REPORT ON

THE 2002 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 2002 Green Turtle Program was conducted under a research permit from the Ministry of Environment and Energy of Costa Rica detailed in resolution Nº 059-2002. All data presented in this report were collected by Field Coordinator Emma Harrison and her dedicated team of research assistants including Dagnia Nolasco (Peru), Douglas Crispin (Cuba), Cory Matthews (Canada), Karim Padidar (UK), Alexander Gaos (USA), Ross Towers (UK), Dennis Jímenez (Costa Rica), Xavier Debade (France), Melissa Paxton (USA), Tawnie Sawyer (USA), Anthoniy Gutiérrez (Tortuguero, Costa Rica), Juan Carlos Garzón (Colombia), Jormmy Machado (Colombia), Ingrid Yañez (Peru), Ana Díaz (Spain) and Arnoldo Redondo (Costa Rica). Several program participants provided valuable help in assisting the data collection. Their hard work and financial support to the program are much appreciated.

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EXECUTIVE SUMMARY

Monitoring and Research Activities Conducted

1. CCC track surveyors conducted a total of 43 track surveys along the entire 18 miles of beach between Tortuguero river mouth and Jalova lagoon, in 2002.
2. Peak nesting was recorded on 10 September when 1,690 green turtle nests were counted. A total of 18.1 % of all green turtle nests recorded during track surveys were deposited between Tortuguero river mouth (mile –3/8) and the mile 5 marker.
3. Low levels of poaching (1-2 green turtles/night) were recorded in April and August.
4. Jaguars killed a minimum of 86 green turtles in 2002.
5. Very low levels of hawksbill nesting (0-1 nest/night) were recorded from April to November.
6. A total of 1,149 green turtles were newly tagged, 415 green turtles with tags from previous years and 470 renesters were recorded during 1,981 team hours of night patrols between 15 June and 31 October.
7. Three green turtles captured in-water and tagged outside of Costa Rica were encountered on the beach in 2002, one was tagged in Panamá, one in México and one in Florida, USA.
8. Overall probability of within-season tag loss from first to last encounter was 0.030 and varied by tagger and by month of tagging.
9. Newly tagged green turtles had evidence of old tag holes or notches in at least one front flipper in 11 % of cases.
10. Tagging efficiency for night patrols varied between 1-67 % with a mean of 14 % for nights preceding track surveys (n=17).
11. A total of 64.1 % of green turtle nests (n=1,192) were deposited in the open zone, 29.2 % in the border zone (n=543) and 6.7 % in the vegetation zone (n=124).
12. Tissue samples from 236 green turtle females were collected and exported (with CITES permits) to Dr. Karen Bjorndal of University of Florida.
13. Eight hawksbill turtles were newly tagged during the 2002 Green Turtle Program.
14. Tissue samples from 11 hawksbill turtles were collected and exported (with CITES permits) to Dr. Peter Dutton of the National Marine Fisheries Service.
15. Mean carapace length for newly tagged green turtle females without evidence of previous tagging was CCLmin 104.1 cm and SCLmax 97.8 cm, for newly tagged green turtle females with old tag holes or notches CCLmin 105.1 cm and SCLmax 98.7 cm, and for previously tagged tagged females CCLmin 106.2 cm and SCLmax 99.6 cm. Mean clutch size for the same groups of females were 108 eggs, 109 eggs and 115 eggs respectively.
16. Measurement precision was higher for CCLmin than for SCLmax for green turtles, both during the same encounter and during 2-3 encounters.
17. Mean carapace length for hawksbill turtles was CCLmin 87.8 cm and SCLmax 83.5 cm.
18. A total of 14 green turtles representing 7.8 % of carefully examined individuals (n=180) were recorded as having fibropapilloma tumors. Tumors varied in size between 0.5 cm to 8 cm.

19. A total of 191 green turtle nests were monitored and their fate determined. Overall hatching success was 57.4 % (12,187 empty shells from 21,217 eggs) and overall emerging success was 54.9 % (11,656 emerged hatchlings from 21,217 eggs).
20. Comparison between egg counts at excavation and the time of laying showed a mean difference of 4.2 more eggs counted at the time of laying.
21. Mean depth for undisturbed green turtle nests (n=110) at excavation was 54 cm from the sand surface to the top egg and 67 cm from the sand surface to the bottom of the egg chamber.
22. The mean incubation period for undisturbed green turtle nests (n=54) was 59 days.
23. Unhatched albino, twin and deformed embryos accounted for 0.12 % of eggs in undisturbed nests, nests dug up by guides and unhatched nests.
24. The mean angular range of green turtle hatchling tracks for undisturbed and unmarked nests was 45º and the mean angular range minus all outliers was 34º.
25. A total of seven hawksbill nests were monitored and their fate determined. Overall hatching success was 37.9 % (423 empty shells from 1,117 eggs) and overall emerging success was 37.5 % (419 emerged hatchlings from 1,117 eggs).
26. Mean depth for undisturbed hawksbill nests (n=2) at excavation was 26 cm from the sand surface to the top egg and 42 cm from the sand surface to the bottom of the egg chamber.
27. August was the month with highest rainfall (763.4 mm) and September was the month with least rain (181.0 mm) during the 2002 Green Turtle Program.
28. Mean monthly sand temperatures during the 2002 Green Turtle Program were highest in June and lowest in August and November. Increased shading caused a decrease in sand temperatures.
29. In late June, the ground water reached levels that may have affected low laying green turtle nests.
30. A total of 25,524 persons visited the CCC Natural History and Visitors Center in 2002.
31. The Tortuguero Conservation Area raised a total of ¢80,651,827 (approx. US$212,242) during the first 10 months of 2002.
32. The capacity of hotels and cabinas in the Tortuguero area increased slightly in 2002.
33. A total of 26,937 tourists were issued permits to go on guided turtle walks in 2002.
34. The Tortuguero Tourguide Association raised ¢2,468,800 (approx. US$6,497) from 116 tourguides hosting walks for 12,344 tourists.
35. A September light survey indicated that the number of lights behind the airport and in front of the village have increased. In August, the Costa Rica Electricity Institute (ICE) shielded the public lights closest to the beach in Tortuguero village.
36. A satellite transmitter was attached to a green turtle named Miss Junie 2. The green turtle swam north to a location south of the Miskito Cays, Nicaragua.
37. A tarpon (153 cm long) was dissected and found to have 13 green turtle hatchlings in its stomach. No other food items were found in its stomach and digestive tract.
38. Two water samples collected from the Suerte river following a fish kill event in October contained a known nematocide at a concentration of 0.7 ì g/L and 0.4 ì g/L respectively.

Conclusions

1. The majority of green turtle nests (98 %) recorded during track surveys were laid between 15 June and 1 November.
2. A increase in park ranger patrols in the National Park in September 2002 caused a decrease in poaching.
3. Track surveyor Enrique Vargas' sighting of a jaguar with two cubs indicates that the jaguars are reproducing successfully in Tortuguero National Park.
4. More green turtles could have been newly tagged if more tags were available.
5. The three green turtles tagged outside of Costa Rica and encountered on the beach in 2002 emphasize the importance of maintaining high effort beach patrols during the nesting season.
6. The probability of within-season tag loss was low (0.030) as a result of the diligence of the Field Coordinator and the RAs in ensuring that tags were properly attached.
7. Low tag loss observed for Inconel tags should decrease the proportion of females returning with evidence of old tag holes and notches but without tags. However, due to green turtles tagged with Monel tags (pre-1998) returning to the nesting beach without tags, it can be expected that it may take some time to achieve this goal.
8. The reason for the SCLmax measurements being less precise than the CCLmin measurements may have been the use of a worn-out set of calipers.
9. Washing out of nests by rough seas was the major factor reducing nest survivorship and hatching success in 2002. Beach zone or distance between the nest and the high tide line at the time of laying can not be used as exclusive clues to determine if a nest will be washed out or not.
10. Lower than average rainfall in November resulted in few nests being inundated.
11. Rainfall was atypical in 2002 in that heavy rains occurred in May.
12. Visitation to Tortuguero dropped after 11 September 2001 but by mid-2002 visitation numbers had recovered. Since August 2002, visitation has increased in comparison with previous years.
13. Increased visitation and increased capacity of hotels and cabinas mean that more people benefit economically from tourism in the Tortuguero area.

Recommendations

1. A new sea turtle law entering into force in November 2002 and calling for stricter penalities for poachers has the potential to reduce poaching as long as beach patrols by park rangers are also increased.
2. It would be desirable to conduct a study to compare the results of immunological tests to those of visual inspection of nesting females in order to evaluate the effectiveness of visual inspections in correctly identifying the presence of fibropapillomas.
3. Studies to determine the presence of pesticides in the Tortuguero beach and waterways and the impact such chemicals may have on flora and fauna should be encouraged.
4. TidBit (Onset Computer Corp.) dataloggers with protective casing should be bought whenever temperature dataloggers need to be replaced.
5. It would be highly desirable to establish an incentive mechanism by which a larger part of the fees raised by the Tortuguero Conservation Area are returned to cover operative costs incurred by the Conservation Area in managing Tortuguero National Park.

6. Tourguides and hotel managers should be encouraged to inform San José based agencies about the temporal distribution of green turtle nesting in Tortuguero.
7. If the tourguide fee paid per tourist to the Tortuguero Tourguide Association is made mandatory, more reliable statistics would be achieved and more money would be raised for community projects.
8. The Costa Rican Electricity Institute (ICE) should be encouraged to continue shielding artifical lights that are visible from the beach.
9. Studies to determine the extent of marine depredation of sea turtle hatchlings off the Tortuguero beach should be encouraged. Cooperation with local sportfishing guides may be a first step in establishing such studies.
10. A formal environmental education program should be established for the Tortuguero School and High School. The second Spanish edition of the CCC Educator's Guide may be used as a resource document when developing such a program.

1. INTRODUCTION

Studies of green turtles in Tortuguero were initiated by Dr. Archie Carr in 1954 (*Carr et al.* 1978). Since 1959, Caribbean Conservation Corporation (CCC) has implemented an annual green turtle program. CCC staff and Scientific Advisory Committee revised the green turtle program monitoring protocol in preparation for the 1998 nesting season. The new protocol states 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 2002 Green Turtle Program represents the fifth consecutive year of implementing the revised monitoring protocol.

The objectives of this report are to summarize and discuss the 2002 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 (RAs) arrived in Tortuguero on 16 and 17 June 2002. During the first week of the program, RAs received training in sea turtle biology and the monitoring protocol was explained to them in detail. Practical training was provided along the beach between the Tortuguero river mouth and the mile 5 marker.

During the first week, the mile markers between the Tortuguero river mouth were repaired, repainted and replaced (if needed). The mile markers were located in the same positions as during the 2002 Leatherback Program (Harrison *et al.* 2003).

2.2 Track Surveys

Track surveys were conducted approximately weekly during the entire green turtle program. The track surveyor conducted surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18). The surveys begun at dawn (4:30-5:00 AM) at the Tortuguero river mouth or at the Tortuguero village and finished at 9:30-10:00 AM by Jalova lagoon. The same person surveyed the beach section between Tortuguero river mouth and village in the afternoon if the section had not been surveyed in the morning. Only tracks from the previous night were recorded and for each track were recorded: species, mile section, half moon or nest, and if the turtle was depredated or not. Dead turtles were considered depredated by jaguars *Panthera onca* when they were surrounded by jaguar tracks or showed characteristic jaguar injuries. A turtle was considered poached when the track indicated that humans had dragged the turtle off the beach.

2.3 Tagging of Nesting Sea Turtles

Tagging teams patrolled the beach every night between 15 June-31 October (except for 19 June, 10 and 12 October). The number of teams varied from one to three, depending on the number of research assistants and program participants present at the field station. 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 AM-4 AM, when the number of station residents allowed.

Every encountered turtle that had finished egglaying 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 2002 Green Turtle Program include National Band&Tag Company (NBTC) Inconel #681 tags no. 92210-18, 92220-50, 92257-71, 92273-74, 92288-95000 and Monel #49 tags no. VA1929-31.

2.3.1 Green turtles

Inconel #681 tags were used to tag a sample of green turtles not carrying old tags. An effort was made not to mix Inconel and Monel tags on the same individual. In some cases, this meant applying a new Monel tag to an individual carrying only one old Monel tag that could not be removed.

A disposable razor blade or a biopsy punch was used to collect tissue samples from green turtles. The samples were kept in ethanol or buffer solution at the CCC station until the end of the program when a CITES permit was obtained and the samples were exported to Dr. Karen Bjorndal at the University of Florida, for analysis.

Probability of tag loss was calculated for green turtles tagged with two Inconel #681 tags and 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 first-to-last encounter.

2.3.2 Hawksbill turtles

Hawksbill turtles (*Eretmochelys imbricata*) were tagged with Inconel #681 tags. A disposable razor blade or a biopsy punch was used to collect tissue samples from hawksbills. The samples were kept in ethanol or buffer solution at the field station until a CITES permit was obtained and the samples could be sent to Dr. Peter Dutton of the National Marine Fisheries Service, for analysis. The tagging team always remained with the hawksbill until it had returned to the sea and thoroughly deleted 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 1-2 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 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

All hawksbills encountered during nightly tagging work were measured. 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.

2.5 Fibropapilloma Assessment

2.5.1 Green turtles

The green turtles, for which clutches were counted, were also examined for fibropapillomas. All soft body parts, including the cloacal region were examined, using a flashlight with red filter. The absence or presence of fibropapillomas, location and size of fibropapillomas and 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. The nests were marked with three pieces of flagging tape. The third piece of flagging tape was used to compensate for pieces of flagging tape that may be lost as a result of camouflaging turtles, insects or persons removing the flagging.

The distances from the nest to the vegetation and to the latest high tide line were recorded when the nest was marked.

Marked nests were inspected daily. Inspection of a nest ceased after it had been excavated. Depredated and dug-up nests were monitored for 65 days before excavation of the nest. If

hatching was observed, the date was noted and the nest was excavated two days later. If no hatchlings or hatchling tracks were observed, the nest was excavated after approximately 65 days (or after 75 days during periods with low sand temperatures). Nests were not excavated if the excavator encountered a large number of hatchlings in the nest. If a few hatchlings were encountered, they were placed in a shallow hole and covered with sand so that they could reach the sand surface and emerge the following night. Nests that could not be easily found were located by probing for soft sand using a wooden stick (after hatching and emerging had taken place). This technique greatly aided in locating many of the marked nests.

Date laid, date excavated, date hatched (if available), mile section, excavator, nest code, distance from sand surface to top egg, distance from sand surface to bottom of egg chamber, empty shells, 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 recorded for each excavated nest.

If a nest could not be found, 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 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 tourguides. Nests for which the fate could not be determined with certainty were excluded from the sample.

2.7 Physical Data Collection

2.7.1 Rainfall

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

2.7.2 Air temperature

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

2.7.3 Sand temperature

Sand temperature was measured using dataloggers located at 30, 50 and 70 cm depth in the open, border and vegetation zones in front of the field station.

2.7.4 Ground water level

The level of the ground water was measured daily at 9 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 15 March 1998). The PVC pipes were almost washed out by rough seas and had to be relocated to a wider beach section in front of the field station on 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 Victor Barrantes requested information on the room and bed capacity from cabina owners and hotel managers.

2.8.3 Turtle walks

The number of tourists going on turtle walks was estimated from the permits issued to tourguides by Tortuguero Conservation Area (ACTo). The Tortuguero Tourguide Association recorded the money raised from tourguide fees, which is to be used for community projects.

2.8.4 Artificial lights

Artificial lights were monitored along the northern 5 2/8 miles of beach. Light surveys were carried out when no moon was visible. The mile section, light source and location (beach side or lagoon side) were recorded for each artificial light.

2.8.5 Hatchling orientation

Hatchling orientation was determined for a sample of nests from which hatchlings had emerged the previous night. The observer, mile section, distance from the nest to the sea (m), the approximate number of tracks, the angular range of the tracks 10 m from the nest (^{o}), the angular range minus outlier at 10 m distance from the nest (^{o}) and the modal direction at 10 m from the nest (^{o}) were determined for each nest, using a compass.

2.9 Additional Research

Several research projects were conducted during the 2002 Green Turtle Program, in addition to the regular monitoring activities. Some of these projects were undertaken by independent researchers and will be reported on separately. Projects completed by CCC staff are reported on below.

2.9.1 Satellite transmitters

On 27 September, a green turtle named Miss Junie 2 was fitted with a satellite transmitter. The transmitter was originally used on green turtle Miss Junie in 2000. In 2001, the green turtle Miss Junie was captured by fishermen in Nicaragua but the transmitter was recovered. The transmitter was refurbished and reused on green turtle Miss Junie 2.

Funding for Miss Junie 2 was provided by Shark Reef at Mandalay Bay, Las Vegas, USA. Additional funding for the Sea Turtle Migration-Tracking Education Program has been

provided by the Disney Wildlife Conservation Fund, the Kenneth A. Scott Charitable Trust and the Geraldine R. Dodge Foundation.

2.9.2 Hatchling depredation

Sportfishing guide and boat captain Eddy Brown kindly provided the remains of a tarpon *Megalops atlanticus* captured off the Tortuguero beach on 15 November 2002. The tarpon was dissected on 16 November 2002 by Field Coordinator Dr. Emma Harrison in order to determine if the tarpon had fed on sea turtle hatchlings.

2.9.3 Fish kill

On 1 October 2002, it was reported that a large number of dead fish was floating into Tortuguero National Park from the Suerte river. The Field Coordinator collected samples of water and dead fish in the Suerte river in the afternoon of 2 October 2002. The samples were refrigerated and sent to the Regional Institute for the Study of Toxic Substances (IRET) of the Costa Rican National University, for analysis.

2.10 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 field station.

3. RESULTS

3.1 Track Surveys

3.1.1 Green turtles

Green turtle nesting was observed from March to December with more than 10 nests/night during the June to November period (Figure 1). Peak nesting was recorded on the 10 September 2002 track survey when 1,690 green turtle nests were counted (Figure 1).

Nesting density was highest between mile 6-9 with peak density at mile 8 (Figure 2). Green turtle nesting between the Tortuguero river mouth (mile –3/8) and the mile 5 marker which is where the majority of night patrols were conducted, accounted for 18.1 % of all green turtle nests recorded during track surveys between the Tortuguero river mouth and Jalova lagoon (Figure 2).

The track surveyors recorded evidence of poaching of nesting turtles during four track surveys in April and August (Figure 3). Notes and anecdotal information on illegal harvest suggest that poaching may have been widespread during part of the nesting season (Appendix 3).

The track surveyors recorded a total of 22 freshly killed green turtles between April and December (Figure 4). Detailed counts forming part of a study conducted by Tortuguero Conservation Area biologist Magaly Castro suggest that at least 86 nesting green turtles were killed by jaguars in 2002 (M. Castro pers. comm.). The CCC Track Surveyor Enrique Vargas sighted a female jaguar with two cubs feeding on a freshly killed green turtle during the 5 December track survey.

3.1.2 Hawksbill turtles

Very low levels of hawksbill nesting (one nest/night) were observed between April and November (Figure 5).

3.1.3 Leatherback turtles

Leatherback nesting was recorded between February and July with peak nesting occurring from April to early June (Figure 6, Appendix 1).

3.2 Tagging of Nesting Sea Turtles

3.2.1 Green turtles

A total of 1,149 newly tagged green turtles, 415 green turtles carrying tags from previous years and 470 renesters were recorded during 1,981 team hours of night patrols (Appendices 1 and 2). These turtles represent a sample of green turtles nesting in Tortuguero during the 2002 Green Turtle Program.

Three green turtles tagged by other researchers were encountered during the 2002 Green Turtle Program. Green turtle MM012 that was seen nesting at mile 3 5/8 on 28 June 2002, was originally caught off Zapatilla Cays in Bocas del Toro Province, Panama on 17 June 1990 (A. Meylan pers.comm.). It was tagged by Drs. Meylan and released the same day. Green turtle Q??80 carried a heavily corroded tag that may originally have read Q6080 and was observed nesting at mile 2 on 13 August 2002. If the number was indeed Q6080, the turtle was captured and tagged off Isla Mujeres, Quintana Roo, Mexico on 9 July 1994 (R. Márquez pers.comm.). Green turtle NNY956 was observed during a half-moon at mile 3/8 on 30 September 2002. The turtle was originally captured and tagged as a juvenile (CCLn-t=46 cm) off Fort Lauderdale, Florida, USA on 14 July 1986 (R. Wershoven pers. comm., Troëng *et al.* 2002).

Tissue samples from 236 green turtles were collected and sent to Dr. Karen Bjorndal at the University of Florida for analysis of mtDNA haplotypes. The samples were collected from nesting green turtles and from green turtles freshly killed by jaguars during the 2002 Leatherback and Green Turtle Programs. The samples were collected and exported under permits from the Ministry of Environment and Energy of Costa Rica and from CITES.

The probability of within-season tag loss from first to last encounter varied with person applying the tags and with month of tagging (Table 1a and 1b). Tag loss was higher for green turtles tagged in September than for any other month (Table 1b).

Newly tagged green turtles had evidence of old tag holes or notches in at least one front flipper as determined from observation during the tagging encounter in 11 % of cases (n=126 of 1,143 newly tagged green turtles).

Tagging efficiency for green turtles emerging (nests and half-moons) between the Tortuguero river mouth and the mile 5 marker on nights preceding track surveys (n=17) varied between 1 % and 67 % with a mean of 14 %.

Green turtle nests recorded during night patrols were located in the open beach zone in 64.1 % of cases (n=1,192), 29.2 % (n=543) were located in the border zone and 6.7 % (n=124) in the vegetation zone.

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

a) by tagger

Tagger	**r_{di}**	**r_{si}**	**1-K_i±95% CL**
FC	23	0	0±0
RA1	20	0	0±0
RA2	11	0	0±0
RA3	10	0	0±0
RA4	9	0	0±0
RA5	7	0	0±0
RA6	7	0	0±0
RA7	5	0	0±0
SD	4	0	0±0
RA8	3	0	0±0
RA9	2	0	0±0
RA10	2	0	0±0
RA11	2	0	0±0
RA12	1	0	0±0
RA13	1	0	0±0
RA14	31	1	0.016±0.032
RA15	15	1	0.032±0.064
RA16	13	1	0.037±0.074
RA17	24	3	0.059±0.068
RA18	24	3	0.059±0.068
RA19	7	1	0.067±0.133
RA20	4	1	0.111±0.221
RA21	2	1	0.200±0.392
RA22	1	1	0.333±0.629
Mixed taggers	1	1	0.333±0.629
TOTAL	**229**	**14**	**0.030±0.016**

b) by month

Month	**r_{di}**	**r_{si}**	**1-K_i±95% CL**
March	1	0	0±0
April	1	0	0±0
May	2	0	0±0
June	28	2	0.034±0.049
July	76	4	0.026±0.026
August	75	3	0.020±0.023
September	44	5	0.054±0.048
October	2	0	0±0
TOTAL	**229**	**14**	**0.030±0.016**

RA=Research Assistant, 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

3.2.2 Hawksbill turtles

Eight hawksbill turtles were newly tagged during the 2002 Green Turtle Program (Appendix 1). No previously tagged or renesting hawksbill turtles were encountered during the night patrols. None of the newly tagged hawksbill turtles showed evidence of old tag holes or notches (n=0 of 8).

Tissue samples from a total of 11 hawksbill turtles were sent to Dr. Peter Dutton of the National Marine Fisheries Service (USA) for mtDNA analysis. The samples included tissue from hawksbill turtles encountered during the 2002 Leatherback and Green Turtle Programs and from a juvenile hawksbill turtle washed up on the Tortuguero beach in May 2002, partly covered in oil. It was cleaned and later released. Also included was a tissue sample collected from a hawksbill in November 2001, after the 2001 samples were exported for analysis. All necessary CITES and Ministry of Environment and Energy permits were acquired for the collection and export of the tissue samples.

Hawkbill nests recorded during night patrols were located in the open beach zone in 57 % of cases (n=4) and 43 % (n=3) were located in the border zone.

3.2.3 Leatherback turtles

One leatherback turtle was newly tagged and one leatherback renester was observed during the 2002 Green Turtle Program (Appendix 1). Both leatherback nests were deposited in the open beach zone.

3.3 Biometric Data Collection

3.3.1 Green turtles

The mean carapace length of newly tagged green turtle females without evidence of previous tagging was slightly smaller than the mean carapace length of newly tagged green turtles with old tag holes or notches and the mean carapace length of previously tagged green turtle females (Table 2).

Table 2. Carapace length and clutch size of green turtles.

Sample	n	$\bar{\times}$ CCLmin ± ST.D. (cm)	n	$\bar{\times}$ SCLmax ± ST.D. (cm)	n	$\bar{\times}$ Clutch size ± ST.D. (eggs)
Females – newly tagged no OTH/OTN	832	104.1 ± 4.9	827	97.8 ± 4.6	123	108 ± 23
Females – newly tagged with OTH/OTN	107	105.1 ± 5.4	116	98.7 ± 5.3	23	109 ± 35
Females – previously tagged	331	106.2 ± 4.7	360	99.6 ± 4.5	42	115 ± 26

Precision of the carapace measurements was higher for research assistants than for program participants (Table 3a). The curved carapace length measurement (CCLmin) was more precise than the straight carapace length measurement (SCLmax) (Table 3a and 3b). This holds true both for measurements collected during the same encounter (Table 3a) as for measurements collected during two or three encounters (Table 3b).

Table 3. Precision of carapace measurements for green turtles:
a) during the same encounter

Observer	_ CCLmin n	×±ST.D.	Range	_ SCLmax n	×±ST.D.	Range
Research Assistants	1307	0.2 ± 0.2	0 - 1.8	1393	0.3 ± 0.2	0 - 3.1
Participants	254	0.5 ± 0.4	0 - 2.7	259	0.5 ± 0.5	0 - 3.9
TOTAL	**1561**	**0.3 ± 0.2**	**0 –2.7**	**1652**	**0.3 ± 0.3**	**0 - 3.9**

b) during more than one encounter

Encounters	_ CCLmin n	×±ST.D.	Range	_ SCLmax n	×±ST.D.	Range
2	194	1.3 ± 1.0	0.1 - 7.0	237	1.4 ± 0.9	0.2 - 5.0
3	26	1.6 ± 0.8	0.7 - 4.4	40	2.1 ± 1.7	0.4 - 10.7
4	2	2.8 ± 1.2	1.9 - 3.6	4	2.0 ± 0.8	1.2 - 3.0
5	0			1	2.1 ± N/A	N/A

3.3.2 Hawksbill turtles

The mean size of hawksbill females is 87.8 cm and 83.5 cm for curved (CCLmin) and straight (SCLmax) measurements respectively. Mean clutch size is 169 eggs (Table 4).

Table 4. Carapace length and clutch size of hawksbills.

Sample	n	$\bar{\times}$ CCLmin ± ST.D. (cm)	n	$\bar{\times}$ SCLmax ± ST.D. (cm)	n	$\bar{\times}$ Clutch size ± ST.D. (eggs)
Females – newly tagged	7	87.8 ± 3.3	7	83.5 ± 3.6	3	169 ± 69

The carapace measurement precision was the same for curved and straight measurements for hawksbill turtles (Table 5). Precision was lower for hawksbill turtles than for green turtles (Table 3a).

Table 5. Precision of carapace measurements for hawksbills.

Sample	CCLmin (cm) n	×	Range	SCLmax (cm) n	×	Range
Females – newly tagged	6	0.4	0.1 – 0.6	6	0.4	0.1 – 1.3

3.3.3 Leatherback turtles

Mean carapace length (CCLmin) for the two leatherback turtles is 155.2 cm and the only counted leatherback clutch contained 45 normal size eggs and 29 yolkless eggs (Table 6).

Table 6. Carapace length and clutch size of leatherbacks.

Sample	n	$\bar{\times}$ CCLmin ± ST.D. (cm)	n	$\bar{\times}$ Normal eggs ± ST.D.	$\bar{\times}$ Yolkless eggs ± ST.D.
Females – newly and previously tagged	2	155.2 ± 16.1	1	45 ± N/A	29 ± N/A

3.4 Fibropapilloma Assessment

3.4.1 Green turtles

A total of 14 green turtle females, representing 7.8 % of carefully examined individuals (n=180) were recorded to have fibropapilloma tumors. Tumors were most common on the front flippers with six females having tumors on the left front flipper, four on the right front flipper and one female had tumors on both front flippers. One female had a tumor on the neck, one female had a tumor in the cloacal region and the location of the tumor on the remaining female was not recorded. Tumors varied in size between 0.5 cm and 8 cm.

Four of the affected females were previously tagged and four of the ten newly tagged females with fibropapillomas had evidence of old tag holes or notches.

3.5 Determination of Nest Survivorship and Hatching Success

Mammals observed depredating eggs and hatchlings during the 2002 Green Turtle Program include coatis (*Nasua narica*), tayra (*Eira barbara*), domestic dogs (*Canis familiaris*) and humans (*Homo sapiens sapiens*).

Bird predators observed include black (*Coragyps atratus*) and turkey vultures (*Cathartes aura*) that were observed depredating eggs and hatchlings from nests that had been opened by other predators or nesting turtles. The vultures also depredated inactive hatchlings during the day. Magnificent frigate birds (*Fregata magnificens*) were observed depredating hatchlings moving down the beach. The frigate birds also depredated hatchlings in the water close to the beach.

Ghost crabs (*Ocypode quadrata*) dug into nests, depredated eggs and recently emerged hatchlings. Fly larvae (*Megaselia scalaris*) were observed depredating eggs, pipped hatchlings and hatchlings in the nest. Tropical fire ants (*Solenopsis geminata)* were observed depredating or killing eggs, pipped hatchlings, hatchlings in the nest and hatchlings in the vicinity of the nest.

3.5.1 Green turtles

A total of 216 green turtle nests were marked with flagging tape in the vegetation behind the nest. All flagging was lost for two nests, two nests still contained hatchlings at the end of the 2002 Green Turtle Program and the fate of 21 nests could not be determined with certainty. These 25 nests have been excluded from further analysis, leaving a sample of 191 green turtle nests monitored from the moment of egglaying until their fates were determined (Table 7 and 8).

Overall hatching and emerging success was calculated and based on the assumption of a mean number of 109.3 eggs per marked nests unless the fate category indicated otherwise (Table 8). The total number of eggs in the monitored nests equals 21,217 eggs (=184 nests x 109.3 eggs + 2 nests x 109 eggs + 5 nests x 112.8 eggs + 3 additional nests x 109.3 eggs to account for nests that were dug up together with other nests). Therefore, overall hatching success is 57.4 % (12,187 empty shells from 21,217 eggs) and overall emerging success is 54.9 % (11,656 emerged hatchlings from 21,217 eggs).

Marked and subsequently poached green turtle nests were located mainly between the airport (mile 1 1/8) and the southern limit of Tortuguero village at mile 3 3/8 (Figure 7). In front and north of Tortuguero village a higher proportion of green turtle nests was poached than inside the National Park between mile 3 3/8 and mile 18 (Table 7 and Figure 7). Also, a higher proportion of green turtle nests in front and north of Tortuguero village was washed out by the sea (Table 7). The digging up of green turtle nests by other nesting turtles affected a higher proportion of nests inside the National Park than along the northern section of beach between mile –3/8 and mile 3 3/8 (Table 7).

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

Fate	**Public n**	**Park n**	**Total n**	**% of total**	**Hatching success (%)**	**Emerging success (%)**
Undisturbed						
1. Undisturbed.	68	43	111	58.1	87.4	83.1
Disturbed						
2a. Poached.	10	4	14	7.3	2.8[a]	2.8[a]
2b. Empty egg chamber.	2	0	2	1.0	0[a]	0[a]
3. Dug up by dogs after hatching.	3	0	3	1.6	51.2[a]	51.2[a,b]
4. Dug up by guide after hatching.	1	1	2	1.0	96.3	95.9[b]
5. Depredated.	0	1	1	0.5	0[a]	0[a]
6. Dug up by nesting turtle.	11	14	25	13.1	17.9[a]	17.8[a]
7. Two nests together.	1	2	3	1.6	85.0[a]	84.6[a]
8. Washed out.	17	5	22	11.5	0[a]	0[a]
9. Invaded by roots.	2	1	3	1.6	34.5[a]	34.5[a]
10. Unhatched.	1	4	5	2.6	0	0
TOTAL	**116**	**75**	**191**	**99.9**	**57.4**	**54.9**
(11. Hatchlings still in nest on 1 December.	1	1	2)			
(12. Flagging lost.	1	1	2)			
(13. Undetermined.	15	6	21)			

[a]Assuming a mean nest size of 109.3 eggs

[b]Assuming that all hatchlings not accounted for emerged before depredation

Table 8. Results of green turtle nest excavations.

Fate	Empty shells	Pipped eggs	Live hatchlings	Dead hatchlings	Unhatch. Embryo	Unhatch. full embryo	Unhatch. No embryo	Depredated	Yolkless	_ × eggs
1	10607	64	408	117	301	157	680	321	33	109.3
2a	43	0	0	0	0	2	3	17	2	N/A
2b	0	0	0	0	0	0	0	0	0	N/A
3	168	0	0	0	9	0	28	14	0	N/A
4	210	2	0	1	1	0	1	4	0	109
5	0	0	0	0	0	0	0	0	0	N/A
6	489	3	2	1	14	7	58	27	1	N/A
7	557	4	0	2	6	0	15	12	1	N/A
8	0	0	0	0	0	0	0	0	0	N/A
9	113	0	0	0	3	1	83	11	1	N/A
10	0	1	0	0	176	0	384	3	4	112.8
ALL	**12187**	**74**	**410**	**121**	**510**	**167**	**1252**	**409**	**42**	**N/A**

For fate, see categories in Table 7.

Monitored green turtle nests deposited in the open zone (n=113) were left undisturbed in 65 % of cases (n=73), 48 % (n=29) of nests in the border zone (n=60) and 50 % (n=9) of monitored nests in the vegetation zone (n=18) were left undisturbed. A total of 11 % of monitored nests in the open zone were washed out, 10 % of nests in the border zone and 22 % of nests in the vegetation zone were washed out.

A comparison between egg counts at the time of laying and at excavation for a sample of undisturbed nests (n=107) shows a mean of 4.2 more eggs (range: +44 to -67 eggs, st.dev.=15.6 eggs) counted at the time of laying.

The distance between the sand surface and the top eggshell at the time of excavation for undisturbed nests (n=110) varied between 23 and 80 cm with a mean of 54 cm. The distance between the sand surface and the bottom of the egg chamber for the same nests varied between 40 and 97 cm with a mean of 67 cm.

The incubation period for undisturbed nests for which emerging was observed (n=54) varied between 51-67 days with a mean of 59 days.

Unhatched albino, twin and deformed embryos accounted for 0.12 % of eggs in undisturbed nests, nests dug up by guides and unhatched nests (Table 9).

Table 9. Incidence of albinism, twins and deformed embryos.

	n	**% of total eggs**
Albinos	2	0.02
Twins	5	0.04
Deformed embryos	9	0.07
TOTAL	**16**	**0.12**

3.5.2 Hawksbill turtles

A total of seven hawksbill nests were marked and monitored. Three nests hatched undisturbed, three nests were washed out and the remaining nest was poached (Table 10).

Table 10. Results of hawksbill nest excavations.

Fate	Nests (n)	Shells	Pipped	Live hatchl.	Dead hatchl.	Unhatch. Embryo	Unhatch. full embryo	Unhatched no embryo	Depred.	Total eggs	Hatching success	Emerging success
1	3 [a]	276	12	0	3	3	7	9	12	319	86.5 %[a,b]	85.6 %[a,b]
2a	1	0	0	0	0	0	0	0	0	0	0 %	0 %
8	3	9	0	0	0	0	0	0	0	9	1.9 %[b]	1.9 %[b]

Fate 1=Undisturbed, 2a=Poached, 8=Washed out and partly washed out

[a]Successful excavation was only achieved for two nests. Hatching success for the third nests is assumed to be the same as the mean of the other two nests.

[b]Assuming mean nest size of 159.5 eggs

The results from the excavation of one of the undisturbed hawksbill nests were unfortunately lost. In the calculation of overall hatching and emerging success, that nest is assumed to have had the same hatching and emerging success as the mean of the other two undisturbed hawksbill nests. Overall hatching success for the hawksbill nests (n=7) was 37.9 % (423

empty shells from 1,117 eggs) and emerging success was 37.5 % (419 emerged hatchlings from 1,117 eggs).

The distance from the sand surface to the top egg at the time of excavation for undisturbed hawksbill nests (n=2) varied between 24-27 cm with a mean of 26 cm. The distance between the sand surface and the bottom of the egg chamber at the time of excavation was 42 cm for both nests.

3.5.3 Leatherback turtles

For more information about leatherback hatching success in Tortuguero in 2002, please consult Harrison *et al.* (2003).

3.6 Physical Data Collection

3.6.1 Rainfall

August was the month with most rainfall during the 2002 Green Turtle Program (Table 11). September was the month with least rainfall (Table 11).

Table 11. Rainfall, January-November 2002.

Month	**Total rainfall (mm/month)**	**$\bar{\times}$ rainfall (mm/24hrs)**
January	848.8	27.4
February	296.8	10.6
March	225.2	7.3
April	253.0	8.4
May	721.2	23.3
June	595.9	19.9
July	713.4	23.0
August	763.4	24.6
September	181.0	6.0
October	348.4	11.2
November	657.8	21.9

*Data for 48 hours for 3-4 January, 16-17, 18-19, 20-21 March, 16-17 April, 17-18 May, 29-30 June
**Data for 72 hours for 25-27 June, 20-22 October
***Data for 96 hours for 23-26 February

3.6.2 Air temperature

Mean minimum air temperature was highest in June and lowest in November (Table 12). Mean maximum air temperature was highest in September and lowest in November (Table 12).

Table 12. Air temperature, January-November 2002.

Month	**$\bar{x}$ minimum temp. (°C)** *	**$\bar{x}$ maximum temp. (°C)** *
January	24.2	30.3
February	24.6	32.8
March	25.4	33.2
April	24.9	33.6
May	25.4	31.6
June	25.8	33.2
July	25.0	31.4
August	25.0	29.8
September	25.5	33.7
October	25.0	31.1
November	24.5	30.7

*No data for 3 January, 23-25 February, 16-18, 20 March, 16-17 April, 17 May, 24-26 June, 29 June, 20-21 October, 5-6 November

3.6.3 Sand temperature

On 1 July, rough seas almost washed out the dataloggers located in the open zone. These dataloggers were subsequently relocated to a wider beach section in front of the field station and placed at the same depths in the open beach zone.

Table 13. Mean monthly sand temperatures.

Zone	$\bar{x}$ Open temp (°C)			$\bar{x}$ Border temp (°C)			$\bar{x}$ Vegetation temp (°C)		
Depth (cm)	*30* [a,b]	*50* [a,c]	*70* [a]	*30*	*50*	*70* [d]	*30*	*50* [e]	*70*
January	N/A	27.5	27.2	26.2	26.1	26.0	24.5	24.6	24.6
February	N/A	28.7	28.6	27.7	27.5	27.3	25.5	25.6	25.7
March	30.4	30.0	29.5	27.7	27.8	27.6	26.1	26.2	26.1
Retrieval depth (cm) 7 March	*N/A*	*58*	*74*	*35*	*57*	*75*	*30*	*50*	*70*
Depth (cm) 7 March	*30*	*50*	*70*	*30*	*50*	*70*	*30*	*50*	*70*
April	31.4	31.1	30.6	27.9	28.2	28.1	26.6	26.7	26.7
May	28.9	28.8	28.5	27.0	27.3	27.4	26.0	26.2	26.3
June	30.9	N/A	30.2	28.5	28.6	28.5	27.0	27.1	27.1
Retrieval depth (cm) 15 June	*32*	*52*	*74*	*26*	*47*	*73*	*34*	*51*	*70*
Depth (cm) 15 June	*30*	*50*	*70*	*30*	*50*	*70*	*30*	*50*	*70*
July	28.4	N/A	27.9	27.1	27.3	27.3	26.1	26.3	26.4
August	27.8	N/A	27.5	26.5	26.9	26.9	25.7	25.9	26.1
September	31.5	30.7	29.4	28.1	28.1	N/A	26.9	27.0	26.8
Retrieval depth (cm) 25 August	*33*	*50*	*69*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Retrieval depth (cm) 6 Sept.	*N/A*	*N/A*	*N/A*	*39*	*60*	*78*	*28*	*50*	*62*
Depth (cm) 25 August, 24 Sept.	*30*	*50*	*70*	*30*	*50*	*70*	*30*	*50*	*70*
October	30.0	29.9	29.3	27.5	27.6	N/A	26.3	26.6	26.8
November	28.2	28.2	27.8	26.4	26.5	N/A	25.1	25.5	25.7
Retrieval depth (cm) 1 Dec.	*N/A*	*51*	*71*	*21*	*30*	*60*	*30*	*50*	*70*

[a] High tides almost washed out the dataloggers located in the open zone on 1 July so dataloggers were relocated to the open zone on a wider beach section.
[b] Data from 7 March onwards, [c] No data for 16 June-24 August, [d] No data after 6 September,
[e] No data for 5 September

Mean monthly sand temperatures during the 2002 Green Turtle Program were highest in June and lowest in August and November (Table 13 and Figure 8a-c). Increased shading caused a lowering of sand temperatures at all depths (30, 50 and 70 cm) and a decrease in the range of temperatures recorded by the dataloggers (Table 13 and Figure 8a-c).

3.6.4 Ground water level

On 1 July, rough seas almost washed out the PVC pipes used to measure ground water. The pipes were relocated to a wider beach section in front of the field station.

Due to miscommunication, ground water level was only monitored until 25 September 2002 but was reinitiated in January of 2003.

During the June-September period the ground water only once, in late June, reached levels that could be detected in the PVC pipes (Figure 9). It is possible that the ground water level at this time reached heights that may have inundated low laying green turtle nests.

3.7 Collection of Human Impact Data

3.7.1 Visitors to Tortuguero

The number of visitors to the CCC Natural History and Visitors Center increased in 2002 and totaled 25,524 persons (Table 14), greater than the annual total for 2000 or 2001. A clear drop in visitation can be seen after 11 September 2001 but by June 2002 the number of visitors had recovered to previous levels (Table 14).

Table 14. Visitors to the CCC Natural History and Visitors Center.

	2000		2001		2002	
Month	**Total**	**× Per Day**	**Total**	**× Per Day**	**Total**	**× Per Day**
January	1681*	67	1846	60	1756	57
February	2427	84	2277	81	2108	75
March	2582	83	2301	74	2581	83
April	1742	58	2002	67	1738	58
May	1365	44	1208	39	1239	40
June	1437	48	1334	44	1463	49
July	2899	94	2720	88	2673	86
August	2645	80	2858	92	3419	110
September	1871	62	1440	48	2043	68
October	1746	56	1597	52	2104	68
November	2215	74	1550	52	2276	76
December	1964	63	1472	47	2124	69
TOTAL	**24574**	**68**	**22605**	**62**	**25524**	**70**

* Visitor Center closed 1-6 January 2000 due to illness

The number of paying visitors to Tortuguero National Park continues to increase and totaled 45,232 persons in 2001 (Table 15). The total fees raised by the Tortuguero Conservation Area staff is also increasing and reached ¢80,651,827 (~ US$212,242) during the first ten months of 2002 (Table 15).

Table 15. Paying Visitors to Tortuguero National Park.

Year	Tortuguero National Park CR Visitors	Foreign Visitors	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	4,987[a]	36,775[a]	41,762[a]	3,379[a]	₡80,651,827 [a]

[a] January-October. All data from ACTo.

3.7.2 Capacity of hotels and cabinas

Tha capacity of hotels and cabinas in the Tortuguero area increased in 2002 and now numbers 325 hotel rooms and 116 rooms in local cabinas (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	9	17	All Rankin Lodge	8	18
Caribbean Magic	16	42	Aracari	12	23
Hollywood/Ever Green	15	30	La Casona	1	2
Hotel Vista del Mar**	17	34	Chanu	5	16
Ilan-Ilan	24	54	Ella y Yo	3	6
Jungle	43	129	Hostel Daryl/Marbella	4	10
Laguna	52	154	Joruki	7	14
El Manati	11	17	Maryscar	22	49
Mawamba	54	135	Ms Miriam	6	12
Pachira	48	100	Ms Junie	12	30
Tortuga	24	55	Sabina***	22	35
Turtle Beach Lodge**	12	24	Tortuguero	7	18
Total – Hotels	*325*	*791*	(CCC	7	32)
Cabinas	**Rooms**	**Beds**			
Pisulin/Tropical Lodge*	-	-	*Total – Cabinas*	*116*	*265*
Pancana*	-	-	**TOTAL**	**441**	**1056**

* Rooms are rented out long-term to village residents instead of tourists
** Located in Caño Palma, operating since 2001
***Data from 2001

3.7.3 Turtle walks

The Tortuguero Conservation Area issued permits for nightly turtle walks to 26,937 visitors in 2002 (Table 17).

The Tortuguero Tourguide Association raised a voluntary fee of ₡200 per tourist from tourguides taking tourists on turtle walks. Between 1 July and 15 November, the Association raised a total of ₡2,468,800 (approx. US$6,497) from 116 tourguides hosting walks for 12,344 tourists (D. Loth pers. comm.).

Table 17. Tourists paying to go on turtle walks.

Month	Public beach (mile -3/8 to 3 3/8)	Park (mile 3 3/8 to 5)	Total	Tourguide nights
March	28	2	30	6
April	157	188	345	54
May	216	54	270	48
June	1608	714	2322	316
July	4304	2215	6519	839
August	5246	2840	8086	1013
September	3625	997	4622	699
October	3068	909	3977	587
November	349	417	766	127
TOTAL	**18601**	**8336**	**26937**	**3689**

Data from ACTo.

3.7.4 Artificial lights

Artificial lights are visible along the same beach sections but the number of lights behind the airport (mile 1 1/8-1 2/8) and in front of the village (mile 2 6/8-3 3/8) has increased (Table 18). In August 2002, the Tortuguero workers of the Costa Rican Electricity Institute (ICE) showed considerable initiative when they shaded the majority of the village street lights located close to the beach.

Table 18. Artificial lights visible from the beach, Tortuguero river mouth to Mile 5.

Mile	Light source	Beach side	Lagoon side	Sept
-2/8	House		X	X
6/8	Tortuga Lodge		X	X
1 4/8	Laguna Lodge	X		X
2 3/8	Mawamba Lodge	X		X
2 5/8	CCC	X		X
2 6/8	Houses	X		X
2 7/8	Houses + Street Lights	X		X
3	Houses + Street Lights	X		X
3 1/8	Houses + Street Lights	X		X
3 2/8	Houses	X		X
0 to 5	Red light on mast (m2 6/8)	X		X
1/8-6/8, 1 1/8-4 6/8	Street lights (m2 7/8-3 2/8)	X		X

3.7.5 Hatchling orientation

The mean angular range of all hatchling tracks for undisturbed green turtle nests (n=72) was 45º ± 16º (Table 19). If all outliers were excluded the mean angular range was 34º ± 12º (Table 19).

Table 19. Hatchling orientation.

Nests	n	$\bar{x}$ hatchling tracks ± ST.D.	$\bar{x}$ angular range ± ST.D.	$\bar{x}$ angular range minus outlier/s ± ST.D.	Circlers ± ST.D.
Undisturbed	72	46 ± 16	45 ± 16	34 ± 12	0.1 ± 0.4

3.8 Additional Research

3.8.1 Satellite transmitters

Green turtle Miss Junie 2 remained close to the coast for approximately 20 days after the release. The turtle may have returned to nest as many as two times during this period. Thereafter, Miss Junie 2 swam in a large halfcircle for approximately 6 days before heading straight towards feeding grounds located south of the Miskito Cays in Nicaragua (Figure 10).

The detailed movements of Miss Junie 2 are available on the CCC website at http://www.cccturtle.org/sat_junie2.htm. The map is regularly updated with new information as data points are received from the satellite transmitter.

3.8.2 Hatchling depredation

The tarpon dissected on 15 November 2002 measured 153 cm. A total of 13 dead green turtle hatchlings were found inside its stomach. No evidence of any other food items were found in the tarpon.

3.8.3 Fish kill

The dead fish collected were too decomposed to find evidence of chemicals in the analysis of tissues from these samples. However, the presence of a nematocide was detected in two of the water samples collected in Río Suerte. The concentration of the nematocide in the water samples amounted to 0.7 µg/L and 0.4 µg/L respectively.

3.9 Environmental Education Activities

In June, the Field Coordinator and RAs conducted environmental education activities at the Tortuguero School and invited students to take part in night patrols. In November, additional environmental education activities were carried out when the Tortuguero School children were invited to the CCC Natural History and Visitor Center.

4. DISCUSSION

4.1 Track Surveys

4.1.1 Green turtles

Green turtle nesting was observed from March to December with the majority of nests recorded between 15 June and 1 November (Figure 1). Green turtle nests recorded at track surveys before 15 June and after 1 November only amounted to 2.0 % of all registered green turtle nests in 2002.

Green turtle nests laid between the Tortuguero river mouth and the mile 5 marker where the majority of night patrols were conducted, made up 18.1 % of all green turtle nests recorded during track surveys (Figure 2).

Poaching of nesting green turtles was registered during track surveys in April and August (Figure 3). These were months when few park ranger patrols were conducted in the National Park, along the beach section where poaching was observed. In September, there was a marked increase in the presence of park rangers along the same beach section and as a result poaching of nesting turtles was reduced. In November 2002, a new sea turtle law (Legislative Assembly 2002) entered into force in Costa Rica. In addition to progressive changes such as including sea turtle conservation in the education at all public schools in Costa Rica, the new law calls for stricter penalties for those caught poaching turtles and eggs. Hopefully, the stipulations of the new law coupled with increased patrols by park rangers will further discourage poaching in 2003.

It appears that the number of green turtles killed by jaguars remain stable (Figure 4). Tortuguero Conservation Area biologist Magaly Castro conducted a more detailed study into this phenomenon during the 2002 Green Turtle Program. CCC provided data and publications to facilitate the research work. On 5 December 2002, CCC track surveyor Enrique Vargas sighted a female jaguar with two cubs/juveniles feeding on a freshly killed green turtle. This means that the jaguars are reproducing successfully and hopefully the jaguar population in Tortuguero National Park will remain healthy.

4.1.2 Hawksbill turtles

It is discouraging to see that hawksbill nesting in 2002 was very low even by Tortuguero standards and only 0-1 nest/night was registered during track surveys (Figure 5). Fortunately, no dead hawksbill turtles killed by jaguars were found during the 2002 Green Turtle Program.

4.1.3 Leatherback turtles

For a discussion about spatial and temporal distribution of leatherback nesting at Tortuguero in 2002, please consult Harrison *et al.* (2003).

4.2 Tagging of Nesting Sea Turtles

4.2.1 Green turtles

The objective to tag 1,000 new green turtles was fulfilled during the 2002 Green Turtle Program (Appendix 1 and 2). More green turtles could have been tagged but instead of increasing the number of newly tagged green turtles (which would have required more tags), a concerted effort was made to encounter more previously tagged turtles and renesters.

The green turtles tagged at projects in Panama, Mexico and USA were particularly exciting and they emphasize the importance of maintaining high effort in terms of nightly beach patrols. The encounter with green turtle NNY956 tagged in Florida was the first case of a green turtle from that project being recaptured abroad (R. Wershoven pers. comm). Unfortunately, the original capture site of NNY956 in Florida may be threatened with habitat destruction as a result of planned renourishment projects. The Minister of Environment and Energy of Costa Rica Lic. Carlos Manuel Rodriguez was informed about the rare tag return because of its international importance. As a result, he wrote a letter to Florida Governor Jeb Bush to express his concern that the shared green turtle population

may be threatened by the destruction of important nearshore habitats in Florida. Hopefully, the Minister's letter will contribute positively to the protection of important sea turtle habitats and the debate regarding beach renourishment in Florida.

Tag loss varied by tagger (Table 1a) and was slightly higher in June and September (Table 1b). June and September were months when new research assistants arrived. It may well be that the RAs' skill in attaching tags improves over time and hence tag loss for green turtles tagged in July/August and October was lower.

The overall tagging efficiency was low which reflects the large number of green turtles coming to nest at Tortuguero. The only ways to increase tagging efficiency would be to purchase more tags or to increase the number of teams patrolling the beach at night. However, increasing tagging efficiency will not necessarily improve the implementation of the monitoring objectives in a substantive manner and is therefore not deemed a priority for future green turtle programs.

4.2.2 Hawksbill turtles

It is discouraging to see that all hawksbill turtles encountered during the 2002 Green Turtle Program lacked tags from previous years. This could indicate that the survivorship of adult female hawksbill turtles is low, preventing remigration to nest in future years. Hopefully, the results from the genetic analysis of tissue samples can be used to discern the location of feeding grounds for the Tortuguero hawksbill population so that threats in the feeding areas can be identified and mitigated.

4.2.3 Leatherback turtles

For a discussion about the tagging of leatherback turtles at Tortuguero in 2002, please consult Harrison *et al.* (2003).

4.3 Biometric Data Collection

4.3.1 Green turtles

The mean carapace length of newly tagged green turtle females with tag holes or notches was larger than the mean carapace length of newly tagged green turtles without old tag holes or notches (Table 2). This could indicate that the old tag holes or notches originate from tags applied during previous years (pre-1998). The low tag loss observed for Inconel #681 tags could decrease the proportion of newly tagged females with old tag holes and notches over the long-term. However, green turtles tagged with Monel tags and subsequently losing those tags would need to be reencountered and fitted with Inconel #681 tags. This can be expected to take several years to achieve.

Surprisingly, the precision of the SCLmax measurement was lower than the precision for the CCLmin measurement (Table 3a and 3b). A major reason for the lower precision of the SCLmax measurement may have been the loss of a new set of measuring calipers during the first week of the 2002 Green Turtle Program. The calipers were lost a very stormy night when the RA carrying the calipers was hit by a wave along a very narrow stretch of beach. In order to avoid being swept out to sea, the RA had to let go of the calipers. The loss of the

calipers necessitated the use of an old set of calipers used during the 2001 Green Turtle Program. This set of calipers was slightly worn down and is likely to have been less exact in its measurements.

4.3.2 Hawksbill turtles

The same tendency as for the green turtle measurements can be seen for the hawksbill turtles in that the precision of the SCLmax measurement is lower than in previous years (Table 5). Again, this is most likely a result of having to resort to a worn set of calipers after losing one of the two new sets of calipers during the first week of the program.

4.3.3 Leatherback turtles

For a discussion about leatherback biometrics at Tortuguero in 2002, please consult Harrison *et al.* (2003).

4.4 Fibropapilloma Assessment

4.4.1 Green turtles

The frequency of green turtles with fibropapilloma tumors appears to be increasing. However, visual inspection of nesting green turtles may be insufficient to determine the frequency of fibropapilloma tumors with a high degree of certainty. Therefore, it is suggested that a veterinarian be invited to conduct a detailed study to compare the results of the visual inspection methodology with immunological tests on blood samples collected from the same sample of green turtles. A doctorate student at the University of Costa Rica has expressed interest in conducting such a study. If the logistical and financial aspects of the study can be addressed, it would be highly desirable if the study could be conducted in 2003.

4.5 Determination of Nest Survivorship and Hatching Success

4.5.1 Green turtles

The single most important cause for reduced green turtle hatchling production during the 2002 Green Turtle Program was the washing out of nests (Table 7 and Table 8). Rough seas and heavy wave action washed out large sections of beach, in particular during the first half of the program. Some stretches of beach were too narrow to allow any green turtle nesting. Erosion also made it difficult to pass certain sections of beach by foot and prevented night patrols along sections of the beach between the Tortuguero river mouth and the end of the airstrip (mile 1 3/8) for much of the nesting season.

It is surprising to see that a higher proportion of green turtle nests located in the vegetation zone were washed out than nests located in the border and open zones. This confirms that the location of the nest at the time of laying is not a good indicator for hatching success.

More positive for hatching success was the lower than normal rainfall during November which meant that few nests were inundated by high ground water (Table 11).

The difference between egg counts conducted at laying and at excavation may have been caused by several factors. It may be that some eggs were depredated (crabs?) and removed

from the nests without the depredation being noted during the morning nest checks. This would explain why, on average, fewer eggs were counted during excavation. Another contributing factor may be that due to the high density of nests during the peak nesting season, other nests located close to the marked nests were excavated. Also, the practice of only counting fragments of shell that make up more than 50 % of an egg as an empty shell could have resulted in underestimates of the total number of eggs for nests where the egg shells were highly fragmented at excavation.

The frequency of albino, twin and deformed embryos is low but is a cause for concern. Extensive use of agricultural pesticides in areas bordering Tortuguero National Park has been documented (Castillo *et al.* 2000). It would be highly desirable to conduct a study to determine if chemicals such as agricultural pesticides are present in the beach environment and if the chemicals influence the frequency of albino, twin and deformed embryos. Contacts have been established with senior staff at the Regional Institute for the Study of Toxic Substances (IRET) of the Costa Rican National University and a joint proposal for a pesticide study in Tortuguero has been submitted to an international funding agency.

4.5.2 Hawksbill turtles

Overall hatching and emerging success for hawksbill nests were lower than for green turtles (Table 7 and Table 10). Again, the washing out of nests was the single most important cause for reduced hawksbill hatchling production.

4.5.3 Leatherback turtles

For a discussion about leatherback nest survivorship and hatching success at Tortuguero in 2002, please consult Harrison *et al.* (2003).

4.6 Physical Data Collection

4.6.1 Rainfall

May is normally a dry month but the rainfall in May 2002 was unusually heavy (Table 11). Severe flooding was reported in many communities to the south of Tortuguero as a result of the unexpected heavy rain. November on the other hand was less rainy than normal (Table 11) which may have contributed to few late green turtle nests being inundated.

4.6.2 Air temperature

The heavy rains in May caused the air temperature for that month to be lower than normal (Table 12).

4.6.3 Sand temperature

The sand temperatures were affected by the heavy rains in May and sand temperatures were consequently lower than normal (Table 13).

The new TidBit (Onset Computer Corp.) datalogger with protective casing that was located at 70 cm depth in the open zone appears to have functioned well during the entire 2002 Green Turtle Program (Table 13, Figure 8a). The 70 cm depth open zone datalogger is

experiencing the most extreme conditions in terms of humidity and high temperatures of all dataloggers. If that datalogger works well, it indicates that the same type of datalogger will probably do well at the other depths (30 cm and 50 cm) and in the other zones (border and vegetation). It is suggested that in case dataloggers fail and need replacement that they be replaced by TidBit (Onset Computer Corp.) dataloggers with protective casing.

4.6.4 Ground water level

Although high ground water levels in late June (Figure 9) may have inundated some low laying green turtle nests, flooding does not appear to have been a serious threat to nest survivorship during the 2002 Green Turtle Program. Beach erosion caused by rough seas and heavy wave action caused more severe nest loss by washing out many of the green turtle nests (Table 7).

4.7 Collection of Human Impact Data

4.7.1 Visitors to Tortuguero

There was a marked drop in the number of visitors to the CCC Natural History and Visitors Center after 11 September 2001 (Table 14). However, visitation in the second half of 2002 was high which indicates that tourism in Tortuguero has recovered. This observation is supported by the increase in the annual number of visitors paying the National Park entrance fee (Table 15).

The Tortuguero Conservation Area is raising more funds from fees every year and total fees raised during the first 10 months of 2002 exceeded the annual total for 2001 (Table 15). Unfortunately, there is little incentive for the Tortuguero Conservation Area to further improve the system of raising fees as there does not exist any mechanism by which a proportion of the funds raised are returned to the Tortuguero National Park budget.

4.7.2 Capacity of hotels and cabinas

The capacity of the hotels and cabinas in the Tortuguero area continues to increase (Table 16). It is likely that the increase in room and bed capacity will ensure that economic benefits from ecotourism activities reach more people.

4.7.3 Turtle walks

The number of permits issued for turtle walks indicates that tourism visitation increased in 2002 (Table 17). The months with most permits issued were July and August that together accounted for 54 % of all turtle walk permits issued in 2002. Peak green turtle nesting season is from June through October (Figure 1). It is possible that the uneven visitation during the green turtle nesting season is caused by the promotion of turtle walks by travel agencies mainly during the July-September period. Tourguides and hotel managers should be encouraged to inform San José based agencies about the temporal distribution of green turtle nesting in Tortuguero.

Tourguides talking tourists on turtle walks only contributed the voluntary fee for 51 % of all turtle walks during the July-November period. If the fee raised by the Tortuguero Tourguide

Association was made mandatory, the amount of money raised for community projects would increase. It would also result in more reliable statistics with regards to the number of people actually participating in turtle walks as overreporting is common by tourguides who want to find more clients during the hours between the issuing of permits and the turtle walk.

4.7.4 Artificial lights

New buildings in Tortuguero village and behind the airstrip are increasing the number of artificial lights visible from the beach (Table 18). The initiative shown by the Tortuguero workers of the Costa Rican Electricity Institute (ICE) to shade public streetlights so they do not shine directly onto the nesting beach is highly encouraging. Private house owners in Tortuguero should be encouraged to shade their lights too. It is likely that the local tourguides will benefit from such actions through an increase in green turtle nesting in front of the Tortuguero village which would mean less walking during turtle walks.

4.7.5 Hatchling orientation

Data collected on hatchling orientation do not indicate that the current level of development in Tortuguero has impaired the orientation of hatchlings moving toward the sea (Table 19).

4.8 Additional Research

4.8.1 Satellite transmitters

Satellite telemetry studies have the potential to increase the knowledge about sea turtle migrations and habitat use but are also very effective in raising awareness and support for sea turtle research and conservation efforts. The attachment of a transmitter to Miss Junie 2 was announced to villagers and tourguides in advance of the release of the turtle. As a result hundreds of people were present at the end of the attachment process and for the release.

A press release with digital photos taken by CCC staff was sent out immediately after the release of Miss Junie 2 and resulted in an article in La Nación, one of the most influential Costa Rican newspapers. It is suggested that similar action be taken in future satellite telemetry studies in order to promote sea turtle research and conservation on a national level.

4.8.2 Hatchling depredation

The 13 hatchlings found inside the dead tarpon emphasize the ecological importance of the Tortuguero green turtle population. The abundance of green turtle hatchlings during hatching season may enhance populations of tarpon and other fish favored by sportfishermen. If so, the economic importance of the green turtle population goes beyond ecotourism and also includes profits from sportfishing activities taking place in the Tortuguero area.

Qualitative and quantitative studies to determine fish depredation on green turtle hatchlings should be encouraged. It may be that working with sportfishing guides in the Tortuguero area and asking them for access to caught fish, could be a first step of such a study.

4.8.3 Fish kill

Fish kills have occurred numerous times in the Tortuguero area in the past. Although widely assumed to be linked to the use of agricultural pesticides in bordering areas, few detailed studies have been conducted to conclusively prove this to be the case. Exceptions include the work by Castillo *et al.* (2000) and the results of the water sample analyses in October 2002. A permanent monitoring program to determine the extent and impact of pesticides on the freshwater and marine fauna in Tortuguero National Park would be highly beneficial. A joint proposal has been developed by CCC, the Costa Rican National University and the Tortuguero Conservation Area. The proposal has been submitted to an international funding agency in order to raise the funds needed for such monitoring.

4.9 Environmental Education Activities

The students at the Tortuguero School and High School always express interest in sea turtle conservation during environmental education activities. However, their interest only rarely extends beyond the school environment. The new sea turtle law states that the Ministry of Public Education needs to include sea turtle conservation in their programs (Legislative Assembly 2002). It would be highly desirable to take advantage of this recent decision to impulse a formal program by which CCC staff and research assistants conduct environmental education activities in the local schools or a more frequent basis, perhaps every week. The second edition of the CCC Educators' Guide in Spanish can be used as a starting point in the development of a detailed education program.

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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).

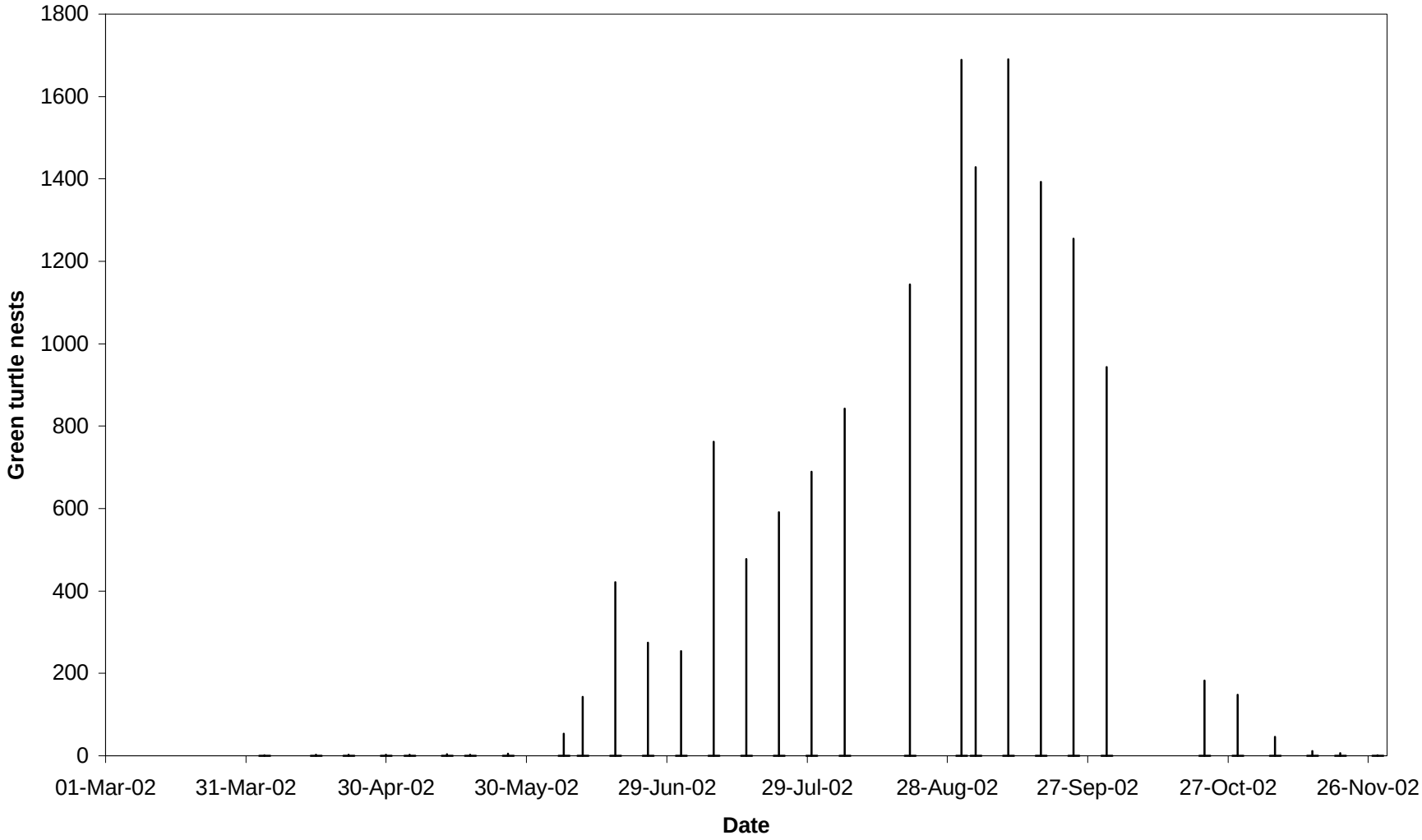


Figure 2. Spatial distribution of green turtle nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

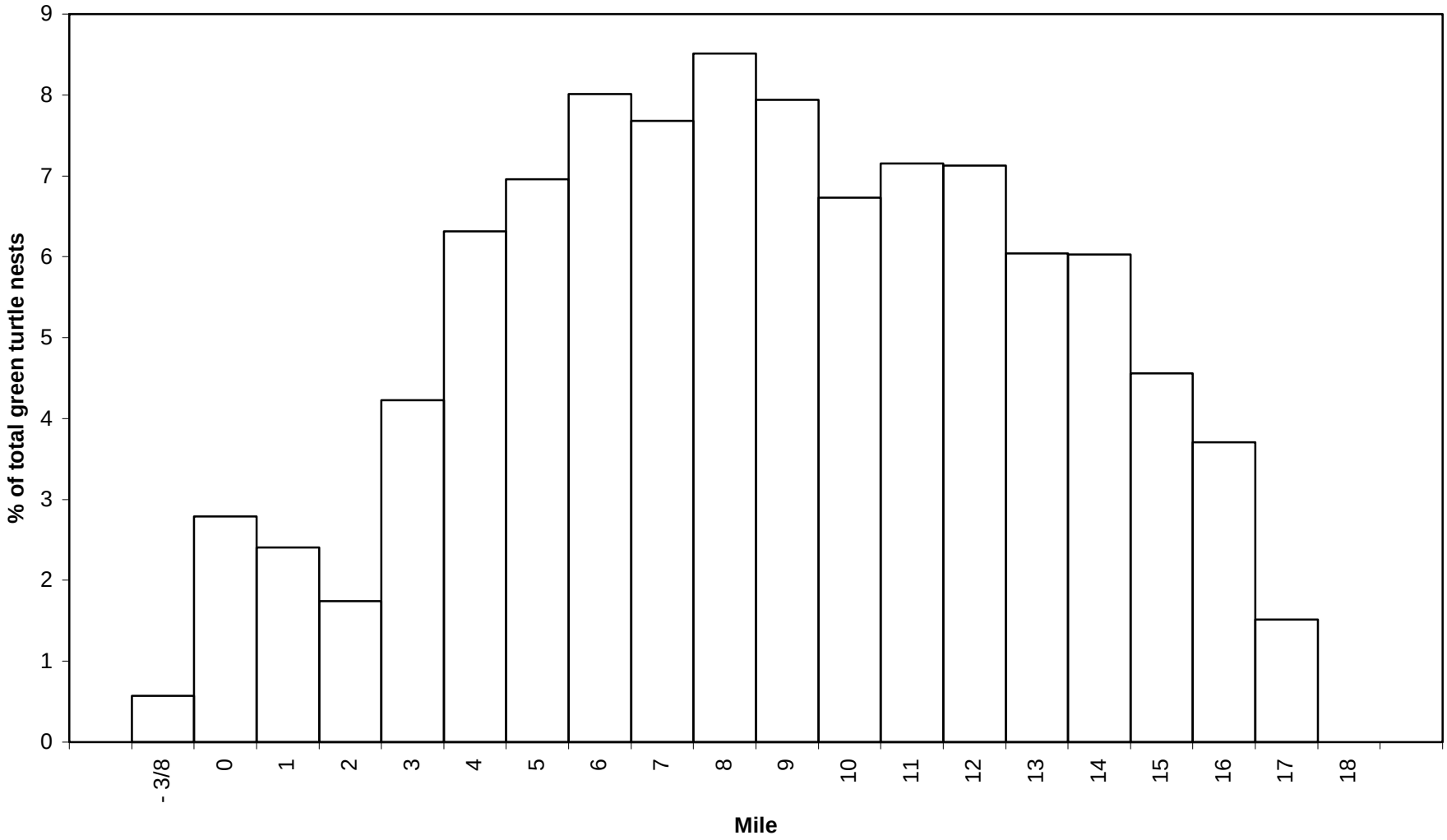


Figure 3. Illegal harvest of green turtles as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

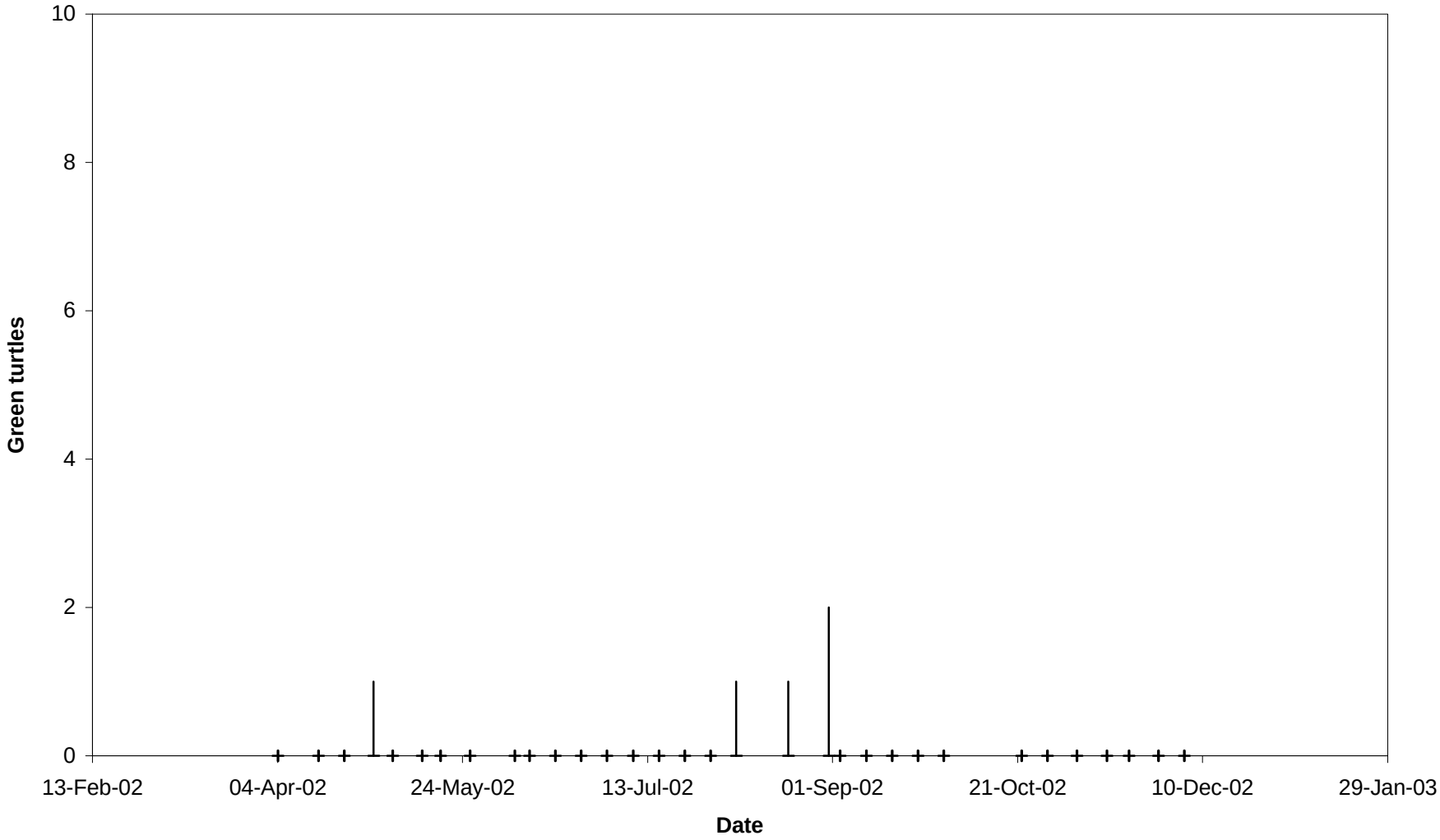


Figure 4. Green turtles killed by jaguars from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

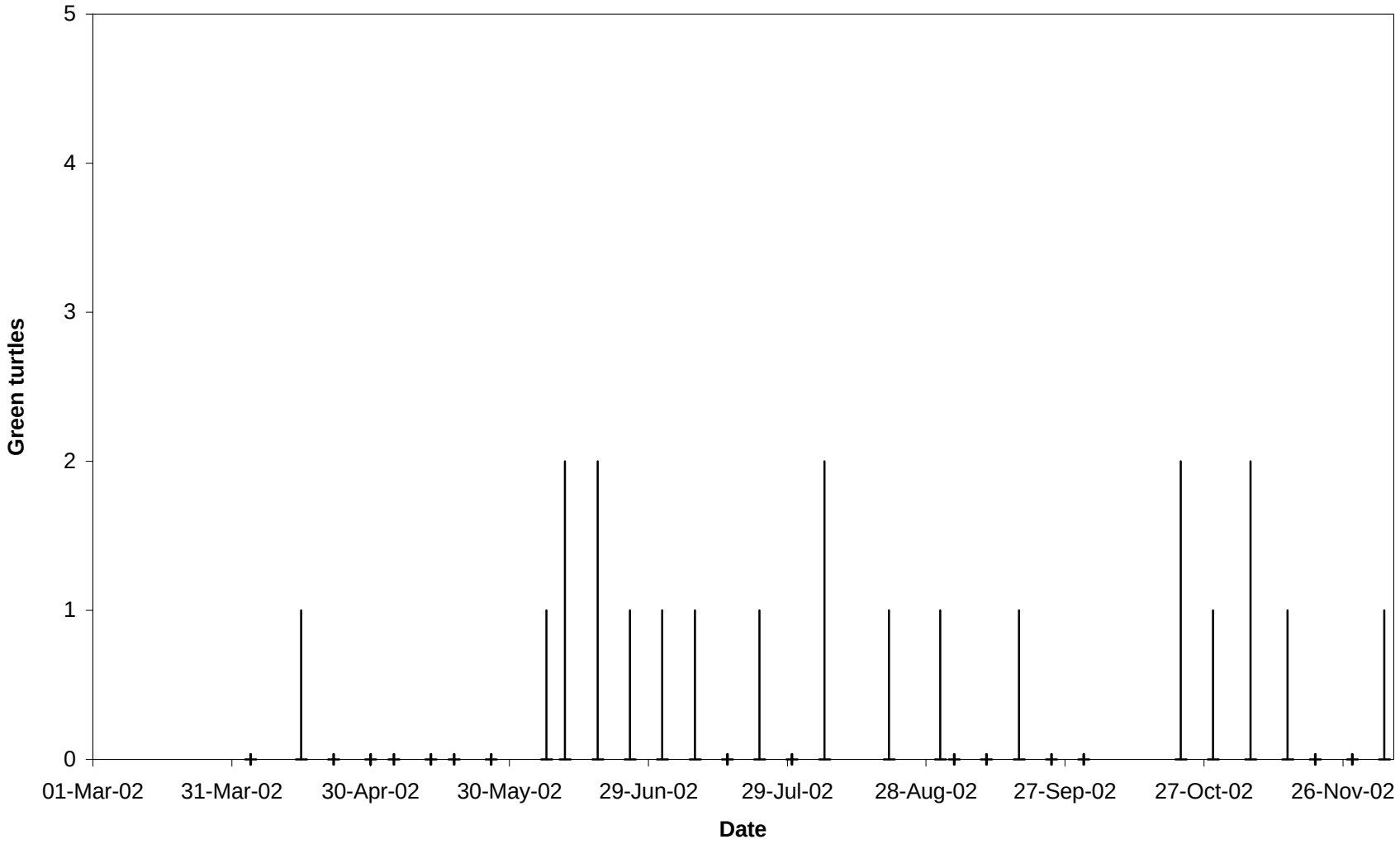


Figure 5. Seasonal distribution of hawksbill nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

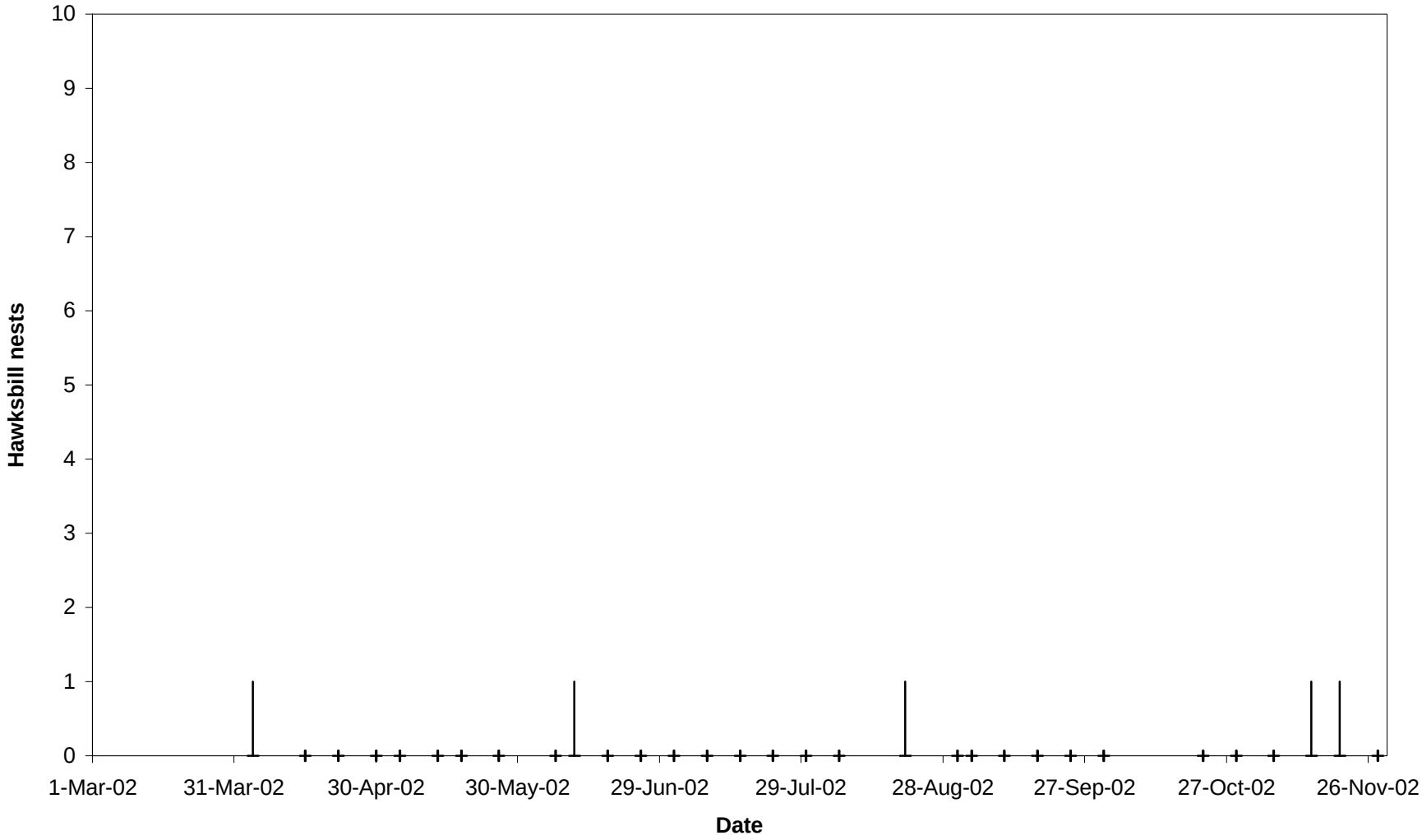


Figure 6. Seasonal distribution of leatherback nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

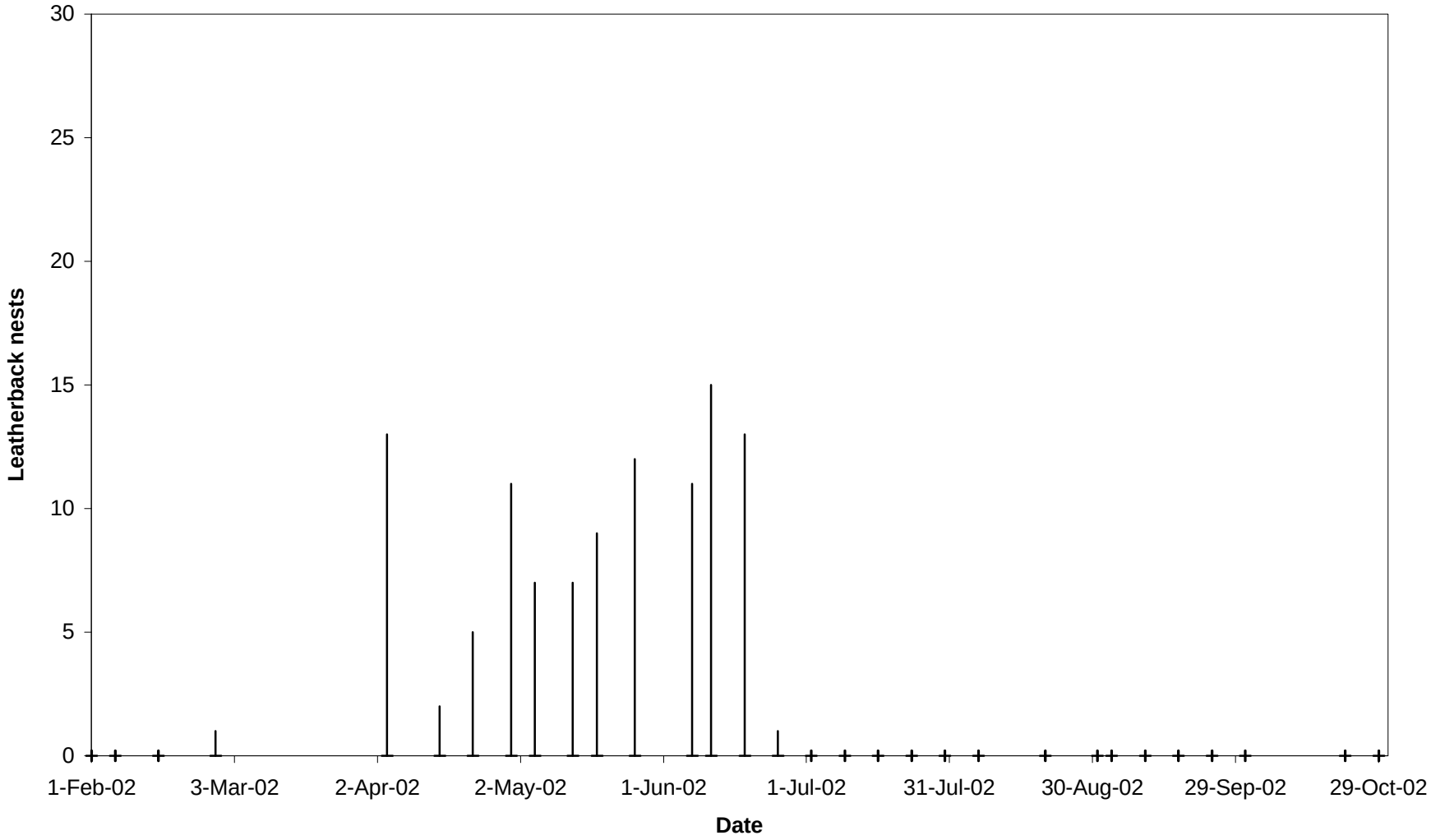


Figure 7. Spatial distribution of marked and subsequently poached nests.

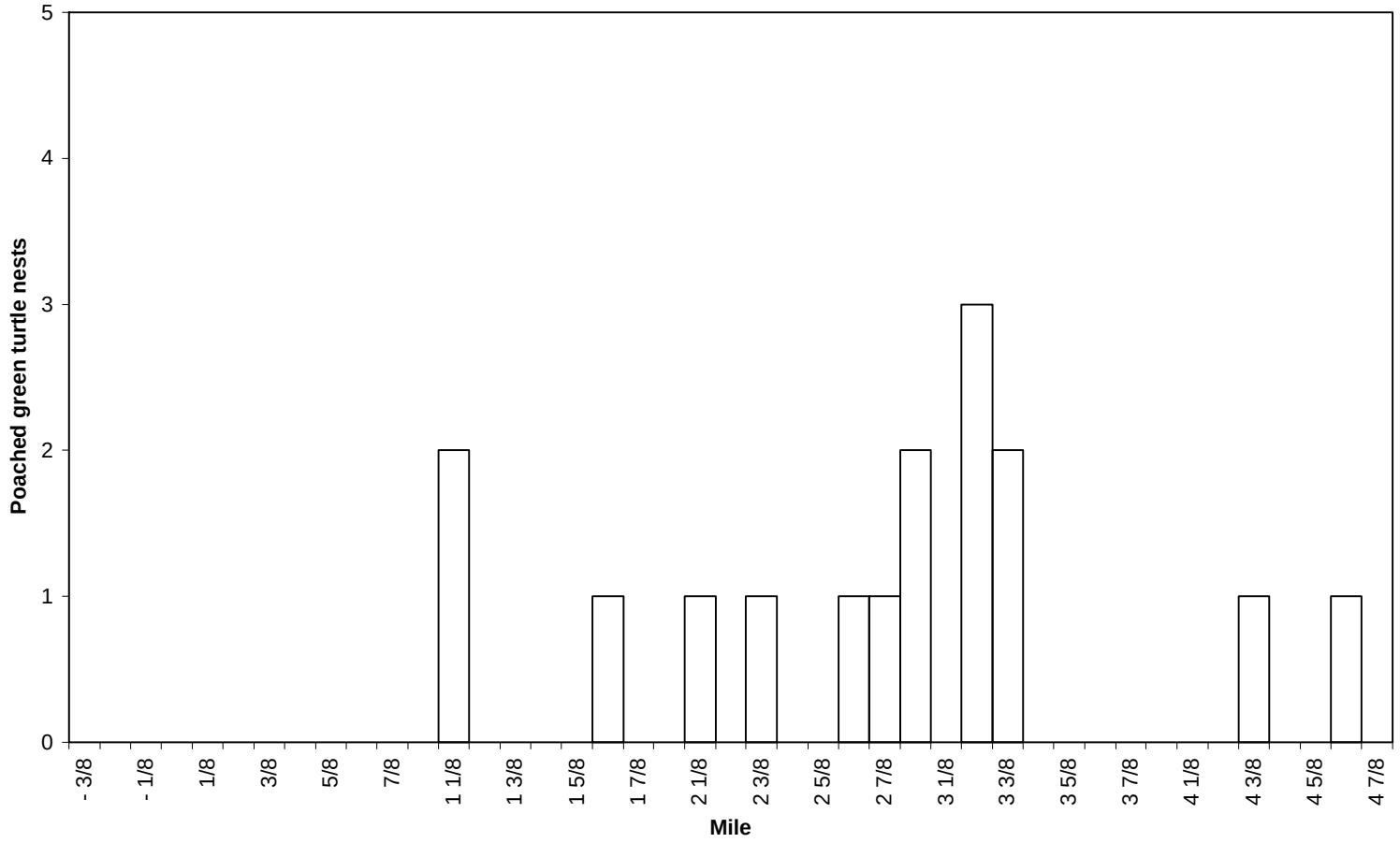


Figure 8. Sand temperatures.

Figure 8a. Sand temperature at 70 cm depth, open zone.

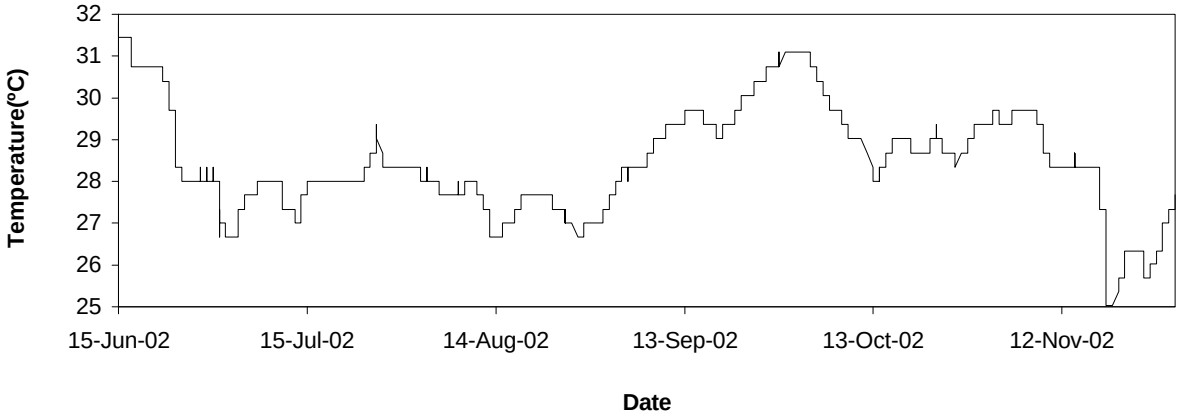


Figure 8b. Temperature at 50 cm depth, border zone.

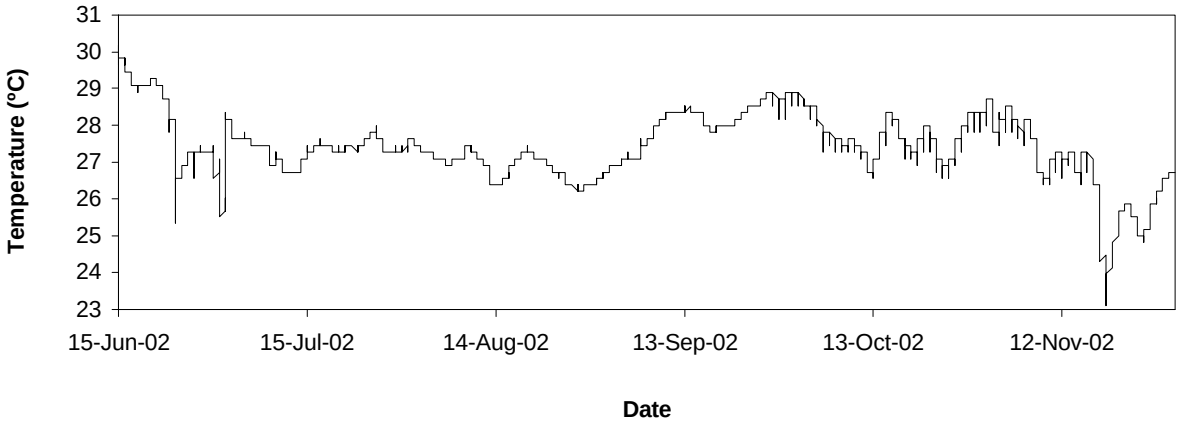


Figure 8c. Temperature at 70 cm depth, vegetation zone.

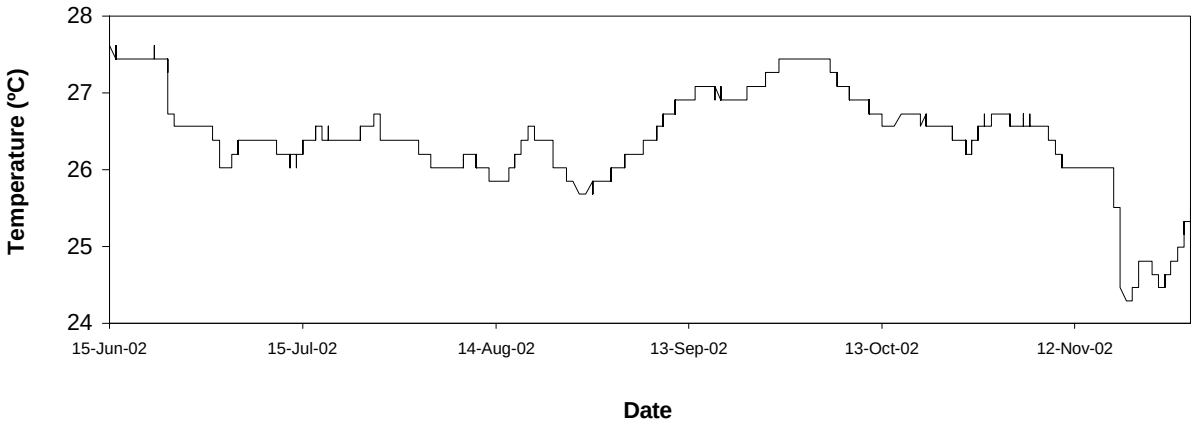
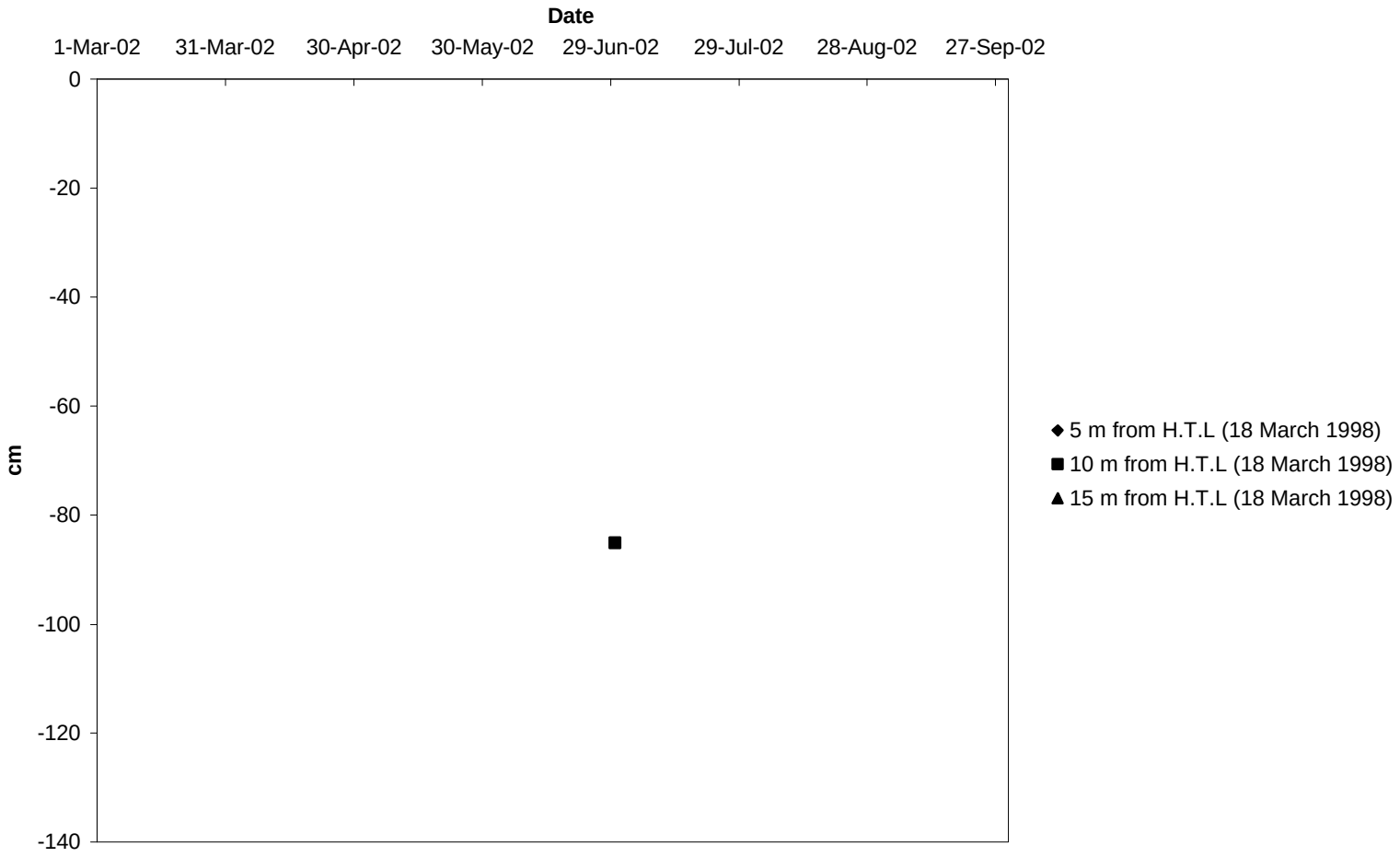


Figure 9. Ground water level.



*PVC pipes used for measuring ground water level were almost washed out due to high tides and were moved to a wider section of beach on 1 July 2002.

Figure 10. Migration path as determined from satellite tracking of green turtle Miss Junie 2.

APPENDIX 1. Sea Turtle Encounters During Regular Night Patrols

Date	Leatherback turtles				Green turtles				Hawksbill turtles			
	Newly tagged turtles	Previously tagged turtles	Renester	Total	Newly tagged turtles	Previously tagged turtles	Renesters	Total	Newly tagged turtles	Previously tagged turtles	Renester	Total
15-Jun-02				0	6	1		7				0
16-Jun-02				0	4	1		12	2			2
17-Jun-02				0	1			13				2
18-Jun-02				0	1	2	1	17				2
19-Jun-02				0				17				2
20-Jun-02				0	1		1	19				2
21-Jun-02				0	5	1	1	26				2
22-Jun-02				0	6			32				2
23-Jun-02				0	5	1	1	39				2
24-Jun-02				0	9		1	49				2
25-Jun-02			1	1	13	1	1	64				2
26-Jun-02				1	9	5	4	82				2
27-Jun-02				1	6	1	1	90				2
28-Jun-02				1	7	4	2	103				2
29-Jun-02				1	4	1	1	109				2
30-Jun-02				1	5		3	117				2
1-Jul-02				1	2		2	121				2
2-Jul-02				1	3		1	125				2
3-Jul-02				1	6	2		133				2
4-Jul-02				1	3	3	1	140				2
5-Jul-02				1	8	1	1	150				2
6-Jul-02	1			2	10	2	3	165				2
7-Jul-02				2	4	2	3	174				2
8-Jul-02				2	11	4	3	192				2
9-Jul-02				2	10	2		204				2
10-Jul-02				2	10	2		216				2
11-Jul-02				2	6	3	1	226				2
12-Jul-02				2	6	5	1	238				2
13-Jul-02				2	1	3	1	243				2
14-Jul-02				2	3	1	2	249				2
15-Jul-02				2	4	2	1	256				2
16-Jul-02				2	7	3	1	267				2
17-Jul-02				2	21	1	2	291				2
18-Jul-02				2	17	1	4	313				2
19-Jul-02				2	8	3	3	327				2
20-Jul-02				2	12	3		342				2
21-Jul-02				2	17		4	363				2
22-Jul-02				2	18	3	4	388				2
23-Jul-02				2	10	6	3	407				2
24-Jul-02				2	10	6	3	426				2
25-Jul-02				2	18	3	1	448				2
26-Jul-02				2	10	8	2	468	1			3
27-Jul-02				2	22	6	4	500				3
28-Jul-02				2	12	7	4	523	1			4
29-Jul-02				2	23	8	4	558				4
30-Jul-02				2	19	7	4	588				4

31-Jul-02		2	18	6	3	615		4
1-Aug-02		2	16	4	3	638		4
2-Aug-02		2	11	4	4	657		4
3-Aug-02		2	5	6	6	674		4
4-Aug-02		2	10	5	5	694		4
5-Aug-02		2	12	7	1	714	1	5
6-Aug-02		2	8	4	3	729		5
7-Aug-02		2	24	7	6	766		5
8-Aug-02		2	6	2	4	778		5
9-Aug-02		2	15	3	3	799		5
10-Aug-02		2	21	5	6	831		5
11-Aug-02		2	10	5	6	852		5
12-Aug-02		2	12	7	4	875		5
13-Aug-02		2	12	5	8	900		5
14-Aug-02		2	5	7	5	917		5
15-Aug-02		2	7	4	5	933		5
16-Aug-02		2	5	1	8	947		5
17-Aug-02		2	5	4	4	960		5
18-Aug-02		2	12	5	5	982		5
19-Aug-02		2	14	10	9	1015		5
20-Aug-02		2	16	8	4	1043		5
21-Aug-02		2	11	6	5	1065		5
22-Aug-02		2	7	4	4	1080		5
23-Aug-02		2	8	6	8	1102		5
24-Aug-02		2	9	6	4	1121	1	6
25-Aug-02		2	8	4	6	1139		6
26-Aug-02		2	13	5	4	1161		6
27-Aug-02		2	12	8	10	1191		6
28-Aug-02		2	11	1	6	1209		6
29-Aug-02		2	4	1	2	1216		6
30-Aug-02		2	8	6	7	1237		6
31-Aug-02		2	4	1	3	1245		6
1-Sep-02		2	8	2	4	1259		6
2-Sep-02		2	10	2	6	1277		6
3-Sep-02		2	11	3	5	1296		6
4-Sep-02		2	11	4	7	1318		6
5-Sep-02		2	7	3	5	1333		6
6-Sep-02		2	7	3	2	1345	1	7
7-Sep-02		2	7	1	3	1356		7
8-Sep-02		2	12	5	4	1377		7
9-Sep-02		2	7	6	4	1394	1	8
10-Sep-02		2	7	2	7	1410		8
11-Sep-02		2	10	4	6	1430		8
12-Sep-02		2	9	5	5	1449		8
13-Sep-02		2	2	4	1	1456		8
14-Sep-02		2	15	4	3	1478		8
15-Sep-02		2	11	1	7	1497		8
16-Sep-02		2	13	4	6	1520		8
17-Sep-02		2	13	6	10	1549		8
18-Sep-02		2	9	1	4	1563		8
19-Sep-02		2	7	2	3	1575		8
20-Sep-02		2	9	2	9	1595		8

21-Sep-02			2	10	1	3	1609				8
22-Sep-02			2	17	2	4	1632				8
23-Sep-02			2	11	4	6	1653				8
24-Sep-02			2	3		3	1659				8
25-Sep-02			2	10		3	1672				8
26-Sep-02			2	10		2	1684				8
27-Sep-02			2	10	1	2	1697				8
28-Sep-02			2	5	2	1	1705				8
29-Sep-02			2	12	5	4	1726				8
30-Sep-02			2	7	4	3	1740				8
1-Oct-02			2		3	5	1748				8
2-Oct-02			2		4	6	1758				8
3-Oct-02			2	1	5	1	1765				8
4-Oct-02			2	1	2	1	1769				8
5-Oct-02			2		2	1	1772				8
6-Oct-02			2	1	5	6	1784				8
7-Oct-02			2		5	9	1798				8
8-Oct-02			2		3	6	1807				8
9-Oct-02			2		2	6	1815				8
10-Oct-02			2		2	3	1820				8
11-Oct-02			2		5	4	1829				8
12-Oct-02			2				1829				8
13-Oct-02			2			4	1833				8
14-Oct-02			2		3	5	1841				8
15-Oct-02			2	1	2	3	1847				8
16-Oct-02			2	1	3	2	1853				8
17-Oct-02			2		3	3	1859				8
18-Oct-02			2		2	4	1865				8
19-Oct-02			2			8	1873				8
20-Oct-02			2		1	7	1881				8
21-Oct-02			2		1	2	1884				8
22-Oct-02			2			3	1887				8
23-Oct-02			2			1	1888				8
24-Oct-02			2		1	1	1890				8
25-Oct-02			2		2	1	1893				8
26-Oct-02			2				1893				8
27-Oct-02			2		1	1	1895				8
28-Oct-02			2	2			1897				8
29-Oct-02			2			2	1899				8
30-Oct-02			2				1899				8
31-Oct-02			2	1			1900				8
TOTAL	**1**	**0**	**1**	**2**	**1020**	**412**	**468**	**1900**	**8**	**0**	**0**	**8**

APPENDIX 2. Sea Turtle Encounters During Additional Night Patrols

Date	Section	Green Turtles			Total
		Newly tagged turtles	Previously tagged turtles	Renesters	
23-Aug-02	Mile 15-18	10			10
29-Aug-02	Mile 15-18	15			25
31-Aug-02	Mile 8-11	11			36
6-Sept-02	Mile 8-11	10			46
11-Sept-02	Mile 8-11	4			50
18-Sept-02	Mile 8-11	28	1		79
19-Sept-02	Mile 8-11	11	1		91
24-Sept-02	Mile 15-18	16	1		108
8-Oct-02	Mile 15-18	10			118
9-Oct-02	Mile 15-18	8			126
16-Oct-02	Mile 15-18	4		1	131
21-Oct-02	Mile 15-18	2		1	134
TOTAL		**129**	**3**	**2**	**134**

APPENDIX 3. Notes and Anecdotal Information on Illegal Harvest.

CCC personnel recorded 223 poaching incidents from June to November 2002. Poaching or attempted poaching of 265 nests accounted for 174 records and the remaining 49 incidents involved poaching or attempted poaching of a total of 55 nesting green turtles. Thirteen of the 55 green turtles were discovered alive and released by CCC research assistants, tourguides, park rangers or villagers. In addition, the CCC track surveyor recorded the poaching of 57 green turtle nests during the 18 mile surveys.

Local poachers are predominantly young men in need of quick cash, often for the purpose of purchasing drugs or alcohol. Outside poachers arrive by boat from the city of Limón and probably also from Barra del Colorado to poach nests and turtles on the beach and harpoon turtles at sea. The major market for turtle eggs and meat is the city of Limón but illegal sale of sea turtle products also occur in other communities in the province of Limón including Siquirres.