more people benefit from the Tortuguero tourism.
27. The pilot project to reduce the impact of tourism visitation along the public beach resulted in less difference in visitation to the two beach sections (public and park) than during previous years.
28. The pilot project created seven new work positions for local Tortuguero villagers which must be seen as very positive.
29. The Costa Rican Electricity Institute (ICE) initiative to replace some of the near beach street lights in Tortuguero with low pressure sodium lights should be applauded.
30. The removal of native beach vegetation in front of Mawamba Lodge and in front of some of the beach front properties in Tortuguero village is unfortunate.
31. The many joint events undertaken by the CCC and the Tortuguero school and high school were educational both for the students and for the Green Turtle Program team.

Recommendations

1. It is suggested that daily tracks surveys between the Tortuguero river mouth and the mile 5 marker be continued as long as the pilot project tourism visitation system is in place.
2. Increased marine patrols by park rangers during the early part of the green turtle nesting season should be encouraged.
3. Tortuguero National Park would be an ideal site for a study on jaguar behavior and feeding biology.
4. Any action that protect nesting hawksbill females, nests or hawksbill females in the interesting habitat should be encouraged.
5. Additional conservation and monitoring programs on nearby beaches will help to protect more of the green turtles that nest in Costa Rica.
6. Any set of tag pliers that does not appear to be in perfect condition should immediately be discarded to reduce tag loss during future programs.
7. Efforts should be made to determine if hawksbill nesting trends in Tortuguero are linked to declining trends found at other hawksbill nesting beaches in the region.
8. Research assistants and particularly participants, must receive adequate training prior to measuring nesting turtles.
9. SCLmax should remain the standard Tortuguero green turtle carapace measurement.
10. It is important to collect information on fibropapilloma frequency as the data provide baseline information should fibropapillomas become more of a problem in the future.
11. Training in nest marking and excavation techniques must be a major part of research assistant training in future programs.
12. It is important that data loggers are carefully hidden and that no visible marks are left when burying the loggers. Regular revision of the location of the data loggers to ensure that nesting turtles have not revealed their presence is also advisable.
13. An alternative method for measuring ground water levels is needed and should be implemented during future programs.
14. It would be desirable to establish a carrying capacity for Park visitation so that tourism does not negatively impact the natural resources of the area.
15. It is suggested that the pilot project for tourism visitation to the public beach be continued in 2005 to better determine if the system is effective in reducing impacts on nesting turtles.
16. If the low pressure sodium lights trial is successful, more of the Tortuguero street lights should be replaced.
17. Hotel and beach front property owners should be encouraged to maintain or replant native vegetation to reduce light pollution.
18. Hatchling orientation data collection should be reinitiated during the 2005 program.
19. It would be desirable to expand environmental education activities during future programs. Large turn-over amongst the teachers at the Tortuguero school and high school necessitates a meeting with new teachers at the onset of the school year to inform them about the importance of the natural resources in the Tortuguero area and to plan joint activities for the entire school year.

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 2004 Green Turtle Program represents the seventh consecutive year of implementing the revised monitoring protocol.

The objectives of this report are to summarize and discuss the 2004 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, 2004. 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. Lectures were supported by practical training 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 2004 Leatherback Program.

The RA's were familiarized with the village, and key people from 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 work.

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 (4:30-5:00am) at the Tortuguero river mouth, or at Tortuguero village, and finished between 9:30am -12:00pm 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 – 29 October (except for 15, 17, 20, 22 June, 28 August and 16 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. Additional night patrols were occasionally conducted between mile 5 and 10 by teams working 8 pm-4 am.

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 2004 Green Turtle Program include National Band&Tag Company (NBTC) Inconel #681 tags no. 98013-98023, 98050, 98062-98074, 98087-98900, 99001-99300, 99401-99800, 99901-100996 and Monel #49 tags no. VA2919, VA2965-VA2966. Inconel #681 tags no. 98901-99000, 99301-99400, 99801-99900 were lost during shipping from NTBC to the CCC Gainesville, Florida office.

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. After 55 days the nest was measured and a “V” of small sticks was placed on the sand behind the site where the three lines intersected. This aided researchers in locating the nest to observe signs of imminent hatching, either a depression or hatchling tracks. 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. 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 Air temperature

Air temperature (current, minimum and maximum) was recorded daily at 9:00 am at John H. Phipps Biological Field Station.

2.7.3 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.

2.7.4 Ground water level

The level of the ground water was measured daily at 9:00 am. The ground water level was determined from the water level in three PVC pipes (8.5 cm x 160 cm) dug down in front of the John H. Phipps Biological Field Station, at 5, 10 and 15 m distance from the high tide line (as of 1 July 2002).

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, Research Coordinator Emma Harrison and Scientific Director Sebastian Troëng requested information on the room and bed capacity from cabina owners and hotel managers in Tortuguero during the 2004 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 2004, a pilot project aimed at reducing the impact of tourism visitation on sea turtle nesting, was implemented along the public part of the nesting beach (Tortuguero river mouth to the National Park entrance at mile 3 3/8. Funds from hotel and cabina owners were used to employ seven 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.

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

No data on hatchling orientation were collected during the 2004 Green Turtle Program.

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 2004 Green Turtle Program team implemented a series of environmental education activities at the Tortuguero village school and high school. A team of veterinarians from the Human Society visited the station and the village in August and provided free neutering and sterilization for local dogs and cats.

3. RESULTS

3.1 Track Surveys

3.1.1 *Green turtles*

Nesting of green turtles was observed from February - November, with more than 50 nests/night recorded between 3 July - 6 November (Figure 1). From the weekly track surveys, peak nesting was observed on 4 September, 2004, when 3,102 nests were recorded in a single night (Figure 1). Using the methodology of Troëng & Rankin (2005), it is estimated that 118,156 green turtle nests were laid during the 2004 nesting season (Figure 11b).

During daily track surveys conducted by research assistants between 21 June and 31 October (with the exception of 27 August and 16 October), a total of 12,442 green turtle nests and 16,896 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 6 - 12, 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 13.5% of nests laid on the entire beach (Figure 3).

The track surveyor did not record the illegal take of nesting green turtles in 2004 (Figure 4). Nest poaching, however, was recorded during 12 track surveys and a total of 232 green turtle nests were recorded as poached.

Between March and October, the track surveyor reported a total of 18 freshly killed green turtles (Figure 5). Park rangers and research assistants reported another 30 green turtles killed by jaguars in 2004. The track surveyor observed jaguars on the beach on five occasions and the research coordinator and research assistants encountered jaguars four times during night patrols and track surveys in 2004. Two jaguar encounters on the beach were also reported by a tour guide and a Tortuguero villager.

3.1.2 *Hawksbill turtles*

Very low levels of hawksbill nesting activity were recorded between April – October (Figure 6, Appendix 1).

3.1.3 *Leatherback turtles*

Leatherback nesting as recorded from track surveys was observed from February - July, with peak nesting occurring on 4 and 22 April, 2004 when 11 nests were noted (Figure 7, Appendix 1).

3.2 Tagging of Nesting Sea Turtles

3.2.1 Green turtles

A total of 1,099 newly tagged, 374 previously tagged and 403 renesting green turtles were encountered by researchers during 1,689 team hours of night patrols between 14 June and 29 October 2004 (Appendices 1 and 2).

Three green turtles tagged at other nesting beaches were encountered during the 2004 Green Turtle Program. Two were tagged in the Pacuare Nature Reserve and one was tagged by the Parismina project. Both these projects are located in Costa Rica, to the south of Tortuguero National Park.

Of 1,092 newly tagged green turtles, 137 (12.5%) were recorded as having evidence of old tag holes or notches in at least one front flipper when encountered the first time during the 2004 Green Turtle Program.

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

a) By tagger

Tagger	r_{di}	r_{si}	$1-K_i \pm 95\%$ CL
RA1	9	0	0 ± 0
SD	6	0	0 ± 0
RA2	5	0	0 ± 0
RA3	4	0	0 ± 0
RA4	4	0	0 ± 0
RA5	4	0	0 ± 0
RA6	3	0	0 ± 0
RA7	2	0	0 ± 0
RA8	2	0	0 ± 0
RA9	2	0	0 ± 0
RA10	1	0	0 ± 0
RA11	1	0	0 ± 0
RA12	12	1	0.040 ± 0.080
RA13	12	1	0.040 ± 0.080
RA14	10	1	0.048 ± 0.095
FC	9	1	0.053 ± 0.105
RA15	8	1	0.059 ± 0.117
RA16	7	1	0.067 ± 0.133
RA17	7	1	0.067 ± 0.133
RA18	13	2	0.071 ± 0.101
RA19	6	1	0.077 ± 0.153
RA20	4	1	0.111 ± 0.221
RA21	6	2	0.143 ± 0.200
RA22	6	2	0.143 ± 0.200
RA23	1	1	0.333 ± 0.629
RA24	6	6	0.333 ± 0.257
RA25	3	4	0.400 ± 0.367
RA26	0	1	N/A
Mixed taggers	1	1	0.333 ± 0.629
TOTAL	154	28	0.083 ± 0.031

b) By month

Month	r_{di}	r_{si}	$1-K_i \pm 95\%$ CL
June	1	1	0.333 ± 0.629
July	25	10	0.167 ± 0.104
August	59	10	0.078 ± 0.049
September	38	7	0.084 ± 0.064
October	31	0	0 ± 0
TOTAL	154	28	0.083 ± 0.031

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, $1-K_i$ = Probability of tag loss, 95% CL = 95% confidence limits

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 ($n = 125$) ranged from 0% to 50% with a mean of 10.3%.

Green turtles encountered during night patrols nested in the open beach zone in 38.7% of cases ($n = 723$), 39.8% ($n = 744$) were located in the border zone and 12.4% ($n = 232$) in the vegetation zone. 9.1% of turtles were encountered during a half-moon ($n = 170$).

Using data from double tagged green turtles, we determined the probability of within-season tag loss.

From Table 1 it can be seen that of 182 turtles that were observed on more than one occasion, 28 were reported to have lost one tag on the subsequent encounter, giving a within-season probability of tag loss of 8.3%. There were considerable differences in the probability of tag loss between researchers, ranging from 0% to 40%. Differences were also observed between months, with the lowest tag loss observed in October, and the highest in June (0% and 33% respectively).

3.2.2 Hawksbill turtles

Three different hawksbill turtles were encountered during the 2004 Green Turtle Program; all were newly tagged, and one of these three individuals was observed on more than one occasion during the season (Appendix 1). None of the newly tagged hawksbill turtles showed evidence of previous tags.

Two of the hawksbill nests recorded during night patrols were located in the border zone (66.7%, $n = 2$), and one was laid in the vegetation zone (33.3%, $n = 1$).

3.2.3 Leatherback turtles

A total of two leatherback encounters were logged at the beginning of the 2004 Green Turtle Program; one was previously tagged and one was a re-encounter encountered previously during the 2004 Leatherback Program. The last leatherback turtle was recorded on the 4 July, 2004 (Appendix 1). Both the leatherback nests observed during night patrols were deposited in the open zone ($n = 2$).

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, newly tagged individuals with evidence of previous tags and previously tagged females (Table 2). The male turtle was smaller than a mean size female.

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

Sample	CCLmin (cm)		SCLmax (cm)		Clutch size (eggs)	
	n	$\bar{x} \pm \text{ST.D.}$	n	$\bar{x} \pm \text{ST.D.}$	n	$\bar{x} \pm \text{ST.D.}$
Newly tagged females - no OTH/OTN	933	104.1 \pm 4.5	829	98.1 \pm 4.1	80	111 \pm 22
Newly tagged females - with OTH/OTN	132	105.2 \pm 5.0	108	98.9 \pm 4.8	12	108 \pm 18
Previously tagged females	352	105.4 \pm 4.5	329	99.3 \pm 4.2	34	111 \pm 22
Newly tagged male	1	93.4	1	91.5	-	-

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 three or four 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

Observer	CCLmin (cm)			SCLmax (cm)		
	n	$\bar{x} \pm \text{ST.D.}$	Range	n	$\bar{x} \pm \text{ST.D.}$	Range
Research Assistants	1422	0.3 \pm 0.2	0 - 1.4	1316	0.3 \pm 0.2	0 - 2.1
Participants	339	0.5 \pm 0.4	0 - 2.5	259	0.5 \pm 0.5	0 - 3.7
TOTAL	1761	0.3 \pm 0.2	0 - 2.5	1575	0.3 \pm 0.3	0 - 3.7

b) Between encounters

Encounters	CCLmin (cm)			SCLmax (cm)		
	n	$\bar{x} \pm \text{ST.D.}$	Range	n	$\bar{x} \pm \text{ST.D.}$	Range
2	214	1.2 \pm 0.9	0.2 - 8.2	197	1.2 \pm 1.3	0.2 - 13.2
3	53	1.9 \pm 1.1	0.4 - 6.2	50	1.5 \pm 0.8	0.4 - 4.0
4	5	2.3 \pm 0.6	1.5 - 3.2	5	1.7 \pm 0.7	0.8 - 2.4
5	1	1.8 \pm N/A	N/A	1	2.5 \pm N/A	N/A
6	1	2.0 \pm N/A	N/A	1	3.1 \pm N/A	N/A

3.3.2 Hawksbill turtles

Newly tagged hawksbill females had a mean CCLmin of 86.1 cm and a mean SCLmax of 82.7 cm (Table 4).

The precision of CCLmin measurements was the same for green and hawksbill turtles ($\bar{x} = 0.3$ cm) (Table 3a and Table 5).

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

Sample	CCLmin (cm)		SCLmax (cm)		Clutch size (eggs)	
	n	$\bar{x} \pm \text{ST.D.}$	n	$\bar{x} \pm \text{ST.D.}$	n	$\bar{x} \pm \text{ST.D.}$
Newly tagged - no OTH/OTN	3	86.1 \pm 5.8	3	82.7 \pm 4.6	1	168 \pm N/A

Table 5. Precision of carapace measurements for hawksbill females

Sample	CCLmin (cm)			SCLmax (cm)		
	n	\bar{x}	Range	n	\bar{x}	Range
Females	3	0.3	0.3-0.4	3	0.2	0.1-0.4

3.3.3 Leatherback turtles

The mean carapace length (CCLmin) of the two leatherback turtles encountered during the 2004 Green Turtle Program was 156.2 cm (Table 6). No clutches were counted for any of these individuals. See Harrison *et al.* (2005) for an analysis of the precision of CCLmin measurements for leatherbacks turtles.

Table 6. Mean carapace length of leatherbacks

Sample	n	CCLmin (cm)
		$\bar{x} \pm \text{ST.D.}$
Previously tagged	2	156.2 \pm 1.6

3.4 Fibropapilloma Assessment

3.4.1 Green turtles

A total of 159 green turtles were subject to a thorough examination for the presence of fibropapilloma tumors; five individuals (3.1%) were recorded to be affected. One of the five was checked twice and only once recorded as being affected. Tumors varied in size 2-6 cm and were located on the neck and shoulder area (five turtles) and on the front flippers (two turtles). Two of the five turtles were newly tagged without evidence of prior tagging and three were previously tagged turtles.

3.5 Determination of Nest Survivorship and Hatching Success

Several mammal predators were observed disturbing nests or taking hatchlings during the 2004 Green Turtle Program, including coatis (*Nasua narica*), domestic dogs (*Canis familiaris*) and humans (*Homo sapiens sapiens*).

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, fly larvae (*Megaselia scalaris*) were observed depredating eggs, pipped hatchlings and hatchlings in the nest.

3.5.1 Green turtles

A total of 184 green turtle nests were marked during the 2004 Green Turtle Program. Of these, two nests could only partly be excavated, all three marker tapes were lost for three nests, four nests still contained hatchlings at the end of the Program, and the fate of 31 nests could not be determined with certainty. These 40 nests were excluded from subsequent analysis, leaving a sample of 144 green turtle nests monitored from the date of oviposition until their fates could be determined (Table 7).

Almost 60% of nests remained undisturbed during incubation (n = 83). Of those that were disturbed, depredation accounted for 8.3% of disturbances and nesting turtles destroyed another 18.1% of nests. Poaching resulted in the loss of a further 9 nests (6.3%). Figure 7 shows the location of all marked nests that were poached. There were two main areas where poaching occurred, both outside of Tortuguero National Park. One area was between Laguna and Mawamba Lodges between miles 1 7/8 – 2 3/8, and the other was close to Tortuguero village, between miles 2 7/8 – 3 3/8 (which marks the northern limit to Tortuguero National Park).

Only four green turtle nests were washed out. Unhatched nests were more common in the Park section than outside of the National Park. Both non-human and human depredation occurred at higher levels outside of the national park limits, in the sector to the north of Tortuguero village (Table 7, Figure 8).

The results of the excavations of the 144 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 100.0 eggs per marked nests unless the fate category indicated otherwise (Table 8b). The estimated total number of eggs in monitored nests equals 14,623 eggs (135 nests x 100.0 eggs + 1 nest x 103 eggs + 8 nests x 102.1 eggs + two nests x 100.0 eggs to account for nests that were dug up together with other nests – fate category 7). Overall hatching success is estimated at 56.5% (8,269 empty shells from 14,623 eggs) and overall emerging success at 55.3% (8,089 hatchlings from 14,623 eggs).

Most of the marked green turtle nests were deposited either in the open (n = 75), or border zones (n = 50), and few were laid in the vegetation (n = 19). When nests were deposited in the vegetation they were more likely to be disturbed than if laid in the border or open zones (58% compared to 38% and 41%, respectively).

A comparison between egg counts at the time of oviposition and at excavation for a sample of undisturbed nests (n = 60) shows a mean of 6.9 more eggs (range: +75 to -46 eggs, st.dev. = 21 eggs) counted at the time of oviposition.

Table 7. Fate of marked green turtle nests

Fate	Public n	Park n	Total n	% of total
<i>Undisturbed</i>				
1. Undisturbed	50	33	83	57.6
<i>Disturbed</i>				
2. Poached	7	2	9	6.3
3. Depredated by dogs	1	0	1	0.7
4. Depredated	10	1	11	7.6
5. Dug up by nesting turtle	13	13	26	18.1
6. Two nests together	1	1	2	1.4
7. Washed out	2	2	4	2.8
8. Unhatched	1	7	8	5.6
TOTAL	85	59	144	100.1
<i>Not included in analysis</i>				
(9. Hatchlings still in nest on 1 December	3	1	4	
10. Could only partly excavate	2	0	2	
11. All three marker tapes lost	1	2	3	
12. Undetermined	14	17	31)	

Table 8. Results of green turtle nest excavations**a) Raw data from excavations**

Fate	Nests n	Empty shells	Pipped eggs	Hatchlings		Unhatched eggs				
				Live	Dead	No embryo	Embryo	Full embryo	Depredated	Destroyed
1	83	7321	111	64	101	346	372	14	138	0
2	9	0	0	0	0	0	0	0	0	0
3	1	98	0	0	0	3	0	0	2	0
4	11	307	11	1	1	32	24	0	124	0
5	26	199	15	7	2	50	18	0	30	7
6	2	341	10	1	2	25	1	0	13	0
7	4	0	0	0	0	0	0	0	0	0
8	8	3	1	1	0	177	601	0	35	0
ALL	144	8269	148	74	106	633	1016	14	342	7

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	83	100.0	88.2	86.2
2	9	N/A	0	0
3	1	103	95.1	95.1
4	11	N/A	27.9 ^a	27.8 ^a
5	26	N/A	7.7 ^a	7.6 ^a
6	2	N/A	85.2 ^a	84.7 ^a
7	4	N/A	0	0
8	8	102.1	0.4	0.4
Total	144	N/A	56.5	55.3

For fate categories see Table 7

^aAssuming a mean clutch of 100.0 eggs^bAssuming that all hatchlings not accounted for emerged before depredation

The distance between the sand surface and the top eggshell at the time of excavation for undisturbed nests (n = 80) ranged between 5 and 91 cm with a mean of 56 cm. The distance between the sand surface and the bottom of the egg chamber varied between 40 and 132 cm with a mean of 71 cm.

The incubation period for undisturbed nests for which emerging was observed (n = 54) ranged from 49 to 68 days with a mean of 56 days.

Unhatched eggs that contained albino and deformed embryos accounted for 0.02 % of eggs in undisturbed nests and unhatched nests (Table 9).

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

	n	% of total eggs
Albinos	1	0.011
Twins	0	0.000
Deformed embryos	1	0.011
TOTAL	3	0.022

3.5.2 Hawksbill turtles

Two 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 two nests, one was undisturbed and one was partly dug up by a nesting turtle.

Table 10. Results of hawksbill nest excavations

Fate	n	Empty shells	Pipped eggs	Hatchlings		Unhatched eggs				Total eggs	Hatching success	Emerging success
				Live	Dead	No embryo	Embryo	Full embryo	Depred.		(%)	(%)
1	1	18	0	0	0	0	3	1	2	0	75.0	75.0
5	1	101	4	2	0	29	13	3	10	0	63.1	61.9
ALL	2	119	4	2	0	29	16	4	12	0	37.2^a	36.6^a

For fate categories see Table 7

^aAssuming mean nest size of 160 eggs

Overall hatching success for hawksbill nests (n = 2) was 37.2% (119 empty shells from 320 eggs) and emerging success was 36.6% (117 emerged hatchlings from 320 eggs).

The distance between the sand surface and the top eggshell at the time of excavation for undisturbed hawksbill nests (n = 2) ranged between 31 and 40 cm with a mean of 36 cm. The distance between the sand surface and the bottom of the egg chamber varied between 45 and 62 cm with a mean of 54 cm.

3.5.3 Leatherback turtles

For more information about the leatherback hatching success in Tortuguero in 2004, please consult Harrison *et al.* (2005).

3.6 Physical Data Collection

3.6.1 Rainfall

During the 2004 Green Turtle Program, which ran from mid-June to the end of November, November was the wettest month, with 842.3 mm of rain recorded (Table 11). September was the driest month of the Program with only 22.4 mm of rain recorded for the month.

Table 11. Rainfall, January-December 2004

Month	Total rainfall (mm/month)	\bar{x} rainfall (mm/24hrs)*
January	494.9	16.0
February	326.0	11.2
March	555.8	17.9
April	611.8	20.4
May	858.6	27.7
June	785.4	26.2
July	336.6	10.9
August	543.8	17.5
September	22.4	0.7
October	258.7	8.3
November	842.3	28.1
December	1687.0	54.4

*Data for 48 hours for 21-22 March, 21-22 April, 3-4, 6-7 August,

*Data for 72 hours for 17-19 September

*Data for 96 hours for 15-18 May, 24-27 June

*Data for 120 hours for 24-28 May, 17-21 August

*Data for 144 hours for 17-22 June, *Data for 312 hours for 3-15 September

*Data for 24-29 April estimated at 150 mm

3.6.2 Air temperature

September had the highest mean maximum air temperature (31.2°C) and January had the lowest (28.6°C) in 2004.

Table 12. Air temperature, January - December 2004

Month	\bar{x} minimum temp. (°C) *	\bar{x} maximum temp. (°C) *
January	24.0	28.6
February	24.1	30.4
March	24.5	31.0
April	25.4	30.6
May	23.5	30.5
June	22.9	30.9
July	23.7	30.6
August	25.1	29.7
September	23.9	31.2
October	24.2	29.9
November	24.2	29.4
December	24.1	29.7

*No data for 11 January, 19-29 April, 17-26 June,

3 July, 3,6 17-21 August, 3-18, 29 September

3.6.3 Sand temperature

Mean sand temperatures are shown in Table 13. Over the course of the year several of the data loggers failed, probably due to excessive humidity levels. In August 2004, a nesting turtle dug up one of the data logger and help an unknown person locate and remove all data loggers. In spite of announcing the loss locally, the data loggers could not be found. Three new data loggers were purchased and buried on 24 August.

At all depths temperatures were greater in the open zone and lower in the vegetation zone (Table 13). The month with the highest sand temperature, was September. December was the month with the lowest sand temperature (Table 13).

Table 13. Mean monthly sand temperatures.

Zone	_ Open × temp (°C)			_ Border × temp (°C)			_ Vegetation × temp (°C)		
	30	50 ^a	70 ^b	30 ^c	50 ^c	70 ^d	30 ^e	50 ^f	70 ^g
<i>Depth (cm)</i>	30	50 ^a	70 ^b	30 ^c	50 ^c	70 ^d	30 ^e	50 ^f	70 ^g
January	N/A	27.5	26.6	N/A	N/A	26.3	N/A	24.8	25.3
February	N/A	29.0	26.5	N/A	N/A	27.2	N/A	25.5	25.8
<i>Retrieval depth (cm) 14 March</i>	40	48	70	N/A	N/A	63	N/A	53	69
<i>Depth (cm) 14 March</i>	30	50	70	N/A	N/A	70	N/A	50	70
March	N/A	29.0	24.8	27.3	27.1	27.0	26.2	25.9	26.1
April	N/A	30.0	24.9	27.7	27.3	27.3	26.4	26.6	26.5
May	N/A	28.5	23.9	27.0	27.0	27.1	26.1	26.5	26.5
June	N/A	28.9	24.0	27.4	27.3	27.4	26.3	26.7	26.7
<i>Retrieval depth (cm) 18 June</i>	N/A	48	65						
<i>Retrieval depth (cm) 21 June</i>				0	0	0			
<i>Retrieval depth (cm) 30 June</i>							28	47	64
July	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
August	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
September	N/A	N/A	32.2	N/A	N/A	32.0	N/A	N/A	27.4
October	N/A	N/A	31.9	N/A	N/A	30.8	N/A	N/A	27.5
November	N/A	N/A	28.1	N/A	N/A	27.0	N/A	N/A	25.5
December	N/A	N/A	26.7	N/A	N/A	26.1	N/A	N/A	24.6
<i>Retrieval depth (cm) 4 Dec</i>	N/A	N/A	68	N/A	N/A	55	N/A	N/A	70

^a Data until 18 June, ^b No data for 8-13 March, data until 17 June, possible that ground water reached data logger, no data for 18 June-23 August, ^c Data for 14 March-20 June, ^d No data for 21 June-23 August, ^e Data for 14 March-30 June, ^f Data until 30 June, ^g No data for 30 June-24 August

Figure 9a, 9b and 9c show the sand temperatures during the 2004 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 September 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 with vegetation, respectively).

3.6.4 Ground water level

High tides and rough seas kept washing out or filling with sand the PVC tubes used to measure ground water level. For these reasons, ground water level monitoring was discontinued in 2004.

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. There has been continuing increase in the number of people coming to the center over the past three years, from 25,524 in 2002 to 30,617 in 2004.

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

Month	2002		2003		2004	
	Total	\bar{x} Per Day	Total	\bar{x} Per Day	Total	\bar{x} Per Day
January	1756	57	2220	72	2814	91
February	2108	75	2855	102	3648	126
March	2581	83	2921	94	3924	127
April	1738	58	2591	86	2940	98
May	1239	40	1410	45	1497	48
June	1463	49	1575	53	2089	70
July	2673	86	3272	106	3106	100
August	3419	110	3864	125	3415	110
September	2043	68	1779	59	1502	50
October	2104	68	1791	58	1482	48
November	2276	76	2453	82	1995	67
December	2124	69	2372	77	2205	71
TOTAL	25524	70	29103	80	30617	84

The number of visitors to Tortuguero National Park, both Costa Rican nationals and foreign tourists, continues to increase and reached 80,319 visitors in 2004, an increase of over 12,000 people from 2003 (Table 15). In 2004, the income generated from the entrance fees to Tortuguero National Park and Barra del Colorado Wildlife Refuge totaled ₡181,222,983 (~ US\$423,700). 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 200 in 2004 (Table 15).

Table 15. Number of paying visitors to Tortuguero National Park

Year	Tortuguero National Park			Barra del Colorado Wildlife Refuge	Tortuguero National Park and Barra del Colorado Wildlife Refuge
	CR Visitors	Foreign Visitors	Total Visitors	Total Visitors	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	9,544	70,775	80,319	184	₡181,222,983

3.7.2 Capacity of hotels and cabinas

The number of hotels and cabinas available in Tortuguero continued to increase in 2004, and there are currently almost 600 rooms for rent in the village and surrounding area, comprising a total of 1365 beds. Approximately 70% of the capacity is within the larger hotels and lodges, as opposed to the smaller cabinas in the village (See Table 16).

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

Hotels/Lodges	Rooms	Beds	Cabinas	Rooms	Beds
Caribe*	-	-	All Rankin Lodge	7	32
Evergreen	30	60	Aracari	13	25
Hotel Vista del Mar	35	85	Casa Marbella	5	10
Ilan-Ilan	24	57	La Casona	6	19
Jungle	44	88	Jumanji***	12	40
Laguna	71	142	Ella y Yo	3	6
El Manati	10	20	La Espiga de Oro	3	12
Mawamba	54	130	Hostel el Icao	5	10
Pachira	80	142	Joruki	9	17
Samoa Lodge**	20	40	Lapa Verde****	5	10
Tortuga	24	49	Meryscar	20	50
Turtle Beach Lodge	30	90	Miss Miriam	14	28
<i>Total – Hotels</i>	<i>422</i>	<i>903</i>	Miss Miriam #2	12	24
			Miss Junnie Hotel	12	24
			Sabina	24	72
			Tortuguero	8	27
			Pisulin/Tropical Lodge	12	24
			(CCC	7	32)
			<i>Total – Cabinas</i>	<i>177</i>	<i>462</i>
TOTAL			599 Rooms		1365 Beds

*Caribe Lodge was not open in 2004, **Samoa Lodge previously known as Caribbean Magic

Jumanji previously known as Chanu, *Lapa Verde previously known as Pancana

3.7.3 Turtle tours

In 2004, a pilot project aimed at reducing the impact of tourism visitation on green turtle nesting was implemented on the public beach. Seven 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.

A total of 31,655 tourists paid to go on a guided turtle tour during the official 2004 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 but the difference in visitation was less than during previous years.

Table 17. Number of tourists paying to go on turtle tours in 2004

Month	Public beach (mile -3/8 to 3 3/8)	Park (mile 3 3/8 to 5)	Total	Tour guide nights
March	0	0	0	0
April	20	0	20	4
May	319	97	416	59
June	280	219	499	173
July	4081	4110	8191	1013
August	6076	5079	11155	1375
September	3505	2216	5721	757
October	2561	2006	4567	611
November	401	685	1086	164
TOTAL	17243	14412	31655	4156

Data from ACTo

3.7.4 Artificial lights

Five light surveys were conducted during the 2004 Green Turtle Program, once a month from June to October (Table 18).

Table 18. Results of light surveys conducted from Tortuguero river mouth to mile 5

Mile	Light source	Location of light		Month				
		Beach side	River side	Jun	Jul	Aug	Sept	Oct
- 3/8	House and street lights		X	X	X			X
- 2/8	House and street lights		X	X	X	X	X	
5/8	Tortuga Lodge		X	X				
6/8	Tortuga Lodge		X	X	X	X	X	X
1 2/8	All Rankin Lodge	X		X	X	X	X	X
1 3/8	Laguna Lodge	X			X	X		
1 4/8	Laguna Lodge	X		X	X	X		X
2 2/8	Mawamba Lodge	X		X	X	X	X	X
2 3/8	Mawamba Lodge	X		X	X	X	X	X
2 4/8	CCC Station	X		X	X	X		
2 5/8	CCC Station	X		X	X	X	X	
2 6/8	House and street lights	X		X	X	X	X	X
2 7/8	House and street lights	X		X	X	X	X	X
3	House and street lights	X		X	X	X	X	X
3 1/8	House and street lights	X		X	X	X	X	X
3 2/8	House and street lights	X		X	X	X	X	X

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 (Table 18). 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. In June, vegetation was cleared in front of Mawamba Lodge which made many more lights visible from the beach.

The Costa Rican Electricity Company (ICE) continued their efforts to reduce the visibility and impact of street lights on the nesting beach. The bulbs of the three street lights closest to the beach, at the southern end of Tortuguero village, were replaced with low pressure

sodium lights. The effect of the lights will be evaluated and if successful, other street lights may also be replaced by low pressure sodium lights.

3.7.5 Hatchling orientation

No data on green turtle hatchling orientation were collected in 2004.

3.8 Environmental Education Activities

Several environmental education activities were carried out during the 2004 Green Turtle Program. The activities were held both at the Tortuguero school and high school and at the CCC station. A group of four students were selected through a sea turtle board game competition and joined the Green Turtle Program team on the trip to the Limón sea turtle festival, held on 28 August, 2004. CCC managed a stand where the public could play the sea turtle game, measure a lifesize turtle model and learn about turtle tagging. The Green Turtle Program team also conducted a much appreciated puppet show for the Limón scouts and the general public. In October, the Tortuguero high school students visited the CCC station and received a talk by Dr. Archie Carr III. At the end of the school year, the Tortuguero high school awarded CCC with a certificate of gratitude for the collaboration provided in 2004.

4. DISCUSSION

4.1 Track Surveys

4.1.1 Green turtles

Green turtle nesting was observed from February to November with the vast majority of nests recorded between 15 June and 31 October. Green turtle nests recorded at track surveys before 15 June and after 1 November only amounted to 0.8 % of all registered green turtle nests in 2004.

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 2004 Green Turtle Program team. These results of these surveys, however, are essential to evaluate the impact of tourism visitation on green turtle nesting. It is suggested that these surveys be continued as long as the pilot project visitation system is in place.

Green turtle nesting between the Tortuguero river mouth and the mile 5 marker represented 13.5% of all green turtle nesting. The highest nesting density, as usual, was between miles 6-12. Studies focusing on density dependence are best conducted between miles 6 and 12 but the large number of nesting green turtles allow for most other types of studies to be conducted between the Tortuguero river mouth and the mile 5 marker, where access is much easier.

Although the illegal take of nesting green turtles was not recorded by the track surveyor during the 2004 program, illegal take of eggs still occurred. The low numbers of nesting turtles taken may be a consequence of park ranger patrols at sea during the beginning of the Green Turtle Program. These patrols resulted in the confiscation of at least two boats and

may have deterred those interested in illegally taking turtles from Tortuguero National Park for the rest of the nesting season. Increased marine patrols by park rangers during the beginning of the green turtle nesting season may be a good way to reduce illegal take of nesting turtles during future green turtle programs and should be encouraged.

The frequent observations of green turtles killed by jaguars and the many reported encounters with jaguars on the beach or swimming across the canal suggests that Tortuguero National Park would be an ideal site for studies of jaguar behavior and feeding biology. The number of green turtles killed is small in comparison to the number of nesting turtles and is not like to represent a serious survival threat to the green turtle population, at least not presently.

4.1.2 Hawksbill turtles

The very low levels of hawksbill nesting observed at Tortuguero in 2004 are cause for grave concern. Any action that protect nesting females, nests or females in the internesting habitat should be encouraged. Hawksbill nesting levels are now so low that every female and nest are important.

4.1.3 Leatherback turtles

A comprehensive discussion of leatherback nesting at Tortuguero in 2004 can be found in Harrison *et al.* (2005).

4.2 Tagging of Nesting Sea Turtles

4.2.1 Green turtles

The goal of 1,000 newly tagged green turtles was achieved quite late during the 2004 Green Turtle Program, due to relatively low nesting levels during the first months of the Program. High levels of nesting during the second half of the program made it possible to reach and ultimately exceed the goal.

The observation of three green turtles tagged at nearby nesting beaches in Costa Rica demonstrate that green turtles can move between nesting beaches along the coast. Although the vast majority of green turtles nest at Tortuguero, the three females with non-Tortuguero tags emphasize the need and importance of additional conservation and monitoring programs to protect more of the green turtles that nest in Costa Rica.

The daily track surveys conducted by the Green Turtle Program team to evaluate tourism visitation impact, also provided data which allowed for a better estimate of tagging efficiency.

Overall within season tag loss was high in 2004, at 8.3%. Tagloss varied with tagger but was much higher during the first months of the program than during the last month (October). Faulty tag pliers may have been the reason for the 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.

4.2.2 Hawksbill turtles

The very few hawksbill turtles encountered during the 2004 program cause grave concern. Efforts should be made to determine if hawksbill nesting trends in Tortuguero are linked to declining trends found at other hawksbill nesting beaches in the region.

4.2.3 Leatherback turtles

Harrison *et al.* (2005) includes a detailed review of the tagging of leatherback turtles at Tortuguero in 2004.

4.3 Biometric Data Collection

4.3.1 Green turtles

Mean carapace measurements of previously tagged females and newly tagged females with evidence of old tag holes or notches were greater than those of newly tagged green turtle females.

Participants showed slightly lower precision than researchers for both CCLmin and SCLmax measurements. It is important to ensure that research assistants and particularly participants, receive adequate training prior to measuring nesting turtles.

For green turtles measured on three or four occasions, SCLmax had greater precision than the CCLmin measurements. It is suggested that SCLmax remains as the standard Tortuguero green turtle carapace measurement.

4.3.2 Hawksbill turtles

The precision of CCLmin measurements for hawksbills was the same as for green turtles.

4.3.3 Leatherback turtles

Harrison *et al.* (2005) contains information about biometric data collection from leatherback turtles nesting in Tortuguero in 2004.

4.4 Fibropapilloma Assessment

4.4.1 Green turtles

Few (3.1%) of the carefully examined green turtles had any evidence of fibropapillomas and the affect turtles had few and most had small tumors. It is, however, important to continue to collect information on fibropapilloma frequency in Tortuguero green turtles. The collected data provide baseline information should fibropapillomas become more of a problem in the future.

4.5 Determination of Nest Survivorship and Hatching Success

4.5.1 Green turtles

Green turtle hatching and emergence success was at the lower part of the range observed since 1998 with 56.5% hatching and 55.3% emerging success. The excavation of nests by other turtles can not realistically be avoided but dog and human predation can be controlled. The visit by a team of veterinarians from the Human Society of the United States began the process of reducing the Tortuguero dog population.

The destiny of more nests (n=36) than normal could not be determined with certainty. It is unclear if this affected the hatching and emergence success estimates. Training in nest marking and excavation techniques must be a major part of the research assistant training in future programs to ensure accurate estimates of hatching success.

It must be seen as a positive sign that the frequency of albinism, twins and deformed embryos was lower than normal.

4.5.2 Hawksbill turtles

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

4.5.3 Leatherback turtles

No leatherback nests were marked during the 2004 Green Turtle Program, however, information on leatherback nest survivorship and hatching success can be found in Harrison *et al.* (2005).

4.6 Physical Data Collection

4.6.1 Rainfall

Rainfall prior to and during the first months of the Green Turtle Program coupled with rough seas and high tides, eroded much of the beach during the first part of the Green Turtle Program. In June and early July, nightly beach patrols could only be conducted along short sections of beach due to the severe erosion.

4.6.2 Air temperature

The high rainfall resulted in low mean minimum air temperatures, particularly in June and July.

4.6.3 Sand temperature

The theft of the data loggers in early August resulted in the loss of sand temperature data from mid/late June until late August. It is important that data loggers are carefully hidden and that no marks that can be identified by persons passing by are left when burying the loggers. Regular revision of the location of the data loggers to ensure that nesting turtles have not revealed their presence is also advisable.

4.6.4 Ground water level

The severe erosion meant that the PVC tubes used to measure ground water levels were frequently washed out or filled with sand. An alternative method for measuring ground water levels is needed and should be implemented during future programs.

4.7 Collection of Human Impact Data

4.7.1 Visitors to Tortuguero

Tourism visitation to Tortuguero National Park continues to grow rapidly and reached over 80,000 visitors in 2004. It would be desirable to establish a carrying capacity for Park visitation so that tourism does not negatively impact the natural resources of the area.

4.7.2 Capacity of hotels and cabinas

The capacity of hotels and cabinas in the Tortuguero area are increasing. It is encouraging to see local cabinas increasing as this may indicate that more people benefit from the Tortuguero tourism.

4.7.3 Turtle tours

The pilot project to reduce the impact of tourism visitation along the public beach resulted in disapproving guides taking their tourists to the park section where the previous system is still in place. This meant that the difference in visitation to the two sections (public and park) was less than during previous years.

The pilot project created seven new work positions for local Tortuguero villagers, paid for by the hotel and cabina owners, which must be seen as very positive.

It is suggested that the pilot project be continued in 2005 to better determine if the new system is effective in reducing the impact on the nesting turtles.

4.7.4 Artificial lights

The initiative of the Costa Rican Electricity Institute (ICE) to replace some of the near beach street lights in Tortuguero with low pressure sodium lights should be applauded. If the trial is successful, hopefully more street lights can be replaced with the low pressure sodium lights.

The removal of native beach vegetation in front of Mawamba Lodge and in front of some of the beach front properties in Tortuguero village is unfortunate. 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

No data on hatchling orientation were collected in 2004 but it is suggested that data collection be reinitiated during the 2005 program.

4.8 Environmental Education Activities

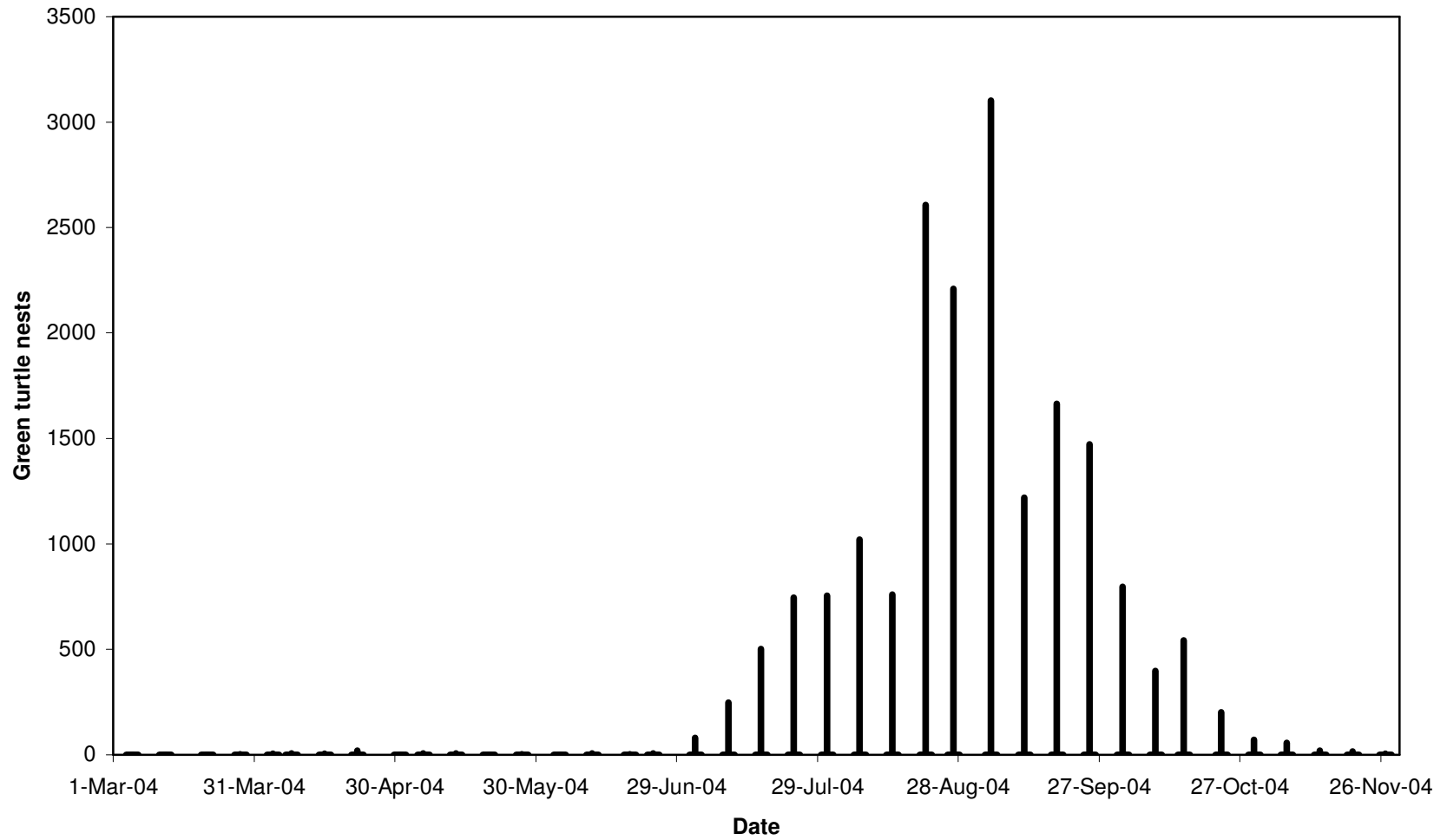
The many joint events undertaken by the CCC and the Tortuguero school and high school were educational both for the students and for the Green Turtle Program team. It would be desirable to expand activities during future programs.

Large turn-over amongst the teachers at the Tortuguero school and high school necessitates a meeting with new teachers at the onset of the school year in February. The objective of such a meeting would be to inform the teachers about the importance of the natural resources in the Tortuguero area and to plan joint activities for the entire school year.

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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).



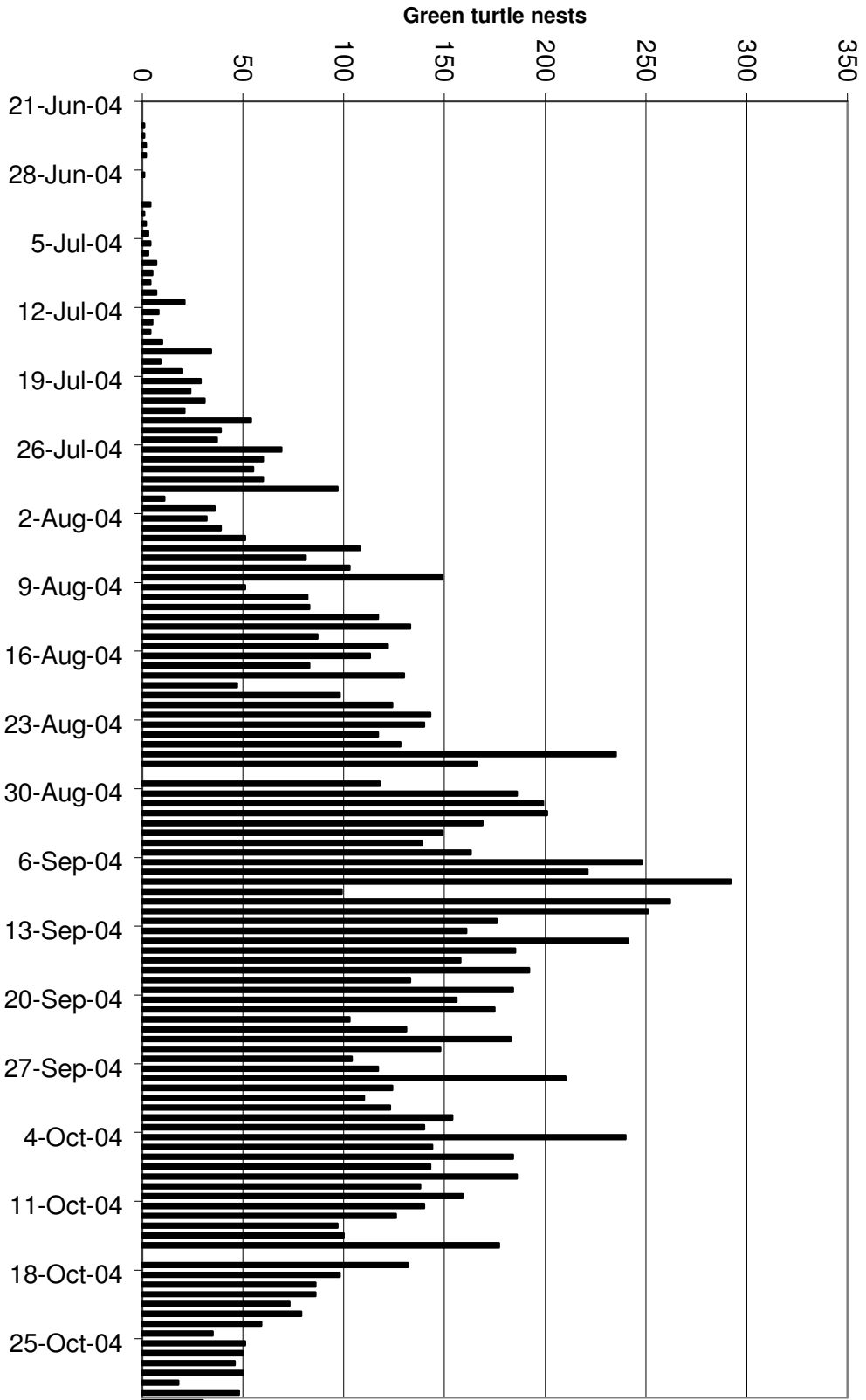


Figure 2. Seasonal distribution of green turtle nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to the mile 5 marker

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)

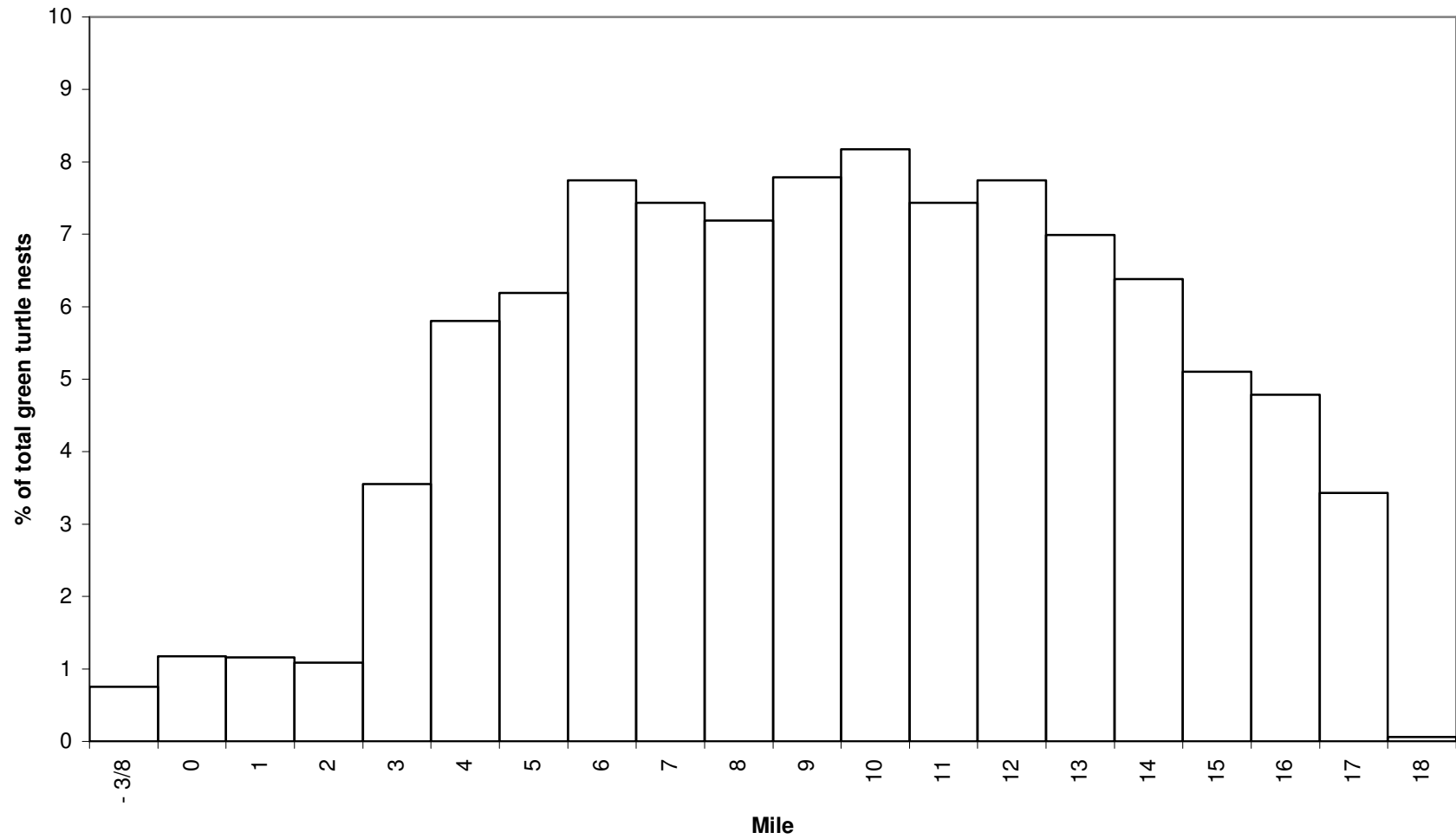


Figure 4. Illegal take of green turtles as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

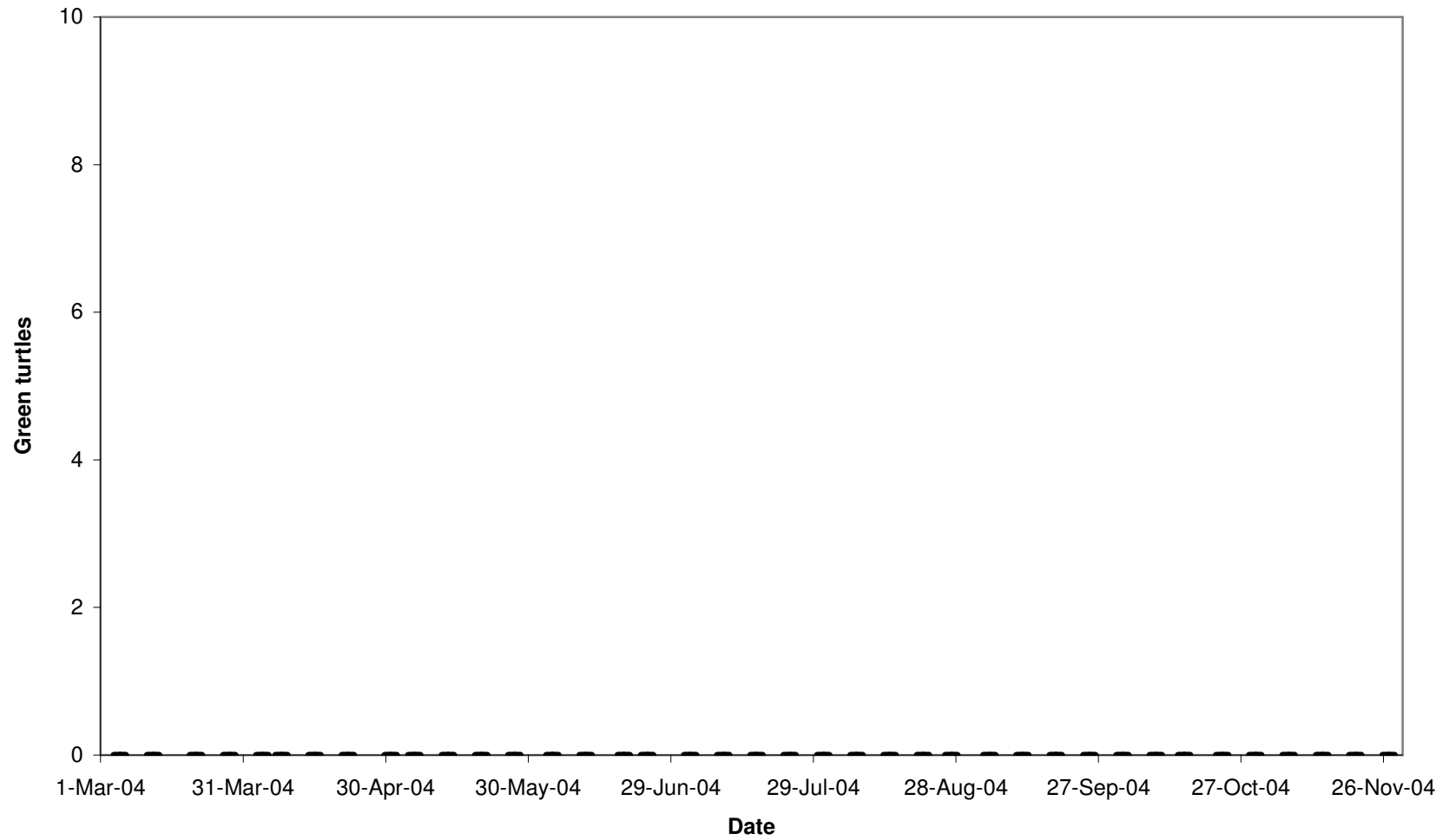


Figure 5. Green turtles killed by jaguars from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

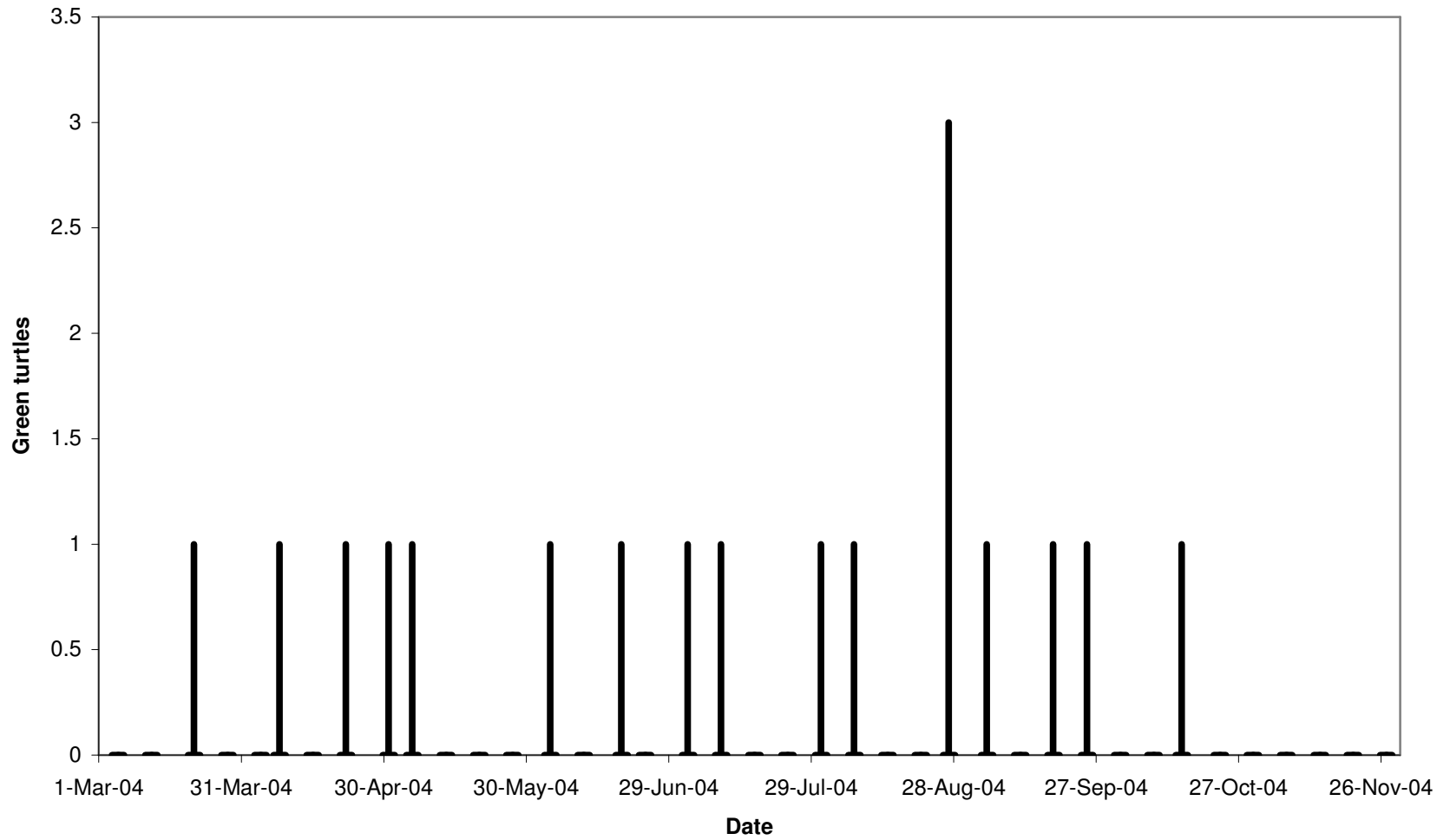


Figure 6. Seasonal distribution of hawksbill nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

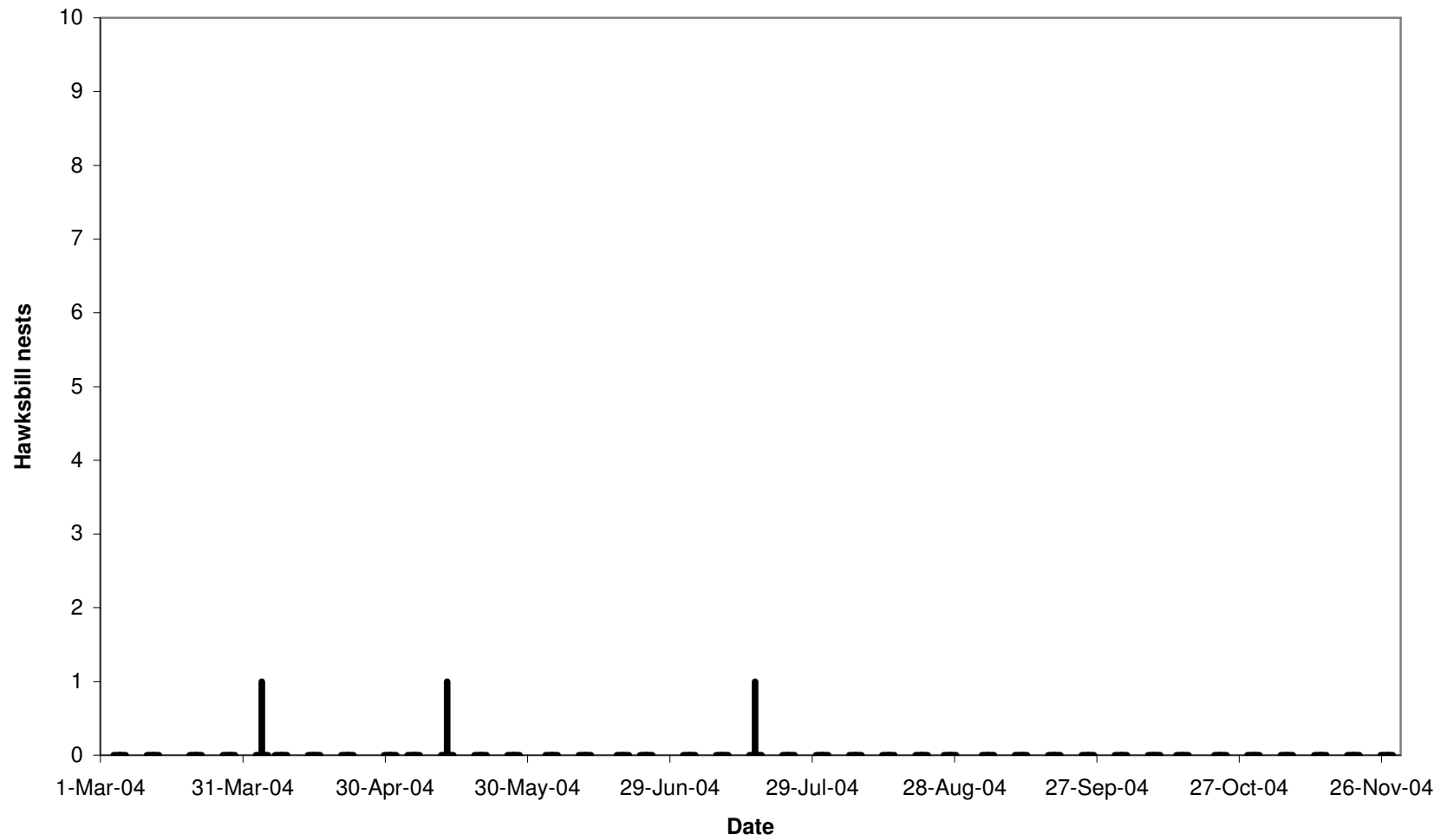
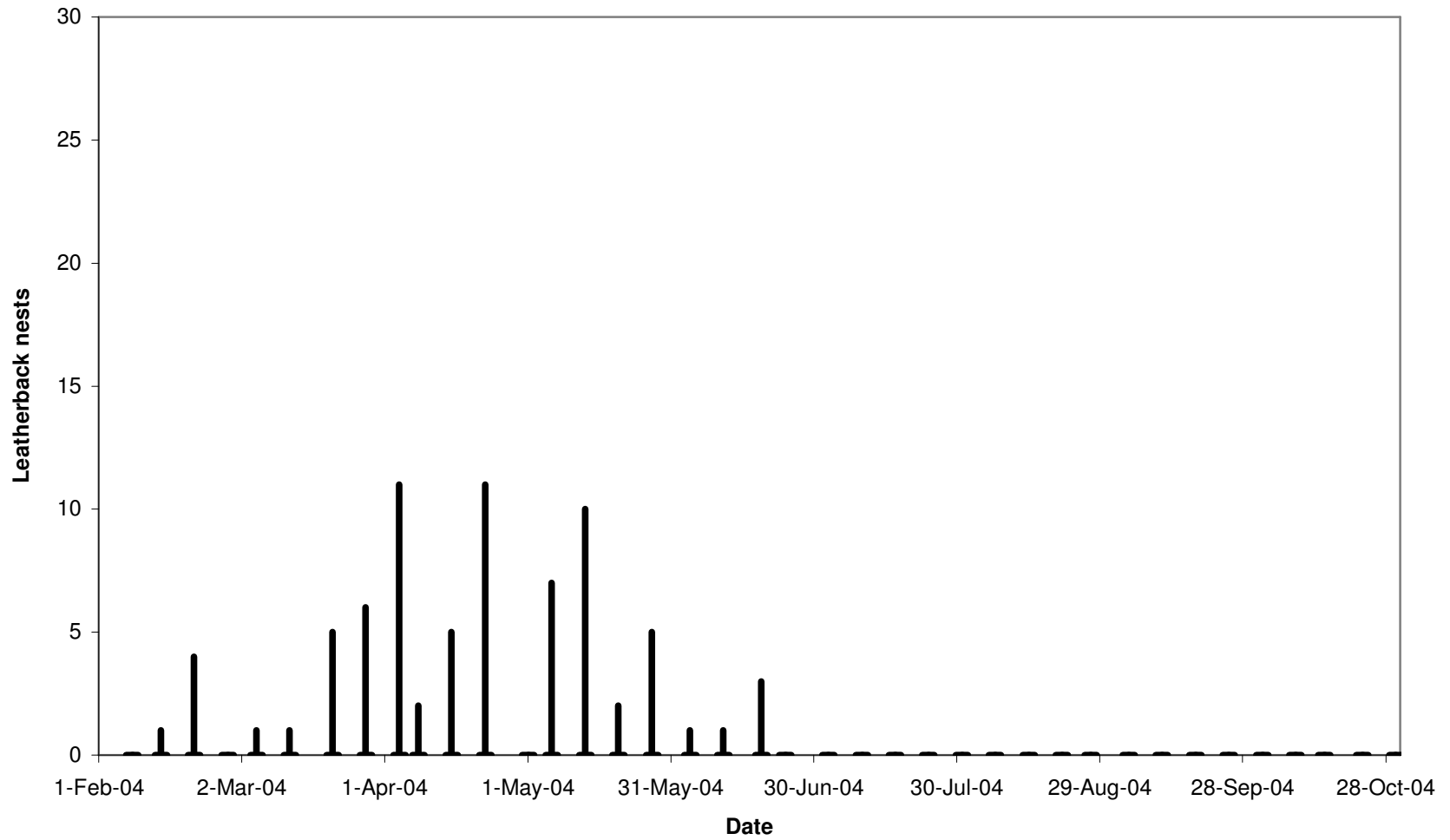


Figure 7. Seasonal distribution of leatherback nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).



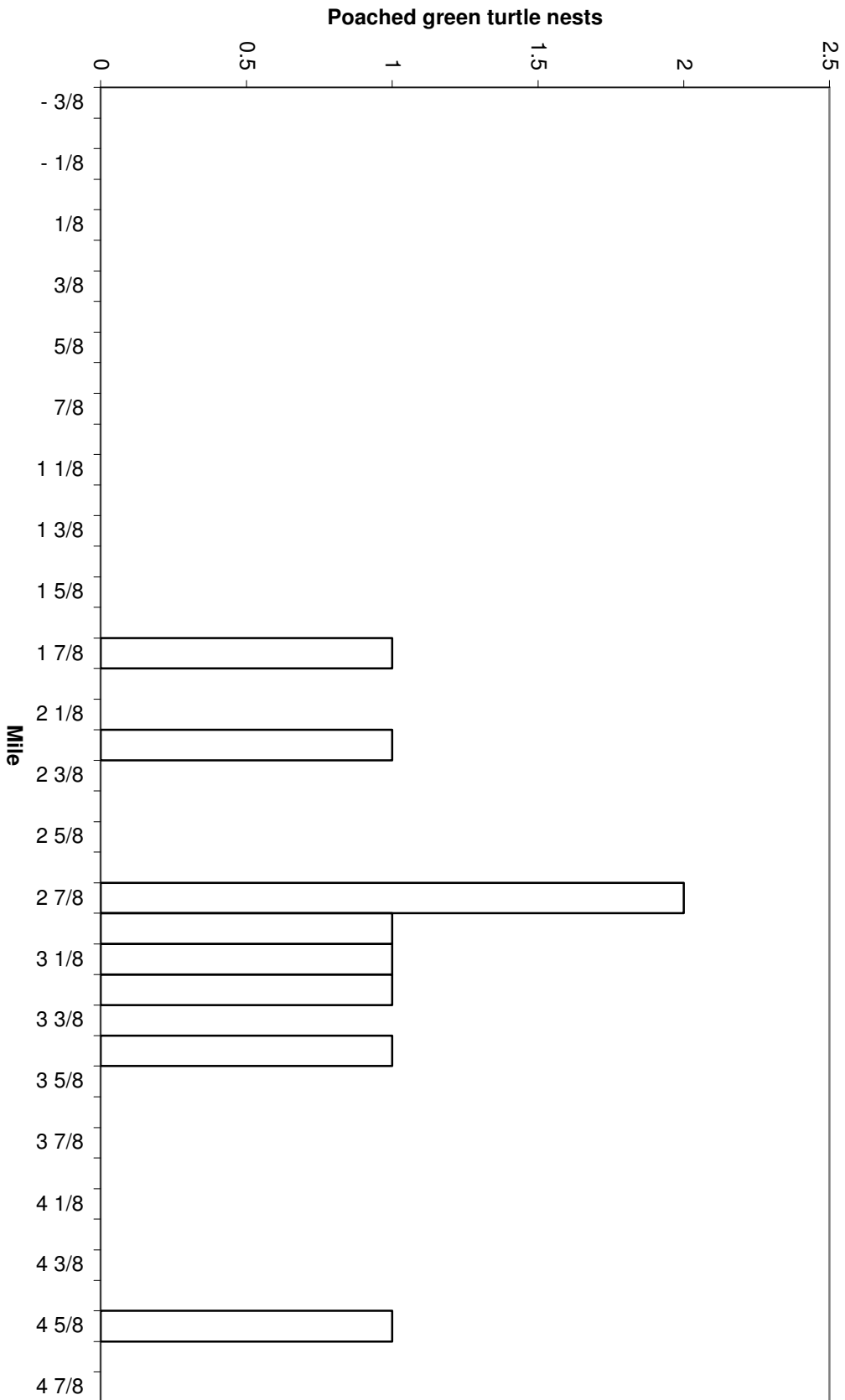


Figure 8. Spatial distribution of marked and subsequently poached nests

Figure 9. Sand temperatures.

Figure 9a. Sand temperature at 70 cm depth, open zone.

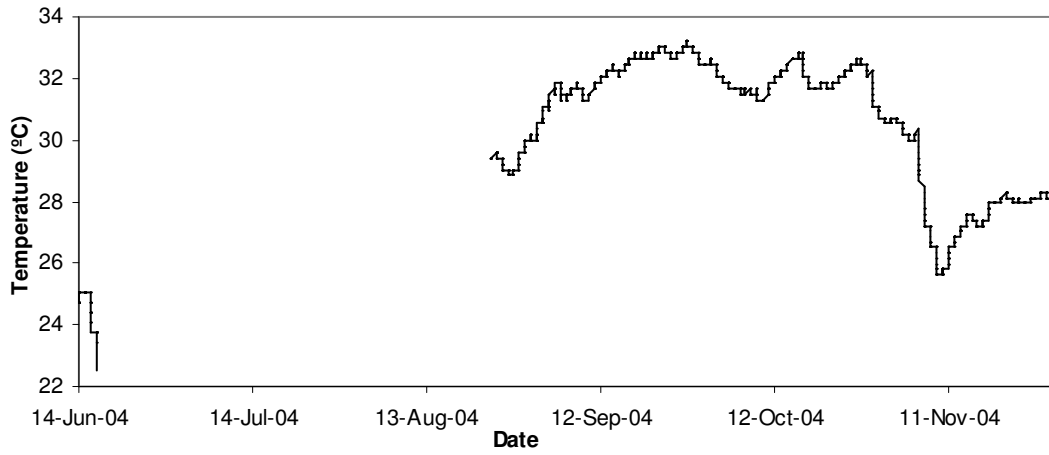


Figure 9b. Sand temperature at 70 cm depth, border zone.

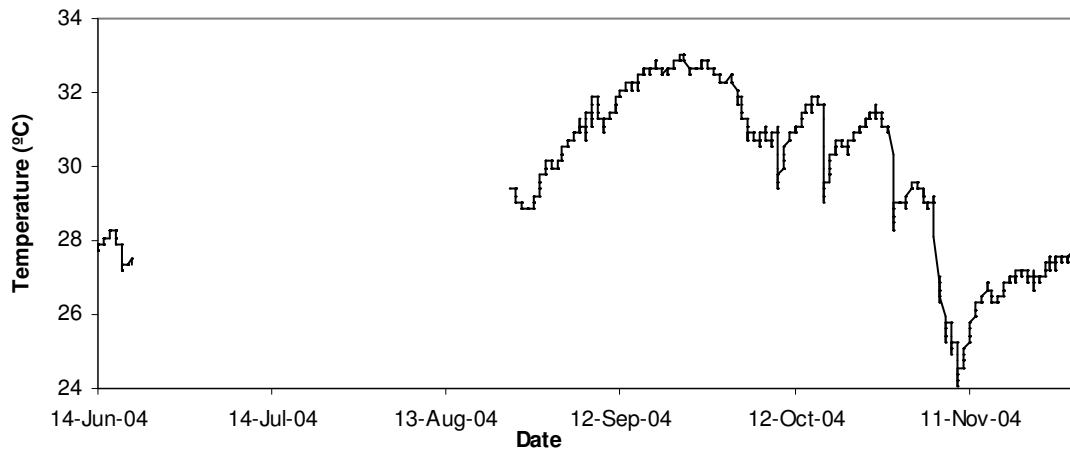


Figure 9c. Sand temperature at 70 cm depth, vegetation zone.

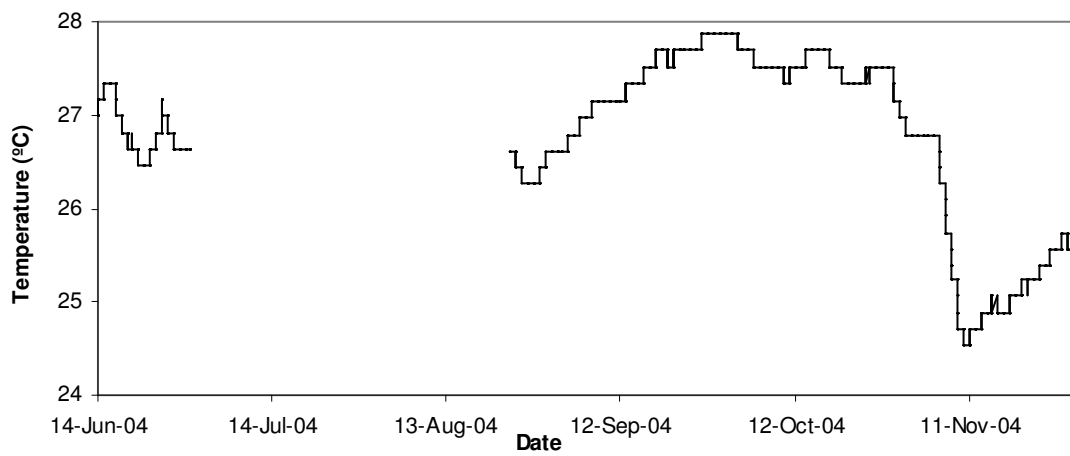


Figure 10. Recaptures of green turtles tagged at Tortuguero, by country.

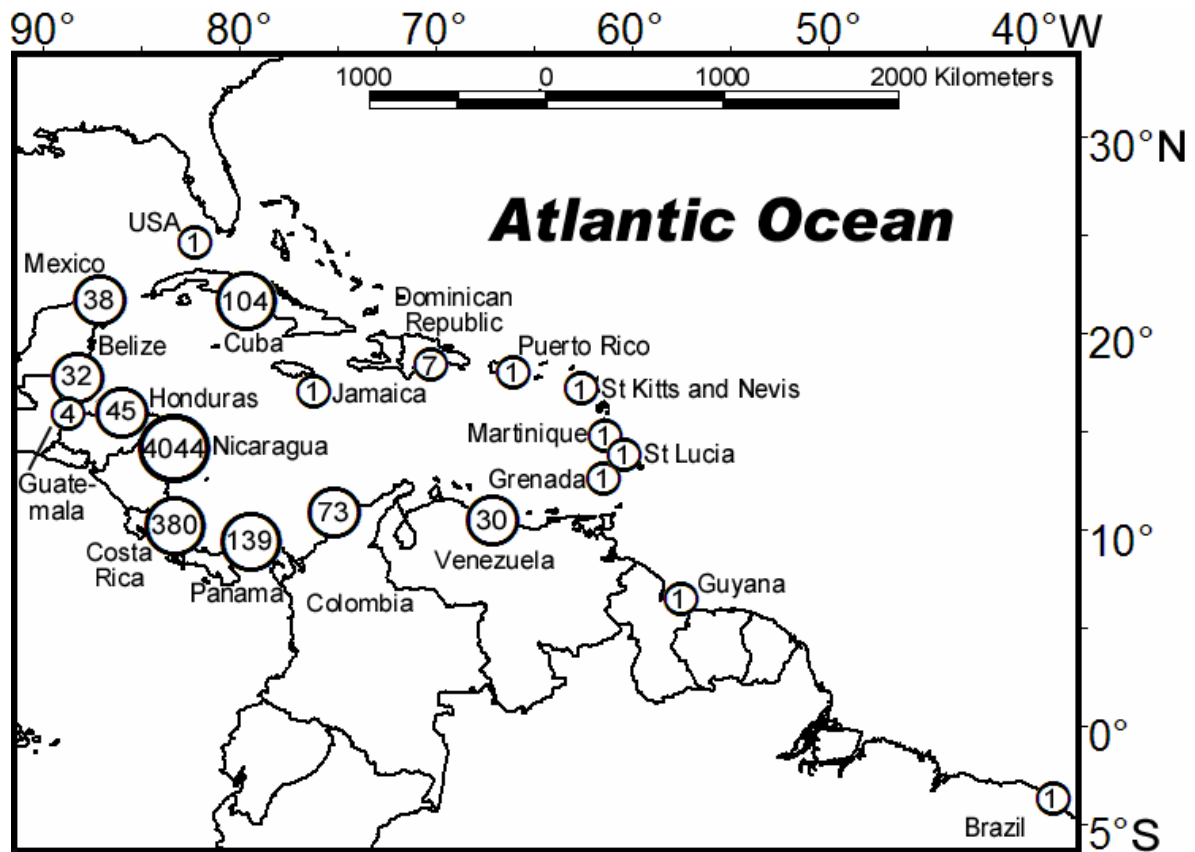
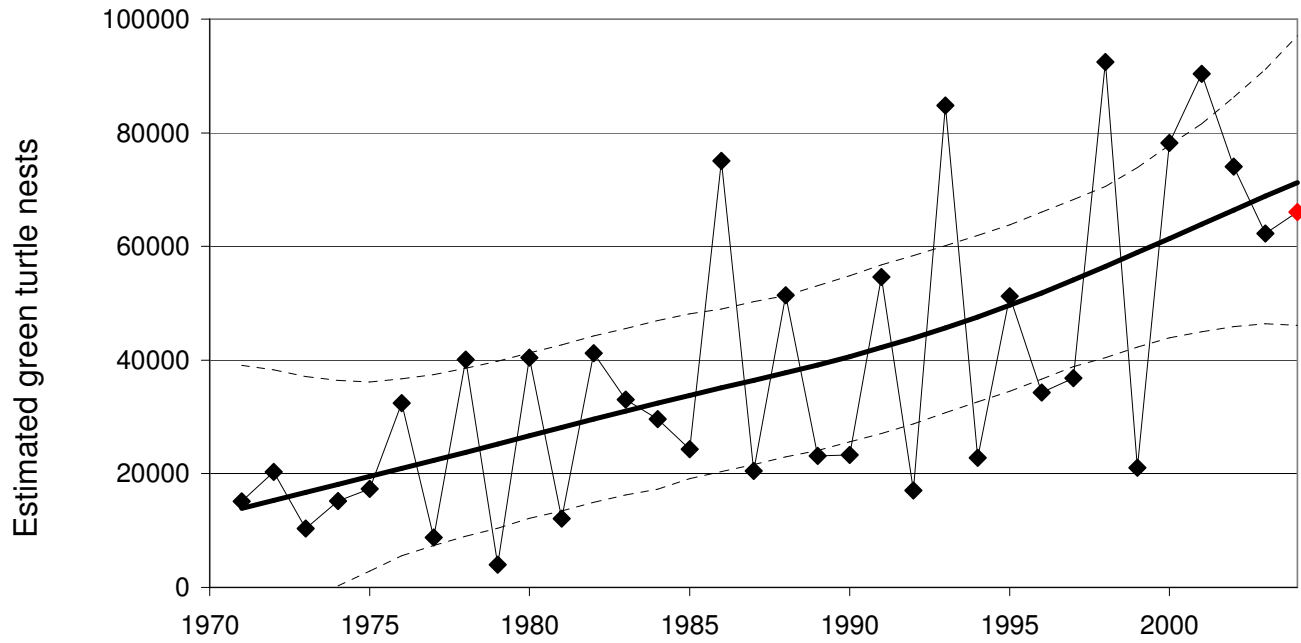


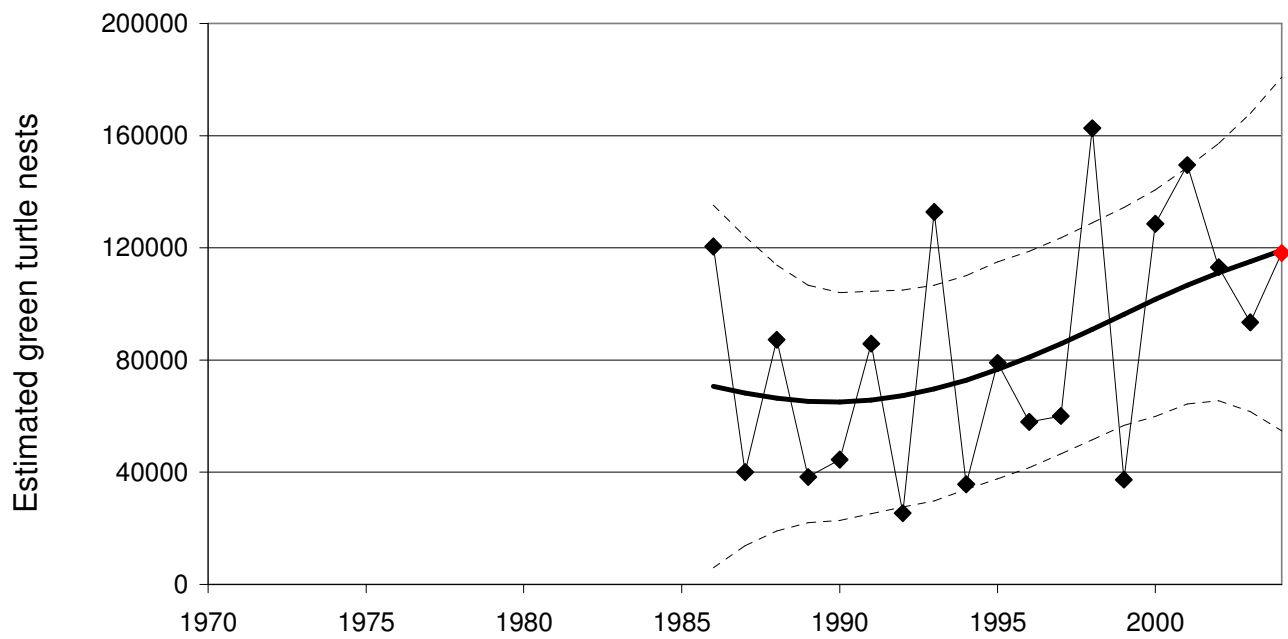
Figure 11. Green turtle nesting trend at Tortuguero.

For analysis methodology consult Troëng & Rankin (2005).

11a. Northern 18 km



11b. Entire beach



APPENDIX 1. Sea Turtle Encounters During Regular Night Patrols

Date	Green turtles				Leatherback turtles				Hawksbill turtles			
	Newly tagged	Previously tagged	Renester	Total	Newly tagged	Previously tagged	Renester	Total	Newly tagged	Previously tagged	Renester	Total
14-Jun-04				0				0				0
15-Jun-04				0				0				0
16-Jun-04				0				0				0
17-Jun-04				0				0				0
18-Jun-04				0				0				0
19-Jun-04				0				0				0
20-Jun-04				0				0				0
21-Jun-04				0				0				0
22-Jun-04				0				0				0
23-Jun-04				0				0				0
24-Jun-04				0				0				0
25-Jun-04			1	1			1	1				0
26-Jun-04				1				1				0
27-Jun-04	2			3				1				0
28-Jun-04				3				1				0
29-Jun-04				3				1				0
30-Jun-04	2			5				1				0
1-Jul-04				5				1	1			1
2-Jul-04			2	7				1				1
3-Jul-04	3	1		11				1				1
4-Jul-04	2	2		15				2			1	1
5-Jul-04		1		16				2				1
6-Jul-04	3	3		22				2				1
7-Jul-04	2	1		25				2				1
8-Jul-04	1	1		27				2				1
9-Jul-04		6		33				2				1
10-Jul-04		1		34				2				1
11-Jul-04	1			35				2				1
12-Jul-04	2	1		38				2				1
13-Jul-04	1	1	1	41				2				1
14-Jul-04	1	3		45				2				1
15-Jul-04	4	3		52				2				1
16-Jul-04	4	1		57				2				1
17-Jul-04	1	4	1	63				2				1
18-Jul-04	3	3	2	71				2				1
19-Jul-04	2	1	1	75				2				1
20-Jul-04	6	1	4	86				2				1
21-Jul-04	5	6		97				2				1
22-Jul-04	6	6		109				2				1
23-Jul-04	12	5	1	127				2				1
24-Jul-04	9	4	2	142				2				1
25-Jul-04	7	2	1	152				2				1
26-Jul-04	9	9	2	172				2				1
27-Jul-04	6	3	1	182				2				1
28-Jul-04	9	5		196				2				1
29-Jul-04	12	8		216				2				1

30-Jul-04	1	1	1	219		2		1
31-Jul-04	3	3	2	227		2		1
1-Aug-04	9	8	5	249		2		1
2-Aug-04	11	5	4	269		2		1
3-Aug-04	10	8	3	290		2		1
4-Aug-04	12	9	2	313		2		1
5-Aug-04	5	6	6	330		2		1
6-Aug-04	11	5	3	349		2		1
7-Aug-04	8	7	3	367		2		1
8-Aug-04	6	10	5	388		2		1
9-Aug-04	7	5	2	402		2		1
10-Aug-04	9	3	8	422		2		1
11-Aug-04	13	7	3	445		2		1
12-Aug-04	9	3	6	463		2		1
13-Aug-04	9	2	3	477		2		1
14-Aug-04	10	7	6	500		2		1
15-Aug-04	9	7	10	526		2		1
16-Aug-04	5	2	3	536		2		1
17-Aug-04	11	6	7	560		2		1
18-Aug-04	6	5	3	574		2		1
19-Aug-04	12	6	4	596		2		1
20-Aug-04	12	7	5	620		2		1
21-Aug-04	10	3	4	637		2		1
22-Aug-04	14	1	1	653		2		1
23-Aug-04	20	10	3	686		2		1
24-Aug-04	20	4	2	712		2		1
25-Aug-04	10	3	4	729		2		1
26-Aug-04	15	1	9	754		2		1
27-Aug-04	4	6	2	766		2		1
28-Aug-04				766		2		1
29-Aug-04	9		5	780		2		1
30-Aug-04	21	6	5	812		2		1
31-Aug-04	13	1	5	831		2		1
1-Sep-04	4	3	3	841		2		1
2-Sep-04	8	2	5	856		2		1
3-Sep-04	5	5	4	870		2	1	2
4-Sep-04	6	1	3	880		2		2
5-Sep-04	11	2	3	896		2		2
6-Sep-04	10	3	6	915		2		2
7-Sep-04	8	8	2	933		2		2
8-Sep-04	1	1	2	937		2		2
9-Sep-04	13	5		955		2		2
10-Sep-04	2	1	1	959		2		2
11-Sep-04	4	1	5	969		2		2
12-Sep-04	7	3	1	980		2		2
13-Sep-04	12	1	2	995		2		2
14-Sep-04	9	2	4	1010		2		2
15-Sep-04	12	4	2	1028		2		2
16-Sep-04	13		3	1044		2		2
17-Sep-04	8		6	1058		2		2
18-Sep-04	1	2		1061		2		2
19-Sep-04	5	2	3	1071		2		2

20-Sep-04	12	4	6	1093				2			2	
21-Sep-04	11	3	4	1111				2			2	
22-Sep-04	14	3	6	1134				2			2	
23-Sep-04	14	5	6	1159				2			2	
24-Sep-04	10	3	9	1181				2			2	
25-Sep-04	8	3		1192				2			2	
26-Sep-04	7	3	2	1204				2			2	
27-Sep-04	13	2	4	1223				2			2	
28-Sep-04	13	1	5	1242				2			2	
29-Sep-04	5	1	2	1250				2			2	
30-Sep-04	8		8	1266				2			2	
1-Oct-04	11	1	7	1285				2		1	3	
2-Oct-04	14	3	4	1306				2			3	
3-Oct-04	12	6	8	1332				2			3	
4-Oct-04	19	4	9	1364				2			3	
5-Oct-04	23	1	8	1396				2			3	
6-Oct-04	11	4	4	1415				2			3	
7-Oct-04	19		6	1440				2			3	
8-Oct-04	10		3	1453				2			3	
9-Oct-04	8	2	4	1467				2			3	
10-Oct-04	8	2	5	1482			1	2			4	
11-Oct-04	18		6	1506				2			4	
12-Oct-04	9	1	4	1520				2			4	
13-Oct-04	15	1	3	1539				2			4	
14-Oct-04	13	4	12	1568				2			4	
15-Oct-04	10	1	4	1583				2			4	
16-Oct-04				1583				2			4	
17-Oct-04	25	2	5	1615				2			4	
18-Oct-04	15	2	7	1639				2			4	
19-Oct-04	7	6	8	1660				2			4	
20-Oct-04	12	2	3	1677				2			4	
21-Oct-04	7	1	5	1690				2			4	
22-Oct-04	11	1	8	1710				2			4	
23-Oct-04	5	1	3	1719				2			4	
24-Oct-04	2	2		1723				2			4	
25-Oct-04	3	2	4	1732				2			4	
26-Oct-04	5		7	1744				2			4	
27-Oct-04	13		5	1762				2			4	
28-Oct-04	5		1	1768				2			4	
29-Oct-04	4		2	1774				2			4	
TOTAL	1007	365	402	1774	0	1	1	2	3	0	1	4

APPENDIX 2. Sea Turtle Encounters During Additional Night Patrols

Date	Section	Green Turtles			Total
		Newly tagged	Previously tagged	Renesters	
8-Sep-04	Mile 8-9 4/8	18	2		20
10-Sep-04	Mile 8-10	22	2		24
12-Sep-04	Mile 7 4/8-9 4/8	21	2		23
15-Sep-04	Mile 8-10	10	2		12
18-Sep-04	Mile 8-10	21	1	1	23
	TOTAL	92	9	1	102

APPENDIX 3. Notes and Anecdotal Information on Illegal Take of Turtles

CCC personnel recorded 107 poaching incidents during the 2004 Green Turtle Program. The large number of poaching incidents recorded in 2004 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. Poaching or attempted poaching of 89 green turtle nests, four hawksbill nests and one leatherback nest accounted for 87 of the poaching records and the remaining 20 incidents involved poaching or attempted poaching of a total of 24 nesting green turtles. Four of the 24 green turtles were discovered alive and released by CCC research assistants, tour guides, park rangers or villagers.

In addition, the CCC track surveyor recorded the poaching of 232 green turtle nests during the weekly 18-mile surveys.