REPORT ON

THE 2001 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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The 2001 Green Turtle Program was conducted under a research permit from the Ministry of Environment and Energy of Costa Rica detailed in resolution Nº 226-2001.

All data presented in this report were collected by the dedicated field coordinator Catalina Reyes (Colombia) and research assistants Daveka Boodram (Trindidad and Tobago), Germán Zapata (Argentina), Juan Rapetti (Uruguay), Ricardo Araya (Costa Rica), Neil Osborne (Canada), Sarah Gaines (USA), Abigail McCarthy (USA), Marina Rujas (Spain), Sherri Magerowski (USA), María Tonelli (Argentina), Viviana Cadena (Colombia), Nick McCann (USA), Minor Astorga (Costa Rica), Augusto Carmona (Spain), Diego Soto (Costa Rica) and Anabel Sandoval (Costa Rica). They were assited by a large number of program participants whom are gratefully acknowledged for their contribution of effort and financial support to the 2001 Green Turtle Program.

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EXECUTIVE SUMMARY

Monitoring and Research Activities Conducted

1. Track surveyor Eddy Rankin conducted a total of 51 track surveys along the entire 18 miles of beach between Tortuguero river mouth and Jalova lagoon, in 2001.
2. Peak green turtle nesting was recorded 15 September when 2,393 green turtle nests were counted. A total of 18.2 % 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 illegal harvest (1-3 green turtle females/night) were recorded previous to (April-May) and after (October-November) the peak nesting season.
4. Jaguars killed a minimum of 97 green turtles, four hawksbill turtles and one leatherback turtle in 2001.
5. Low levels of hawksbill nesting (0-2 nests/night) were recorded from May to October with a peak in late July.
6. A total of 1,182 green turtles were newly tagged, 388 green turtles with tags from previous years and 721 green turtle renesters were recorded during 2,086 team hours of night patrols between 17 June-10 November.
7. One female green turtle encountered in 2001 was first tagged in Tortuguero during the 1978 nesting season. This represents a reproductive lifespan of at least 23 years!
8. Overall probability of within-season tag loss from first to last encounter was 0.033 and varied by tagger and by month of tagging.
9. Tagging efficiency for night patrols varied between 0-44 % with a mean of 5.0 % for nights preceeding track surveys (n=18).
10. One turtle killed by jaguars was originally captured and tagged in waters off Zapatilla Cays, Panamá.
11. A total of 61.4 % of green turtle nests (n=1,071) were deposited in the open zone, 31.8 % in the border zone (n=554) and 6.8 % in the vegetation zone (n=118).
12. Green turtles with old tag holes or notches in at least one front flipper represented 9 % (n=106 of 1,177 green turtles) of newly tagged green turtles.
13. Nine hawksbills were newly tagged, two hawksbill females with tags from previous years and seven renesting hawksbills were encountered during the Green Turtle Program.
14. Tissue samples were collected from 14 hawksbill females and exported (with CITES permits) to Dr. Peter Dutton of National Marine Fisheries Service.
15. Mean carapace length for newly tagged green turtle females without evidence of previous tagging was CCLmin 104.2 cm and SCLmax 98.2 cm, for newly tagged green turtle females with old tag holes or notches CCLmin 105.2 cm and SCLmax 99.2 cm, and for previously tagged females CCLmin 105.2 cm and SCLmax 99.1 cm. Overall mean clutch size was 109 eggs.
16. Measurement precision for green turtles was higher for SCLmax than for CCLmin both during the same and during more than one encounter.
17. Mean carapace length for hawksbill turtles was CCLmin 88.3 cm and SCLmax 82.7 cm.
18. Six green turtle females, representing 4.4 % of carefully examined green turtles (n=136) had fibropapilloma tumors. The tumors varied in size from 1 cm to 4 cm.
19. A total of 177 green turtle nests were monitored and fate, hatching and emerging success determined. Overall hatching success for green turtle nests was 58.2 % (11,612

empty shells from 19,968 eggs) and overall emerging success was 55.1 % (11,000 emerged hatchlings from 19,968 eggs).

20. Comparison between egg counts at excavation and the time of laying showed a mean difference of 3.2 more eggs counted at the time of laying.
21. Mean green turtle nest depth at excavation was 61 cm from the sand surface to the top egg and 77 cm from the sand surface to the bottom of the egg chamber.
22. Mean incubation period for green turtle nests was 62 days (n=31).
23. Unhatched albino, twin and deformed embryos made up 0.04 % of all green turtle eggs.
24. The mean angular range of green turtle hatchling tracks for undisturbed nests was 71º and the mean angular range minus all outliers was 47º.
25. A total of nine hawksbill nests were monitored and had a mean hatching success of 44.7 % (637 empty shells from 1,425 eggs) and mean emerging success of 30.9% (440 emerged hatchlings from 1,425 eggs).
26. Mean hawksbill nest depth at excavation was 47 cm from the sand surface to the top egg and 63 cm from the sand surface to the bottom of the egg chamber.
27. November was the month with highest rainfall (1,769 mm) and September (421 mm) was the month with lowest rainfall during the 2001 Green Turtle Program.
28. Mean monthly sand temperatures during the 2001 Green Turtle Program were highest in October and lowest in November. Increased shading caused a decrease in sand temperature.
29. Heavy rains in late June and in the second week in November caused the ground water to raise to levels that may have negatively affected green turtle nests.
30. A total of 21,133 persons visited the CCC Visitor Center during the first 11 months of 2001.
31. The Tortuguero Conservation Area raised a total of ¢70,465,465 (approx. US$207,251) from entrance and other fees during the first 11 months of 2001.
32. The capacity of the hotels in the Tortuguero area remained similar to previous years but the capacity of the cabinas in the village increased in 2001.
33. A total of 22,626 tourists received permits to go on turtle walks in 2001.
34. The Tortuguero Development Association raised ¢3,180,400 (approx. US$9,354) from 15,902 tourists going on turtle walks. Part of the funds will be used to repair the roof on the village information kiosk.
35. Monthly surveys to record artificial lights visible from the beach were conducted July-October. Artificial lights behind the airport and in front of the village increased in 2001.
36. Satellite transmitters were attached to three green turtles. All three turtles swam to waters in the vicinity of the Miskito Keys, Nicaragua.
37. Dr. Sharon Deem of the Wildlife Conservation Society conducted ultrasound and laparoscopy examination of five female turtles as part of a preliminary health study of Tortuguero green turtles.
38. The CCC Scientific Director together with the Costa Rican Coast Guard undertook a field trip to a driftline off the port city of Limón and sighted three juvenile green turtles.

Conclusions

1. The majority (99 %) of green turtle nests recorded during track surveys were laid between 15 June and 1 November.
2. The proportion of nests deposited along the northern 5 miles (18.2 %) is larger than for previous seasons. This could be a real change or related to the implementation of the track survey methodology.
3. Poaching of green turtles and their nests was low during the 2001 Green Turtle Program as a result of efficient enforcement on behalf of Tortuguero park rangers.
4. The large number of sea turtles killed by jaguars could be a threat to turtles, in particular the hawksbill population, but also represents an excellent opportunity for studies of sea turtle depredation and jaguar biology.
5. The number of inconel tags available (3,000) limited the tagging efficiency during the 2001 Green Turtle Program.
6. The green turtle recorded at Tortuguero every three-four years over the past 23 years highlights the importance of long-term projects and of having turtle taggers patrol the beach at night every year for decades.
7. The probability of within-season tag loss was low (0.033) as a result of the diligence of the Field Coordinator and the RAs in ensuring that tags were properly attached.
8. The biometric characteristics of newly tagged female green turtles with old tag holes and/or notches were more similar to previously tagged females rather than to newly tagged females without tag holes or notches. This indicates that green turtles continue to grow after their first nesting season or that larger green turtles are more likely to loose their tags than are smaller females.
9. Heavy rains causing flooding may have been the main reason for the relatively low green turtle hatching and emerging success observed during the 2001 Green Turtle Program.
10. The high rainfall recorded during the 2001 Green Turtle Program resulted in low sand temperatures and a longer than normal average incubation period for green turtle nests.
11. The increase in the capacity of cabinas in the Tortuguero Area may be an indication of villagers being willing to invest in their own business to ensure more profits from the area's tourism.

Recommendations

1. Increased beach and marine patrols by park rangers during the months of March-June and November could contribute to a further decrease in poaching, as would an increase in beach patrols along the mile –3/8 to mile 3 3/8 section.
2. Jaguar studies at Tortuguero should be encouraged. A major objective of such a study should be to quantify the impact of depredation on the hawksbill nesting population.
3. An increase in the number of green turtles to be tagged each year should be considered.
4. New calipers for measuring SCLmax should be purchased for each new green turtle nesting season.
5. A detailed green turtle population health study should be encouraged. One objective of the study should be to develop a more elaborate fibropapilloma examination protocol.
6. From a conservation perspective, it would be desirable if more of the funds raised from entrance fees would be reinvested in protection of Tortuguero National Park and conservation of its natural resources rather than be sent to the central Government.

7. More reliable statistics on tourists going on turtle walks could possibly be achieved if the Development Association fee paid by turtle guides was made mandatory.
8. It would be desirable to develop and implement a plan to limit the number of artificial lights visible from the beach.
9. Satellite transmitter attachment events should be organized as part of future programs as it has proven a successful method for raising awareness and interest in sea turtle issues, both locally and nationally.
10. Several poorly known aspects of sea turtle biology can be studied in the driftlines off Tortuguero. Any such studies should be encouraged.
11. Interested local youths should be accepted as RAs in coming programs as long as this does not encourage local students to leave formal high school education or compromise their families' ability to maintain themselves economically.

1. INTRODUCTION

Studies of green turtles (*Chelonia mydas*) at Tortuguero were initiated by Dr. Archie Carr in 1954 (Carr et al. 1978). Since 1959, the Caribbean Conservation Corporation (CCC) has been implementing an annual green turtle program. The protocol for monitoring was revised by CCC staff and Scientific Advisory Committee in preparation for the 1998 nesting season. The new protocol is implemented 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 2001 Green Turtle Program represents the fourth year of implementing the new monitoring protocol.

The objectives of this report are to summarize and discuss the results of the 2001 Green Turtle Program and provide recommendations for future monitoring, research and conservation activities in Tortuguero.

2. METHODS

2.1 Preparations

The Research Assistants (RAs) arrived in Tortuguero on 16 and 17 June 2001. During the first week they were given lectures on sea turtle biology, the monitoring protocol, station rules and other information relating to the green turtle program. Practical training in tagging and data collection were provided along the northern five miles of beach as well as further into the national park, between miles 7 and 9 (20-21 June).

The mile markers along the northern five miles were repaired and painted during the first days of the Green Turtle Program. The same mile marker positions were used as during the 2001 Leatherback Program (Reyes et al. 2001).

2.2 Track Surveys

Track surveys were conducted approximately weekly during the entire green turtle program. Eddy Rankin conducted track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18). The surveys begun at dawn (4:30-5:00 AM) at 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 or another person surveyed the section in the early 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 if they were surrounded by jaguar tracks or showed characteristic jaguar injuries. A turtle was considered poached if 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 17 June-30 October (except for 13 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 five

miles of 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. Each section was patrolled by separate teams 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 nesting 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 2001 Green Turtle Program include National Band&Tag Company (NBTC) Inconel #681 tags no. 89082-84, 89087, 89091-91971, 91976-92000 and Monel #49 tags no. 79807-12, 79824, 79828-33, 79837-38, 79840-41, 79852-53, 79863-65, 79877.

2.3.1 Green turtles

Inconel #681 tags were used to tag a sample of green turtles without 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.

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 Hawksbills

Hawksbills (*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 Leatherbacks

Leatherbacks (*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 subsample 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 Hawksbills

All hawksbills encountered during nightly tagging work were measured. The clutch was counted, if the hawksbill had not already started to oviposition at the time of encounter.

2.4.3 Leatherbacks

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 make up 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 (in some cases to the current water 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 tour guides. 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 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).

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 cabinas owners and hotel managers.

2.8.3 Turtle walks

The number of tourists going on turtle walks was estimated from the permits issued to tour guides by Tortuguero Conservation Area (ACTo). The Tortuguero Development Association recorded the money raised from tour guide 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 2001 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 and research assistants are reported on below.

2.9.1 Satellite transmitters

On 11-13 September, satellite transmitters were attached to three female green turtles after they had completed the nesting process. Volvo Ocean Adventure, the Rotterdam Zoo (Netherlands) and Shark Reef at Mandalay Bay (Las Vegas, USA) provided funding for one green turtle each.

Additional funding for the Sea Turtle Migration-Tracking Education Program has been provided by the Disney Wildlife Conservation Fund, the Geraldine R. Dodge Foundation, the Elizabeth Ordway Dunn Foundation, the Educational Foundation of America and the Kenneth A. Scott Charitable Trust (A Key Bank Trust).

2.9.2 Laparoscopy

On 3-5 October, Dr. Sharon Deem of the Wildlife Conservation Society performed ultrasound and laparoscopy examination of five female green turtles, at the CCC field station.

2.9.3 Visit to a driftline

On November 27, the Costa Rican Coast Guard and the CCC Scientific Director undertook a field trip to a driftline in waters off the Port City of Limón.

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 recorded from March to December with more than 10 nests/night during the June-November period (Figure 1). Peak nesting was recorded during the 15 September track survey when 2,393 green turtle nests were counted (Figure 1).

Nesting density for green turtles was highest between miles 8-12 with peak density at mile 12 (Figure 2). Green turtle nests deposited between the Tortuguero river mouth (mile –3/8) and the mile 5 marker, where the majority of night patrols were conducted, accounted for 18.2 % of all green turtle nests recorded during track surveys.

Illegal harvest of green turtles was low during the 2001 nesting season as a result of the patrol efforts by the Tortuguero National Park rangers. Low levels of illegal harvest of nesting green turtles (1-3 females/night) were recorded by the track surveyor in April-May and October-November (Figure 3). This corresponds to the time before and after peak green turtle nesting.

Notes and anecdotal information on illegal harvest are summarized in Appendix 3.

The track surveyor recorded a total of 20 fresh green turtles killed by jaguars (Figure 4). However, records by park rangers and research assistants patrolling the beach more frequently indicate a minimum of 97 green turtles, four hawksbill turtles and one leatherback killed by jaguars in 2001 (E. Moreno pers. comm.). CCC staff and research assistants recorded two jaguar sightings during the 2001 Green Turtle Program – the track surveyor spotted a jaguar on the morning of 11 August and two RAs sighted a jaguar on the night of 23 September. Park rangers and tour guides reported additional jaguar sightings during the 2001 Green Turtle Program.

3.1.2 Hawksbills

Very low levels of hawksbill nesting (0-2 nests/night) were recorded from May to October with a peak in late July (Figure 5).

3.1.3 Leatherbacks

Leatherback nesting was recorded from February to July with peak nesting in late April (Figure 6).

3.2 Tagging of Nesting Sea Turtles

3.2.1 Green turtles

A total of 1,182 newly tagged green turtles, 388 green turtles carrying tags from previous years and 721 renesters were recorded during 2,086 team hours of night patrols (Appendices 1 and 2). This represents a sample of green turtles nesting in Tortuguero during the 2001 Green Turtle Program and also includes a male green turtle washed up on the beach when copulating (tagged on 7 July).

On 12 August 2001, a green turtle female with ID#17139 was encountered at mile 1 4/8. Green turtle #17139 has had a reproductive lifespan of at least 23 years. The female was first tagged at Tortuguero during the 1978 nesting season and has since been observed by CCC taggers during the 1982, 1986, 1989, 1992, 1995, 1998 and 2001 nesting seasons!

Only one tag return from a green turtle tagged outside of Costa Rica was recorded during the 2001 Green Turtle Program. Jorge Cedeño and Noldán Chavarría, two Tortuguero park rangers (on 16 June) encountered a green turtle killed by a jaguar at mile 6. The turtle carried a tag that identified it as a green turtle caught in a net off the Zapatilla Cays in Bocas del Toro Province, Panamá and tagged by Drs. Meylan on 22 June 1990 (A. Meylan pers. comm.). The female was seen nesting at Tortuguero in 1990 (at mile 6 1/8) but there are no further records of the turtle until its demise at the teeth of the jaguar.

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**
RA1	10	0	0±0
RA2	8	0	0±0
RA3	5	0	0±0
RA4	4	0	0±0
RA5	38	1	0.013±0.026
RA6	34	1	0.014±0.029
RA7	29	1	0.017±0.034
RA8	39	2	0.025±0.035
RA9	29	2	0.033±0.047
RA10	53	4	0.036±0.036
RA11	25	2	0.038±0.054
RA12	12	1	0.040±0.080
RA13	20	2	0.048±0.067
RA14	28	4	0.067±0.067
RA15	1	1	0.333±0.629
RA16	1	2	0.500±0.612
Mixed taggers	3	0	0±0
TOTAL	**339**	**23**	**0.033±0.014**

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

b) by month

Month	R_{di}	R_{si}	$1\text{-}K_i \pm 95\%$ CL
June	7	1	0.067±0.133
July	84	15	0.082±0.042
August	202	4	0.010±0.010
September	45	3	0.032±0.037
October	1	0	0±0
TOTAL	**339**	**23**	**0.033±0.014**

r_{di}=number of green turtles encountered with two tags, r_{si}=number of green turtles encountered with one tag, $1\text{-}K_i$=probability of tag loss, 95%CL=95% confidence limits

Probability of within-season tag loss from first-to-last encounter varied by tagger (Table 1a). Tag loss also varied by month of tagging with a higher probability of tag loss for green turtles tagged in June-July than for turtles tagged during the August-September period (Table 1b).

Green turtles with old tag holes or notches in at least one front flipper represented 9 % (n=106 of 1,177 green turtles) of newly tagged green turtles.

Tagging efficiency for green turtles coming ashore between the Tortuguero river mouth (mile –3/8) and the mile 5 marker (i.e. nests + half moons) varied between 0 % and 44 % with an overall mean of 5.0 % for nights preceeding track surveys (n=18)

A total of 61.4 % of green turtle nests recorded during night patrols were deposited in the open zone (n=1,071), 31.8 % of the green turtle nests were laid in the border zone (n=554) and 6.8 % were located in the vegetation zone (n=118).

3.2.2 Hawksbills

Nine hawksbills were newly tagged, two hawksbill females with tags from previous years and seven renesting hawksbills were recorded (Appendices 1 and 2). Of these, tour guides reported one female with tags from previous years and one renester to the field coordinator. None of the newly tagged females showed any evidence of old tag holes or notches (n=0 of 9).

Tissue samples from a total of 14 hawksbill females, collected during the 2001 Leatherback and Green Turtle Programs, were exported to Dr. Peter Dutton of the National Marine Fisheries Service (USA) for genetic analysis to determine their mtDNA haplotypes.

A total of 60 % of hawksbill nests were deposited in the open zone (n=9), 33 % of the nests were laid in the border zone (n=5) and 7 % of hawksbill nests were located in the vegetation zone (n=1).

3.2.3 Leatherbacks

Two leatherback females were newly tagged, four leatherbacks with tags from previous years or other projects and six renesting leatherbacks were encountered during the 2001 Green Turtle Program. All leatherback nests were deposited in the open zone (n=10).

3.3 Biometric Data Collection

3.3.1 Green turtles

The mean size of newly tagged green turtle females without evidence of old tag holes or notches is slightly smaller than the mean size of newly tagged green turtle females with evidence of old tags and previously tagged green turtle females (Table 2). Newly tagged green turtles without evidence of old tags also laid fewer eggs (Table 2).

The only male green turtle encountered was smaller than the average female green turtle (Table 2).

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

Sample	**n**	**× CCLmin ± ST.D. (cm)**	**n**	**× SCLmax ± ST.D. (cm)**	**n**	**× Clutch size ± ST.D. (eggs)**
Females – newly tagged no OTH/OTN	1031	104.2 ± 4.7	880	98.2 ± 4.3	85	107 ± 19
Females – newly tagged with OTH/OTN	103	105.2 ± 5.1	97	99.2 ± 4.8	16	115 ± 21
Females – previously tagged	376	105.2 ± 4.7	349	99.1 ± 4.3	31	113 ± 21
Male	1	94.7	-	-	-	-

Precision of green turtle carapace measurements is higher for research assistants than for short-term participants (Table 3a). Precision during more than one encounter is higher for the straight than for the curved carapace measurement (Table 3b).

Table 3. Precision of carapace measurements for green turtles:

a) during the same encounter

	CCLmin			**SCLmax**		
Observer	**n**	**×±ST.D.**	**Range**	**n**	**×±ST.D.**	**Range**
Research Assistants	1377	0.2±0.2	0-4.4	1438	0.2±0.2	0-1.3
Participants	781	0.4±0.2	0-1.8	440	0.3±0.2	0-1.7
TOTAL	**2158**	**0.3±0.2**	**0-4.4**	**1878**	**0.2±0.2**	**0-1.7**

b) during more than one encounter

	CCLmin			**SCLmax**		
Encounters	**n**	**×±ST.D.**	**Range**	**n**	**×±ST.D.**	**Range**
2	303	1.4±0.9	0.1-6.0	268	0.8±0.6	0.1-4.3
3	105	2.2±1.3	0.3-7.2	91	1.3±0.8	0.2-4.7
4	35	2.2±0.8	0.5-3.9	29	1.5±0.7	0.5-4.2
5	3	2.3±0.7	1.5-2.7	4	1.6±0.4	1.2-1.9
6	3	4.9±1.6	3.6-6.6	N/A	N/A	N/A

3.3.2 Hawksbills

The mean size of hawksbills is CCLmin 88.3 cm and SCLmax 82.7 cm and the mean clutch size is 154 eggs (Table 4).

Table 4. Carapace length and clutch size of hawksbills.

Sample	**n**	**× CCLmin ± ST.D. (cm)**	**n**	**× SCLmax ± ST.D. (cm)**	**n**	**× Clutch size ± ST.D. (eggs)**
Females – newly and previously tagged	11	88.3 ± 4.9	10	82.7 ± 4.0	4	154 ± 42

Precision for hawksbill carapace measurements (during the same encounter) is higher for the straight than for curved carapace length (Table 5).

Table 5. Precision of carapace measurements for hawksbills.

Sample	CCLmin (cm)			SCLmax (cm)		
	n	×	Range	n	×	Range
Females – newly and previously tagged	16	0.4	0-1.2	15	0.2	0.1-0.5

3.3.3 Leatherbacks

The mean curved carapace length for leatherback females is 160.5 cm and the mean clutch size 83 normal and 30 yolkless eggs (Table 6).

Table 6. Carapace length and clutch size of leatherbacks.

Sample	n	× CCLmin ± ST.D. (cm)	n	× Normal eggs ± ST.D.	× Yolkless eggs ± ST.D.
Females – newly and previously tagged	10	160.5 ± 6.4	4	83 ± 9	30 ± 9

3.4 Fibropapilloma Assessment

3.4.1 Green turtles

Six females, representing 4.4 % of carefully examined green turtles (n=136) had fibropapilloma tumors. Two of the affected females had tumors on the left front flippers, the remaining four females had tumors on their right front flippers. Fibropapilloma tumors on these females varied in size from 1 cm to 4 cm.

One of the affected green turtle carried tags from previous years. Two of the five newly tagged green turtles with fibropapillomas showed evidence of old tag holes or notches in at least one flipper.

Several other female green turtles were found to have fibropapilloma tumors but they were not part of the sample of carefully examined females. The information from these females has therefore not been considered when calculating the proportion of female green turtles affected by fibropapillomas.

3.5 Determination of Nest Survivorship and Hatching Success

Mammals observed depredating eggs and hatchlings during the 2001 Green Turtle Program include the 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 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*) and common black-hawks (*Buteogallus anthracinus*) were observed depredating hatchlings moving down the beach. The frigate birds also depredated hatchlings in the water close to the beach. In one case a

group of pelicans landed close to where the frigate birds were depredating hatchlings but it was not clear if this was a coincidence or if the pelicans were actively depredating hatchlings.

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 187 green turtle nests were marked with flagging tape in the vegetation behind the nest. All flagging tapes were lost for four nests and the fate of six nests could not be determined with certainty. These ten nests have been excluded from further analysis leaving 177 green turtle nests that were monitored and excavated after emergence (Table 7 and 8).

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.	51	39	90	50.8	90.9	88.2
Disturbed						
2a. Poached.	7	1	8	4.5	29.2[a]	29.1[a]
2b. Empty egg chamber.	3	1	4	2.3	1.4[a]	1.4[a]
3. Flooded.	11	14	25	14.1	25.3[a]	15.7[a]
4. Depredated	7	11	18	10.2	34.0[a]	31.7 [a, b]
5. Dug up by nesting turtle.	8	11	19	10.7	16.4[a]	16.2[a]
6. Two nests together.	2	1	3	1.7	57.1[a]	52.7[a]
7. Washed out.	4	5	9	5.1	12.0[a]	12.0[a]
8. Invaded by roots	0	1	1	0.6	45.1[a]	44.2[a]
TOTAL	**93**	**84**	**177**	**100**	**58.2**[a]	**55.1**[a]
(9. Flagging lost.	0	4	4)			
(10. Undetermined.	4	2	6)			

[a]Assuming a mean nest size of ×= 110.9 eggs
[b]Assuming that all hatchlings unaccounted for, had emerged before depredation

Overall hatching and emerging success was determined assuming a mean number of 110.9 eggs per marked nest (=mean number of eggs as determined through excavation of undisturbed nests). The total number of nests is 177 plus three to adjust for nests encountered together with another nest. Therefore overall hatching success is 58.2 % (11,612 empty shells from a total of 19,968 eggs) and overall emerging success is 55.1 % (11,000 emerged hatchlings from 19,968 eggs).

Comparison between results of egg counts at the time of laying and at excavation for a sample of undisturbed nests (n=55) shows a mean of 3.2 more eggs (range: +66 to –49 eggs, st.dev.=21.0 eggs) counted at the time of laying.

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	Destroyed	Yolkless
1	9073	83	159	107	90	44	473	219	3	21
2a	259	2	1	0	7	5	23	11	0	2
2b	6	0	0	0	1	0	0	1	0	1
3	701	36	24	242	203	623	647	138	5	3
4	678	9	25	21	16	4	110	219	0	3
5	345	21	2	1	9	1	60	54	18	1
6	380	0	1	28	12	26	93	40	0	0
7	120	3	0	0	0	0	1	1	0	0
8	50	0	1	0	0	0	0	0	0	0
ALL	**11612**	**154**	**213**	**399**	**338**	**703**	**1407**	**683**	**26**	**31**

For fate, see codes in Table 6.

The distance from the sand surface to the top egg at the time of excavation for undisturbed green turtle nests (n=88) varied between 30-98 cm with a mean of 61 cm. The distance from the sand surface to the bottom of the egg chamber at the time of excavation for the same nests varied between 47-123 cm with a mean of 77 cm.

The incubation period for undisturbed green turtle nests where emerging was observed (n=31) varied between 53-73 days with a mean of 62 days.

Marked and subsequently poached green turtle nests were located north of the village (located at mile 2 7/8-mile 3 3/8) between mile 2/8 and mile 2 6/8 (Figure 7). Few nests were poached inside Tortuguero National Park (Table 7 and Figure 7). Depredation (mainly by dogs and coatis) was more common for green turtle nests deposited in the National Park as was the digging up of nests by other turtles (Table 7).

Monitored green turtle nests deposited in the vegetation zone (n=15) were left undisturbed in 53 % of cases, 41 % of nests laid in the border zone (n=63) and 57 % of nests in the open zone (n=99) were left undisturbed. Flooded and washed out nests accounted for 13 % of nests in the vegetation zone, 19 % of nests in the border zone and 20 % of nests in the open zone.

Depredated nests (n=18) were located in the vegetation zone in 11 % of cases, in the border zone in 61 % and in the open zone in 28 % of cases.

Unhatched albino, twin and deformed embryos accounted for 0.04 % of all green turtle eggs (Table 9).

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

	n	**% of total eggs**
Albinos	2	0.010
Twins	1	0.005
Deformed embryos	5	0.025
TOTAL	**8**	**0.040**

3.5.2 Hawksbills

Overall hatching success for monitored hawksbill nests (n=9) was 44.7 % (637 empty shells from 1,425 eggs) and emerging success was 30.9 % (440 emerged hatchlings from 1,425 eggs).

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	468	0	142	2	0	2	2	3	475	98.5 %	68.2 %
2a	2	0	0	0	0	0	0	0	0	0	0 %	0 %
4	1	151	1	0	53	0	0	2	0	154	98.1[a] %	63.6[a] %
5	3	18	0	0	0	0	0	0	0	18	3.8[a] %	3.8[a] %

Fate 1=Undisturbed, 2a=Poached, 4=Depredated and 5=Dug up by nesting turtle

[a]Assuming mean nest size of ×=158.3 eggs

The distance from the sand surface to the top egg at the time of excavation for undisturbed hawksbill nests (n=3) varied between 40-62 cm with a mean of 47 cm. The distance between the sand surface and the bottom of the egg chamber at the time of excavation for the same nests varied between 51-81 cm with a mean of 63 cm.

3.5.3 Leatherbacks

For more information about leatherback hatching success in Tortuguero in 2001, please consult Reyes et al. (2001).

3.6 Physical Data Collection

3.6.1 Rainfall

Table 11. Rainfall, January-November 2001.

Month	Total rainfall (mm/month)	× rainfall (mm/24hrs)
January	736.7	22.3
February	171.9	6.9
March	130.5	3.8
April	157.8	5.3
May	89.3	2.9
June	1051.9	35.1
July	623.1	20.1
August	642.3	20.7
September	421.1	14.0
October	485.1	15.6
November	1769.3	59.0

[*]Data for 48 hours for 7-8 February, 1-2 April, 9-10 April, 12-13 April, 21-22 April, 1-2 May, 10-11 May, 27-28 May, 10-11 June

[**]Data for 72 hours for 1-3 February, 21-23 February

[***]Data for 96 hours for 30 December-2 January (included in January total), 15-18 April, 25-28 August

[****]Data for 164 hours for 26 February-3 March (included in March total), 17-22 March

November was the rainiest month since the new raingauge was installed in March 1998 (Table 11). September was the month with the lowest rainfall during the 2001 Green Turtle Program (Table 11).

3.6.2 Air temperature

January was the month with the lowest mean minimum temperature and November was the month with the lowest mean maximum temperature (Table 12). May had the highest mean minimum and maximum air temperatures (Table 12).

Table 12. Air temperature, January-November 2001.

Month	× minimum temp. (^{o}C) *	× maximum temp. (^{o}C) *
January	22.4	29.7
February	23.8	33.1
March	24.0	33.2
April	25.3	32.8
May	26.4	33.5
June	25.4	30.1
July	25.3	29.7
August	25.5	30.2
September	25.4	31.7
October	25.8	32.3
November	24.2	27.1

*No data for 1, 16 January, 1-4, 6, 21-22 February, 9, 12-14, 17-19, 21 March, 1, 5-6, 9, 12, 15-17, 21 April, 1, 6, 10, 27 May, 10 June, 10-13 July, 25-27 August

3.6.3 Sand temperature

During the 2001 Green Turtle Program, mean monthly sand temperatures were lowest in November and highest in October (Table 13 and Figure 8).

Mean monthly sand temperatures decreased with increase in shading. Increase in shading also caused a decrease in the overall range of temperatures (Table 13 and Figure 8).

Problems with high humidity coupled with high temperatures caused the dataloggers at 70 cm in the open zone to fail repeatedly (Table 13). Therefore, the temperature at 50 cm is displayed in Figure 8 for the open zone.

Table 13. Mean monthly sand temperatures.

	Field station			Field station			Field station		
Zone	Open	Open	Open	Bord.	Bord.	Bord.	Veg.	Veg.	Veg.
Depth (cm)	*30* [a]	*50* [a]	*70* [a]	*30*	*50*	*70*	*30*	*50*	*70*
January, × temp (ºC)	25.8	25.5	25.4[d]	24.3	24.2	24.2	23.6	23.5	23.7
February, × temp (ºC)	28.0	27.5	-	26.4	26.3	26.1	25.5	25.2	25.1
March, × temp (ºC)	30.4	29.4[c]	29.7[d]	27.8	27.9	27.8	26.7	26.6	26.5
Retrieval depth (cm) 8 March	*50*	*69*	*91*	*31*	*50*	*70*	*30*	*49*	*70*
Depth (cm) 8 March	*30*	*50*	*70*	*30*	*50*	*70*	*30*	*50*	*70*
April, × temp (ºC)	30.3	30.8[c]	29.8	28.1	28.2	28.1	26.9	26.8	26.9
May, × temp (ºC)	32.8	32.5	31.7	30.8	30.3	29.8	27.8	27.7	27.6
June, × temp (ºC)	30.4[b]	29.6	29.7	28.3	28.5	28.5	26.2	26.4	26.7
Retrieval depth (cm) 20 June	*31*	*48*	*71*	*29*	*48*	*72*	*29*	*48.5*	*68.5*
Depth (cm) 20 June	*30*	*50*	*70*	*30*	*50*	*70*	*30*	*50*	*70*
July, × temp (ºC)	N/A	28.2[c]	N/A	27.3	27.1	26.9	25.5	25.6	25.7
August, × temp (ºC)	N/A	28.9	N/A	27.6	27.6	27.5	25.9	26.0	26.0
September, × temp (ºC)	N/A	30.1	N/A	28.1	28.1	27.9	26.1	26.3	26.4
Retrieval depth (cm) 24 Sept.	*N/A*	*55*	*72*	*31*	*50*	*68*	*30*	*51*	*73*
Depth (cm) 24 Sept.	*N/A*	*50*	*70*	*30*	*50*	*70*	*30*	*50*	*70*
October, × temp (ºC)	N/A	30.6	- [e]	28.9	28.6	28.4	26.4	26.5	26.6
November, × temp (ºC)	N/A	26.3	- [e]	25.7	25.4	25.4	24.3	24.5	24.6
Retrieval depth (cm) 5 Dec.	*N/A*	*51*	*71*	*21*	*30*	*60*	*30*	*50*	*70*

[a] High tides washed out the dataloggers located in the open zone on 5 July. The dataloggers were relocated in the open zone (5 m closer to the vegetation line) on 7 July

[b] Data until 20 June only

[c] No data for 9 March-24 April, 5-7 July

[d] No data for 9 January-8 March, 5-7 July

[e] Datalogger did not record data 24 Sept-5 Dec

3.6.4 Ground water level

Heavy rains in late June and the second week of November caused an increase in the ground water level which was noticed in the PVC pipes (Figure 9). The increase in the ground water level was particularly marked in November and as a result many green turtle nests may have been inundated.

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 was slightly lower during the first 11 months of 2001 in comparison with 2000 (Table 14). August was the month with most visitors, May and June were the months with least visitation (Table 14).

The number of visitors paying to enter Tortuguero National Park increased slightly in 2001, as did income derived from the entrance and other fees (Table 15).

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

	1999		2000		2001	
Month	**Total**	**× Per Day**	**Total**	**× Per Day**	**Total**	**× Per Day**
January	2282	74	1681*	67	1846	60
February	1967	70	2427	84	2277	81
March	2068	67	2582	83	2301	74
April	1475	49	1742	58	2002	67
May	1006	32	1365	44	1208	39
June	1093	36	1437	48	1334	44
July	2567	83	2899	94	2720	88
August	2740	88	2645	80	2858	92
September	1640	55	1871	62	1440	48
October	1574	51	1746	56	1597	52
November	1984	66	2215	74	1550	52
December	1163	38	1964	63		
TOTAL	**21559**	**59**	**24574**	**68**	**21133**	**63**

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

Table 15. Paying Visitors to Tortuguero National Park.

	Tortuguero National Park			**Barra del Colorado Wildlife Refuge**	**Tortuguero National Park and Barra del Colorado Wildlife Refuge**
Year	**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	5,669[a]	35,959[a]	41,638[a]	2,554[a]	₡70,465,465 [a]

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

3.7.2 Capacity of hotels and cabinas

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

Hotels/Lodges	**Rooms**	**Beds**	**Cabinas**	**Rooms**	**Beds**
Caribe	11	21	All Rankin Lodge***	6	18
Caribbean Magic	16	38	Aracari	12	24
Hollywood	12	24	Chanu	5	16
Ilan-Ilan	24	54	Ella y Yo	3	6
Jungle	43	129	Hostel “Daryl”	3	6
Laguna	52	138	Joruki	6	11
El Manati	11	17	Maryscar	23	43
Mawamba	54	137	Miriam	6	12
Pachira	48	103	Ms Junie	12	30
Tortuga	24	55	Sabina	22	35
Total – Hotels	*295*	*716*	Tortuguero	5	15
Cabinas	**Rooms**	**Beds**	(CCC	7	32)
Pisulin/Tropical Lodge*	-	-	*Total – Cabinas*	*110*	*248*
Pancana**	-	-	**TOTAL**		

*closed during the 2001 season

**Rooms are rented out long-term to village residents instead of tourists

***All Rankin Lodge opened in July 2001 with 4 rooms and 12 beds and expanded to 6 rooms and 18 beds in September 2001

The capacity of the hotels in the Tortuguero area remained at levels similar to 2000 but the capacity of the cabinas increased in 2001 (Table 16).

3.7.3 Turtle walks

Tortuguero National Park issued a total of 22,626 permits for persons to go on guided turtle tours at night in 2001 (Table 17).

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	Tour guide nights
March	16	2	18	4
April	238	91	329	59
May	423	71	494	91
June	821	55	876	127
July	4,481	1,265	5,746	754
August	5,361	1,672	7,033	950
September	3,776	417	4,193	602
October	3,156	279	3,435	489
November	412	90	502	70
TOTAL	**18,684**	**3,942**	**22,626**	**3,146**

Data from ACTo.

During the time period between 1 July-31 October, the Tortuguero Tour Guide Association charged guides an optional ¢200 fee per tourist going on turtle tours. From this fee the Tortuguero Tour Guide Association raised a total of ¢3,180,400 (approx. US$9,354) (E. Obando pers. comm.). In addition, ¢436,900 in outstanding fees from 2,185 tourists has yet to be paid by 25 tour guides.

ACTo recorded 20,407 permits for the time period 1 July-31 October and the Tortuguero Tour Guide Association recorded 15,902 permits for the same time period.

Part of the funds raised in 2001 will be used to repair the roof of the Tortuguero information kiosk (E. Obando pers. comm.).

3.7.4 Artificial lights

The number of artificial lights behind the airport (mile 6/8-mile 1 3/8) and in the village (mile 2 7/8-mile 3 2/8) increased between the 2000 and the 2001 Green Turtle Program (Table 18, pers. obs.).

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

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

3.7.5 Hatchling orientation

The total angular range of hatchlings tracks for undisturbed green turtle nests (n=80) was $71^{o} \pm 25^{o}$ (Table 19). If all outliers were excluded the mean angular range was $47^{o} \pm 24^{o}$ (Table 19).

Table 19. Hatchling orientation.

Nests	n	× hatchling tracks ± ST.D.	× angular range ± ST.D.	× angular range minus outlier/s ± ST.D.	Circlers ± ST.D.
Undisturbed	80	49 ± 19	$71^{o} \pm 25^{o}$	$47^{o} \pm 24^{o}$	0.2 ± 0.6

3.8 Additional Research

3.8.1 Satellite transmitters

Once released and after completing nesting at Tortuguero, all three green turtles swam to the waters off northern Nicaragua. Two of the green turtles followed a more or less straight line from Tortuguero to northern Nicaragua but the third green turtle completed a circle and remained for approximately three weeks in waters between Limón and the Costa Rica-Panamá border before swimming north to Nicaragua.

Complete migration paths are available at the CCC website at: http://www.cccturtle.org

3.8.2 Laparoscopy

Ultrasound examination was completed on five green turtles and several internal structures could be identified. Four of the five laparoscopic examinations were successful but the fifth was aborted to avoid exceeding the time limit established as a safety measure. The ultrasound and laparoscopy examinations formed part of a preliminatory study and it is hoped that a more detailed study into the health status of the Tortuguero green turtle population be implemented by Dr. Deem in 2002.

3.8.3 Visit to a driftline

The Coast Guard vessel left Limón harbor at 10:20 AM, with sunshine and little wind, conditions that are atypical for the November-December period which is normally characterized by rough seas and heavy rains (as demonstrated by the November rainfall, Table 11). After two hours of cruising in a N-NE direction the first driftline was spotted at N010º12.38 W082º55.35, approximately 14 miles N-NE of Limón harbor. The water color was distinctilly different from surrounding waters, possibly due to high concentrations of plancton. Water hyacint (probably originating from rivers and coastal lagoons and washed out to sea by the heavy rains during the first half of November), sargassum sea weed (two different structures could be easily identified), coconuts, plastic garbage and several species of fish could be seen along the driftline.

At first, the sargassum sea weed concentrations were not particularly dense but as we followed the driftline in a northerly direction a large raft was sighted in the distance. The raft was reached at 12:54 PM and was located at N 10º14.46 W 082º55.19. It measured approximately 50-100 m at its widest section and it extended for several hundred meters. The raft was circled for approximately one hour before the boat returned to Limón. During this time, three small green turtles estimated to be approx. 30+ cm CCL were sighted. Their carapaces were brownish-yellowish in color and very similar to the color of the sargassum sea weed, the plastron was white. All three green turtles were seen at 10-20 m distance from the edge of the sargassum sea weed raft. They were very fast and efforts to capture them with a butterfly net were unsuccessful.

3.9 Environmental Education Activities

On 16-19 July, a tour guide training course was held at the CCC station. Approximately 100 guides took part in the course which was coordinated by the Tortuguero Conservation Area (ACTo) in cooperation with the Costa Rican Tourism Institute (ICT) and the National Learning Institute (INA). CCC provided the lectures and practical sessions on sea turtle biology and conservation.

4. DISCUSSION

4.1 Track Surveys

4.1.1 Green turtles

Most green turtle nests recorded during track surveys were laid between 15 June and 1 November (Figure 1). Although nests were encountered before and after this time period, those nests represent only 1 % of all green turtle nests recorded during track surveys in 2001.

Nests recorded in the northern 5 miles made up 18.2 % of all green turtle nests (Figure 2). This is larger proportion than in previous years and could represent a shift in nesting towards the northern section of the Tortuguero beach. A less likely explanantion, given the extensive experience of the track surveyor, would be that the track surveyor overestimates the number of green turtle nests along the northern three miles that are normally surveyed in the

afternoon. Another unlikely explanation could be that turtle tours along the northern five miles cause more green turtles to make half-moons and that some half-moons are recorded as nests by the track surveyor.

Poaching of nesting green turtles was low in 2001 and mainly restricted to before and after peak nesting (Figure 3). Increased beach and marine patrols by park rangers during the months of March-June and November could further decrease poaching. Near Tortuguero, poaching of a limited number of nesting turtles was restricted to the beach section between the village and the river mouth (mile –3/8 to mile 3 3/8).

The large number of green turtles killed by jaguars and reported by the park rangers represents both a concern and an opportunity. Firstly, continued monitoring is necessary to determine if the number of green turtles killed by jaguars is growing to unacceptable levels. Secondly, if the increase in turtles killed by jaguars is a result of decreased prey availability and an increase in the jaguar population then jaguars may present a danger to turtle taggers, in particularly during the period before peak nesting when green turtles are scarce. It should be made clear that there are so far no indications that this is the case and that it is pure speculation at this point. More positively, the large number of jaguar kills offers an excellent opportunity to study both turtle depredation and jaguar biology. A Tortuguero Conservation Area (ACTo) biologist in cooperation with the Wildlife Conservation Society (WCS) is planning a study of the area's jaguars and turtle depredation for the 2002 nesting season. It is suggested that the CCC be fully supportive of such a study and provide the biologist with any CCC data she may need.

4.1.2 Hawksbills

Hawksbill nesting at Tortuguero remains at very low levels (Figure 5). A minimum of four hawksbill females were killed by jaguars according to the park rangers. The low number of nesting females means that jaguar depredation could be a threat to the hawksbill population. Therefore, one of the primary objectives of the jaguar study should be to quantify the number of hawksbills killed by jaguars each year.

4.1.3 Leatherbacks

For a discussion about temporal and spatial distribution of leatherback nesting at Tortuguero in 2001, please consult Reyes et al. (2001).

4.2 Tagging of Nesting Sea Turtles

4.2.1 Green turtles

Tagging efficiency was limited by the number of tags available for the 2001 program. According to the monitoring protocol a minimum of 1,000 green turtles should be newly tagged each season. To ensure that enough tags are available, a total of 3,000 inconel #681 tags are purchased each year. However, because of the large number of green turtles coming ashore to nest in 2001, the goal of 1,000 newly tagged green turtles was reached already in the first week of September. If more tags were bought each year, tagging efficiency could be increased without increasing the number of tagging teams.

The encounters with green turtle #17139 over 23 years highlight the importance of long-term projects such as the Tortuguero Sea Turtle Programs. The only reason we know about female #17139's impressive life history is because CCC has had turtle taggers patrolling the beach every year since the female was first tagged. It would not have been possible to record turtle #17139 over 23 years without the hundreds of volunteers and research assistants walking the beach during the last decades. Hopefully, CCC's continued commitment to the Tortuguero Green Turtle Program will result in some of the newly tagged green turtle females from 2001 being seen again in 23 or more years time.

The Panamá tags removed from one of the turtles killed by jaguars was an exciting recovery. It emphasizes the importance of cooperation between CCC and ACTo park rangers as well as the need for careful examination of green turtles killed by jaguars in order to recover any tags.

Overall tag loss was low thanks to the diligence of the field coordinator and the RAs in ensuring that tags were properly attached (Table 1a). It appears that tag loss was higher for the first two months of the the 2001 Green Turte Program (Table 1b). This can be explained by RAs improving their tag application skills with time or faulty equipment being identified and removed as the season progressed. Another possible explanation is that green turtles tagged in June and July on average had a longer time period between first to last encounter (a mean of 33 days) than did green turtles tagged in August-October (mean of 30 days). However, the small difference in the mean number of days from first to last encounter is unlikely to account for all the difference in tag loss between green turtles tagged in June-July and those tagged in August-October.

The low proportion of newly tagged green turtles with evidence of old tag holes and notches may be the result of low tag loss for green turtles tagged with inconel #681 tags since 1998.

4.2.2 Hawksbills

One of few encouraging signs with regards to hawksbill turtles was the return in 2001 of two females tagged in previous years (one tagged in 1997 and one in 1999)(Appendices 1 and 2).

The efforts of the field coordinator and the RAs in collecting tissue samples paid off with samples from 14 females exported for analysis. After the samples had been exported, an additional sample was collected from a 15th female. This sample will be stored and exported for analysis in 2002. The results of the genetic analysis will be valuable in determining the composition of the Tortuguero hawksbill population and have implications for regional management of hawksbill turtles in the Caribbean region.

4.2.3 Leatherbacks

For a discussion about tagging of leatherback turtles at Tortuguero in 2001, please consult Reyes et al. (2001).

4.3 Biometric Data Collection

4.3.1 Green turtles

In terms of biometric charateristics, it appears that newly tagged green turtles with evidence of old tag holes and/or notches are more similar to previously tagged turtles than to newly tagged turtles without evidence of tag holes or notches (Table 2). This indicates that green turtles continue to grow (although not much) after their first nesting season or that larger green turtles are more likely to loose their tags.

SCLmax is consistently more precise than the CCLmin measurements for green turtles (Tables 3a and 3b). The grading on the tree-calipers used for measuring SCLmax tends to fade towards the end of the season due to abrasion caused by the fine Tortuguero sand. Therefore, purchasing new calipers for each green turtle season should be considered.

4.3.2 Hawksbills

SCLmax was also more precise than the CCLmin measurement for hawksbill turtles (Table 5). For hawksbill turtles the precision of the CCLmin measurement may be lower because of the narrow distance between the supracaudal scutes that make precise CCLmin measurements difficult.

4.3.3 Leatherbacks

For a discussion about leatherback biometrics at Tortuguero in 2001, please consult Reyes et al. (2001).

4.4 Fibropapilloma Assessment

4.4.1 Green turtles

Fibropapillomas occurrence appears to have become more common over the last three years. It would be interesting to investigate if the apparent increase in fibropapillomas has any relationship with the increase in the green turtle population. An objective of the detailed health study on the green turtle population that may be conducted by a WCS veterinarian in 2002 could be to develop a more elaborate protocol for investigating fibropapilloma occurrence in Tortuguero. On a positive note, none of the fibropapilloma cases seem to have been serious as observed tumors have generally been small in size and not very abundant in numbers.

4.5 Determination of Nest Survivorship and Hatching Success

4.5.1 Green turtles

The relatively low green turtle hatching and emerging success recorded during the 2001 Green Turtle Program was caused primarily by many nests being flooded and washed out (Table 7). The relatively late peak of the nesting season (mid-September) coupled with heavy rains in the second week of November that raised the ground water levels (Figure 9), caused the inundation of many nests before they had time to hatch.

The mean incubation period for green turtle nests was 62 days which is longer than for previous years, most likely as a result of low sand temperatures in 2001 caused by the abundant rainfall (Table 11).

Poaching of green turtle nests is more common along the beach section between the National Park limit (mile 3 3/8) and the Tortuguero river mouth (mile –3/8) (Table 7 and Figure 7). Increased park ranger patrols along this beach section could aid in decreasing egg poaching. Also, dogs were observed depredating nests after hatching (but before emergence) and stricter dog control would also contribute to an increase in green turtle emerging success.

4.5.2 Hawksbills

Hawksbill hatching and emerging success were lower than green turtle hatching and emerging success (Tables 7 and 10). It is discouraging to see that two of the nine monitored hawksbill nests were poached.

4.5.3 Leatherbacks

For a discussion about leatherback nest survivorship and hatching success at Tortuguero in 2001, please consult Reyes et al. (2001).

4.6 Physical Data Collection

4.6.1 Rainfall

September was rainer in 2001 than in previous years (Table 11). The same is true for November 2001 which was the rainiest month on record since the new raingauge was installed in March 1998 (Table 11). The heavy rains in the second week of November resulted in the beach zone (vegetation, border and part of the open zone) close to the vegetation, being completely inundated. Pools of water were clearly visible where many of the green turtle nests were deposited. A contributing factor to the high rainfall may have been the higher than normal sea surface temperatures in the North Atlantic and the colder than normal sea surface temperatures in the East Pacific (P. Waylan pers. comm.).

4.6.2 Air temperature

Air temperatures were higher in October than in September which is reverse in comparison with air temperatures in previous years (Table 12).

4.6.3 Sand temperature

The heavy rains in November caused the sand temperature to fall several degrees (Table 13). October was the month with the highest sand temperatures during the 2001 Green Turtle Program instead of September that normally has the highest sand temperatures (Table 13). The relatively low sand temperatures can explain the longer than normal mean incubation period for green turtle nests in 2001.

4.6.4 Ground water level

The heavy rains in the second week of November resulted in ground water levels that may have inundated many green turtle nests (Figure 9). From personal observations it appears

that the ground water level may be closer to the sand surface along the beach section south of mile 3 3/8 in comparison with the beach section between mile –3/8 and mile 3 3/8.

4.7 Collection of Human Impact Data

4.7.1 Visitors to Tortuguero

Although the number of visitors was slighty down in 2001, the income from the CCC Natural History and Visitors Center increased thanks to the diligent work of the administrator (pers. obs., A. Castillo pers. comm.).

The funds raised by ACTo from National Park entrance fees and other fees show that eco-tourism in Tortuguero have financial benefits. It would be desirable from a conservation perspective if more of the raised funds would be reinvested in protection of Tortuguero National Park and conservation of its natural resources.

4.7.2 Capacity of hotels and cabinas

It is encouraging to see the capacity of the cabinas in the Tortuguero area increase (Table 16). This indicates that villagers may be prepared to invest in own businesses in order to ensure that more of the tourism income benefits local people.

4.7.3 Turtle walks

The number of permits issued for turtle walks remained at a level similar to previous years (Table 17). There was a drop off in the number of permits issued after 11 September possibly as a result of the terrorist attacks in the US.

The number of tourists recorded by the Tortuguero Conservation Area as going on guided turtle walks and the number recorded by the Tortuguero Development Association show clear differences. There is a tendency by some guides to request more permits than they need in order to recruit tourists after the daily permits have been issued. Tortuguero Conservation Area include permits issued for walks that may never have taken place but the Development Association does not include such walks. It is possible that if the fee paid to the Development Association by guides for each tourist, was made mandatory that more reliable statistics could be achieved.

4.7.4 Artificial lights

It would be desirable to develop and implement a plan to limit the visibility of artificial lights from the beach, especially as more buildings are constructed behind the beach in and north of Tortuguero village.

4.7.5 Hatchling orientation

The angular range of all green turtle hatchling tracks was slightly higher than in previous years but if outliers were excluded the results were very similar to those of the past three seasons (Table 19).

4.8 Additional Research

4.8.1 Satellite transmitters

The satellite transmitter attachment events were as always well received by research assistants, participants, local school children, tour guides and tourists. The media impact of the event was unfortunately less than what had been anticipated, mainly due to the fact that the first green turtle carrying a transmitter was released on the morning of 11 September. However, it is suggested that similar events be organized in future programs as it has proven a successful method for raising awareness and interest in sea turtle issues both locally and nationally.

4.8.2 Laparoscopy

The preliminary health study conducted by Dr. Deem was an educational experience for station staff and research assistants. Hopefully a more detailed health study in 2002 could be combined with an educational component to build sea turtle health assessment capacity in the region.

4.8.3 Visit to a driftline

There are several aspects of green turtle biology to be studied in the driftlines e.g. tissue sampling for genetic analysis, feeding behaviour and food item selection, radio telemetry and collection of basic biometric data. It is suggested that such studies be conducted using a small vessel so that the fast moving green turtles could be pursued with ease. Also, a large butterfly net may facilitate capture of post-hatchling green turtles. Major costs associated with such a study would be crew salaries, fuel and boat costs. The rough weather at certain times of the year may be the most important limiting factor to consider – the ideal time to conduct the study would be March-May and September-October when normally there is less wave action.

4.9 Environmental Education Activities

One of the research assistants with the 2001 Green Turtle Program was a youth from Tortuguero. It is suggested that other interested youths be accepted as RAs in coming programs as long as this does not encourage local students to leave formal high school education.

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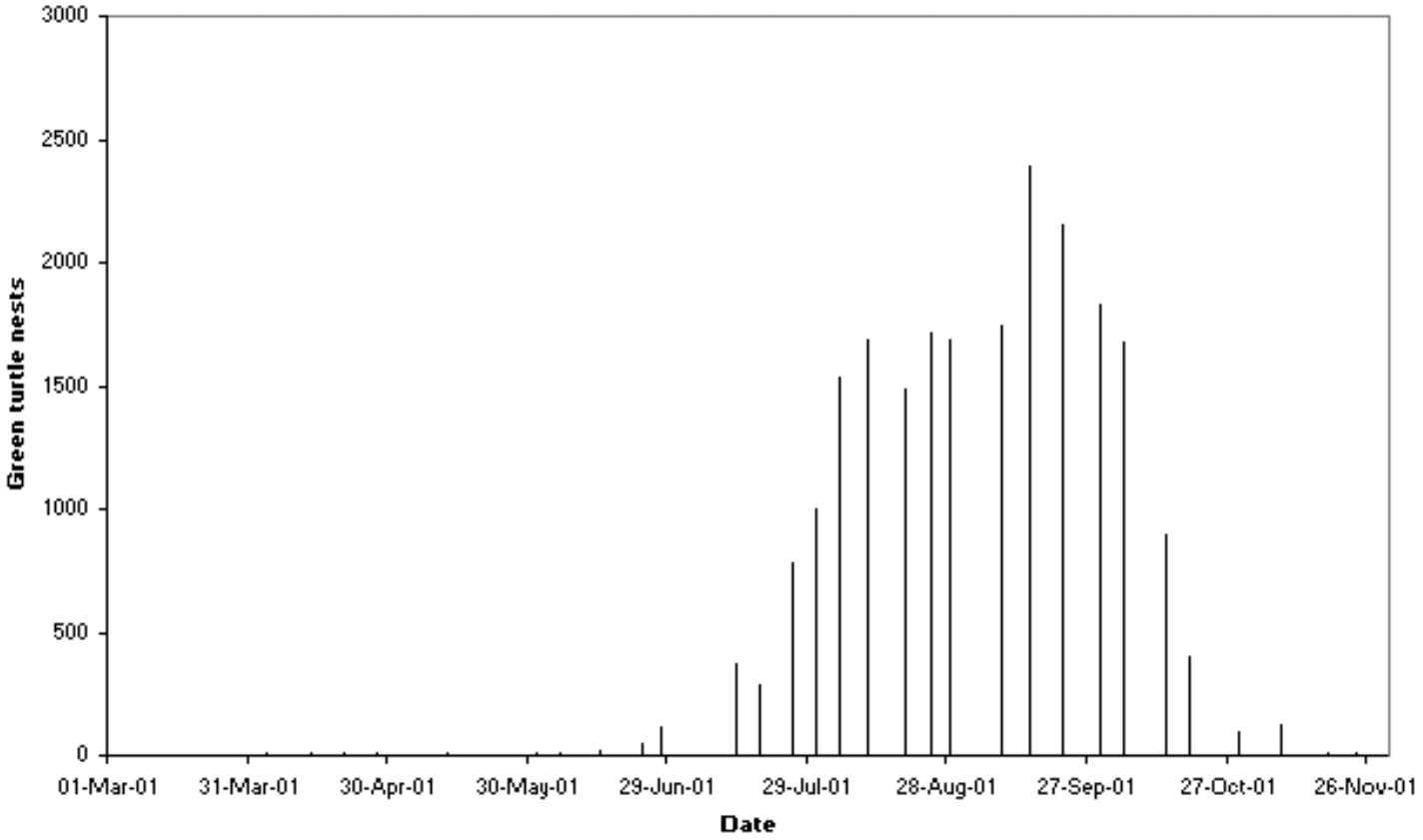
Figure 1. Seasonal distribution of green turtle nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).



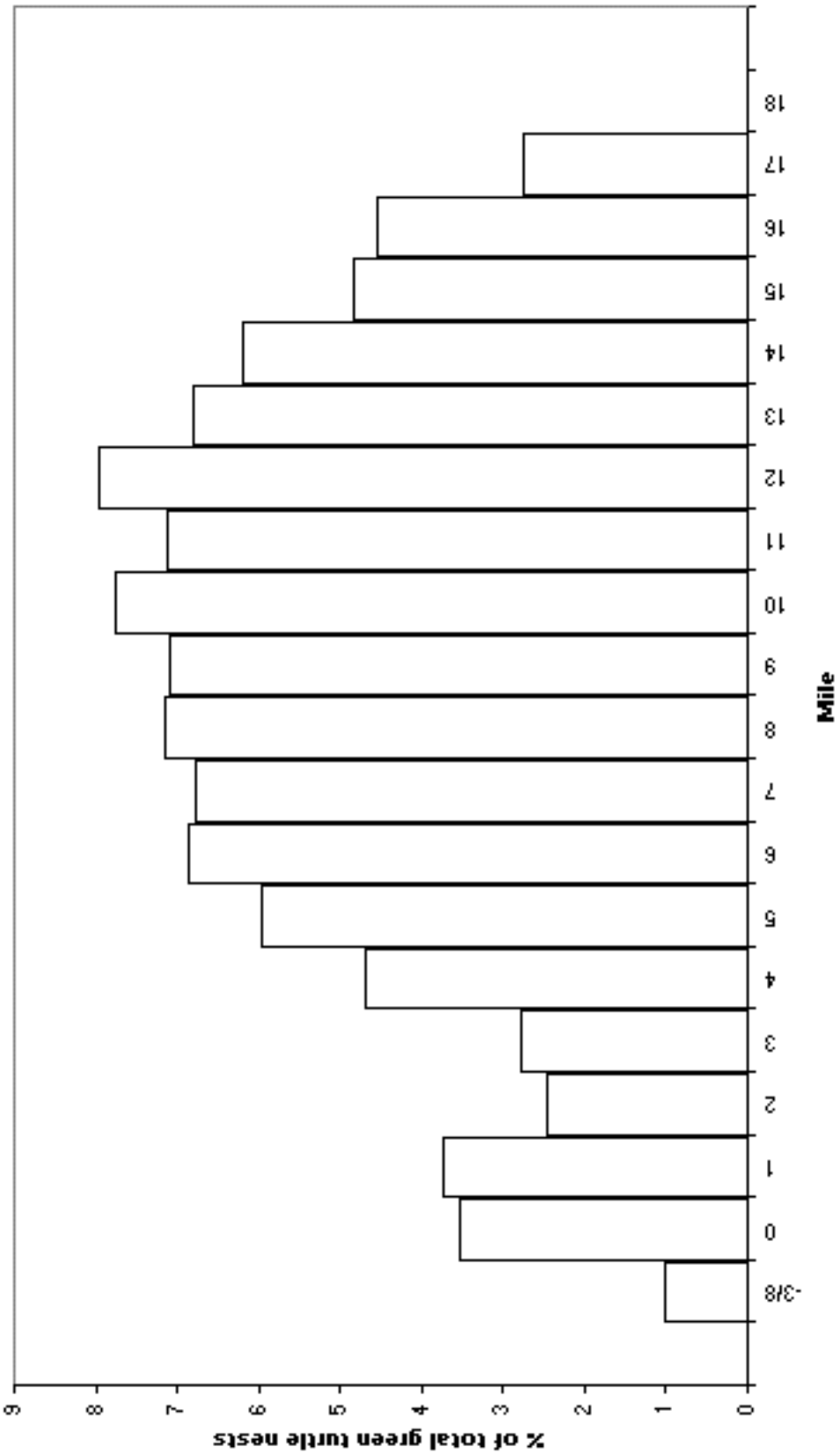


Figure 2. Spatial distribution of green turtle nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

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

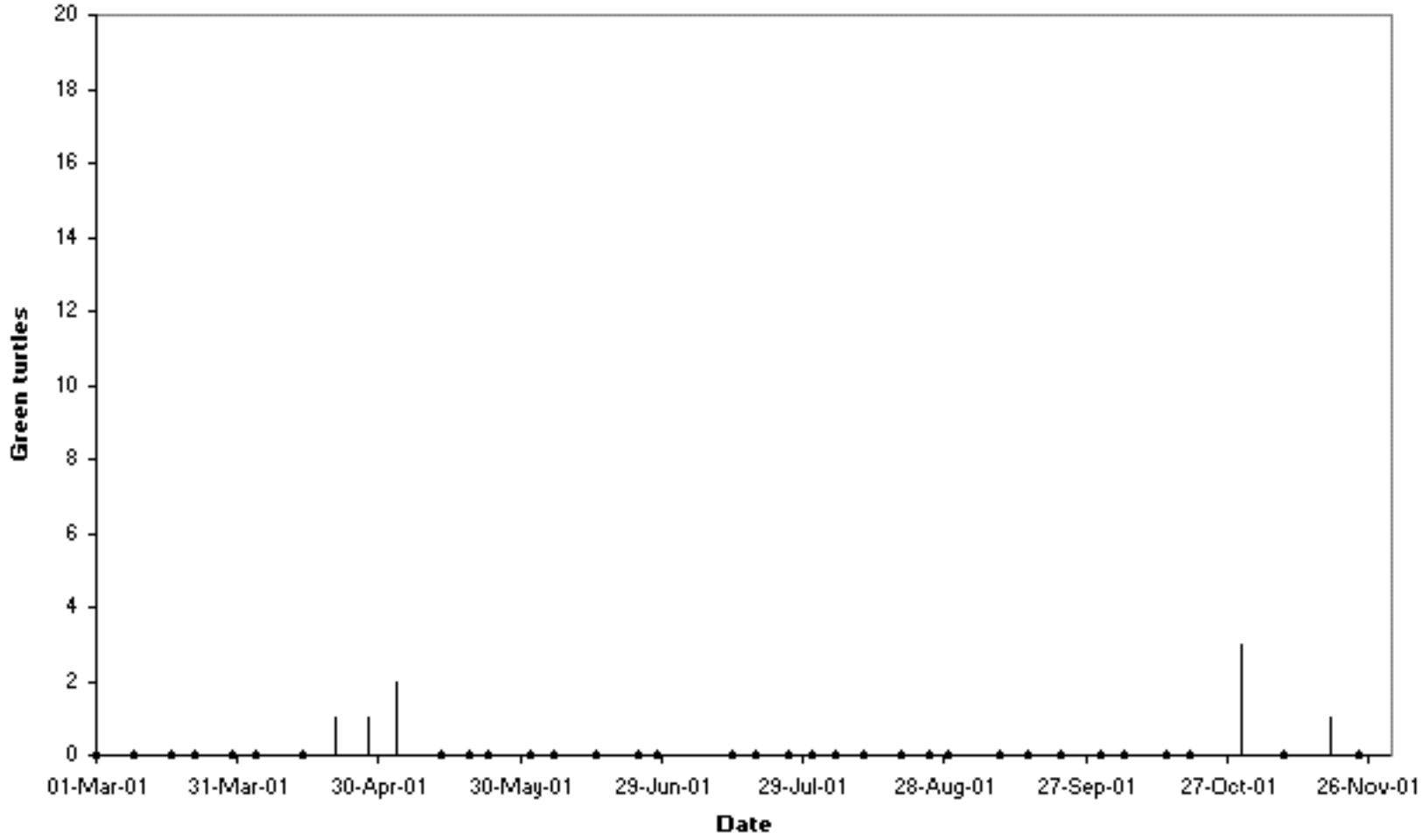


Figure 4. Green turtles killed by jaguars from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

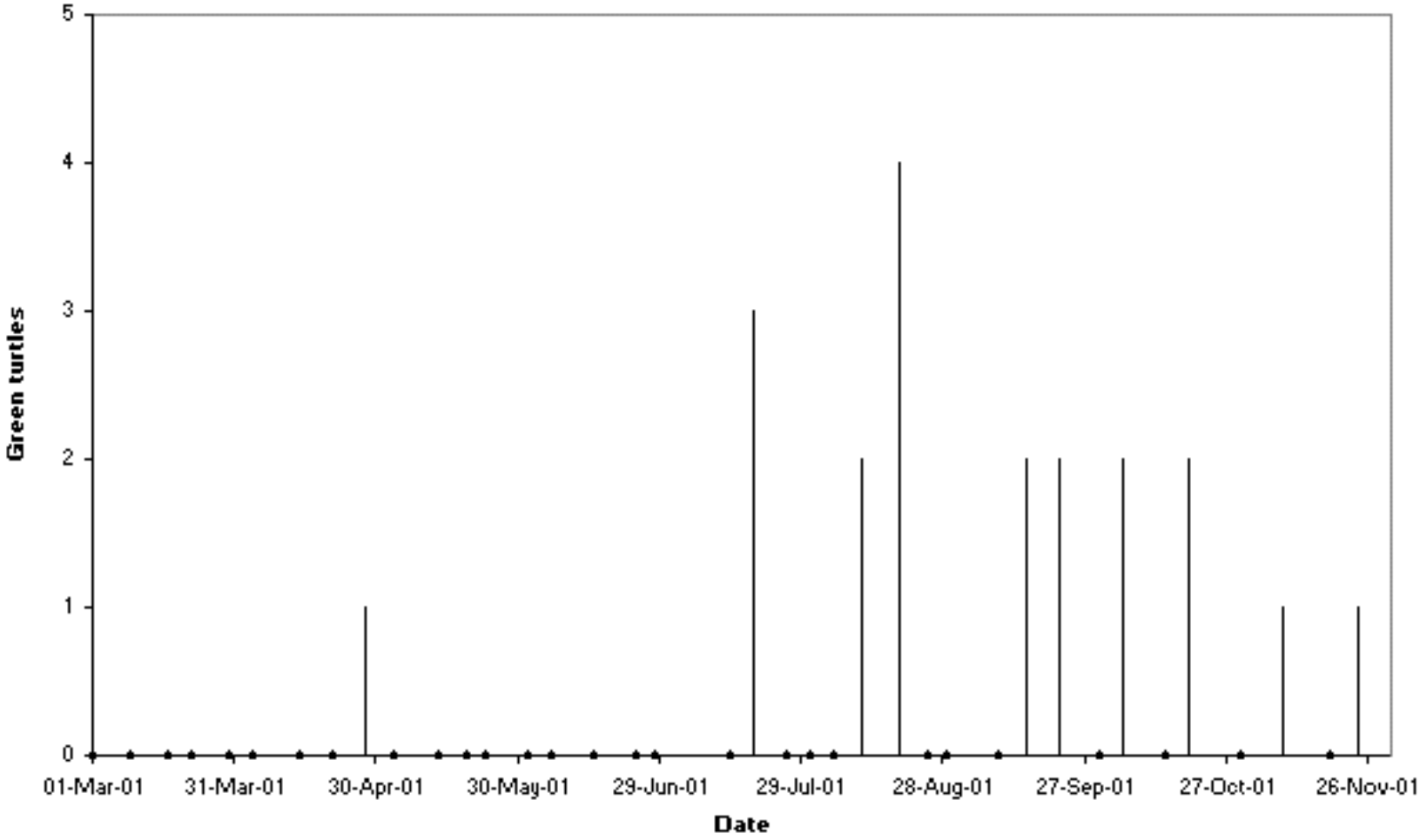


Figure 5. Seasonal distribution of hawksbill nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).

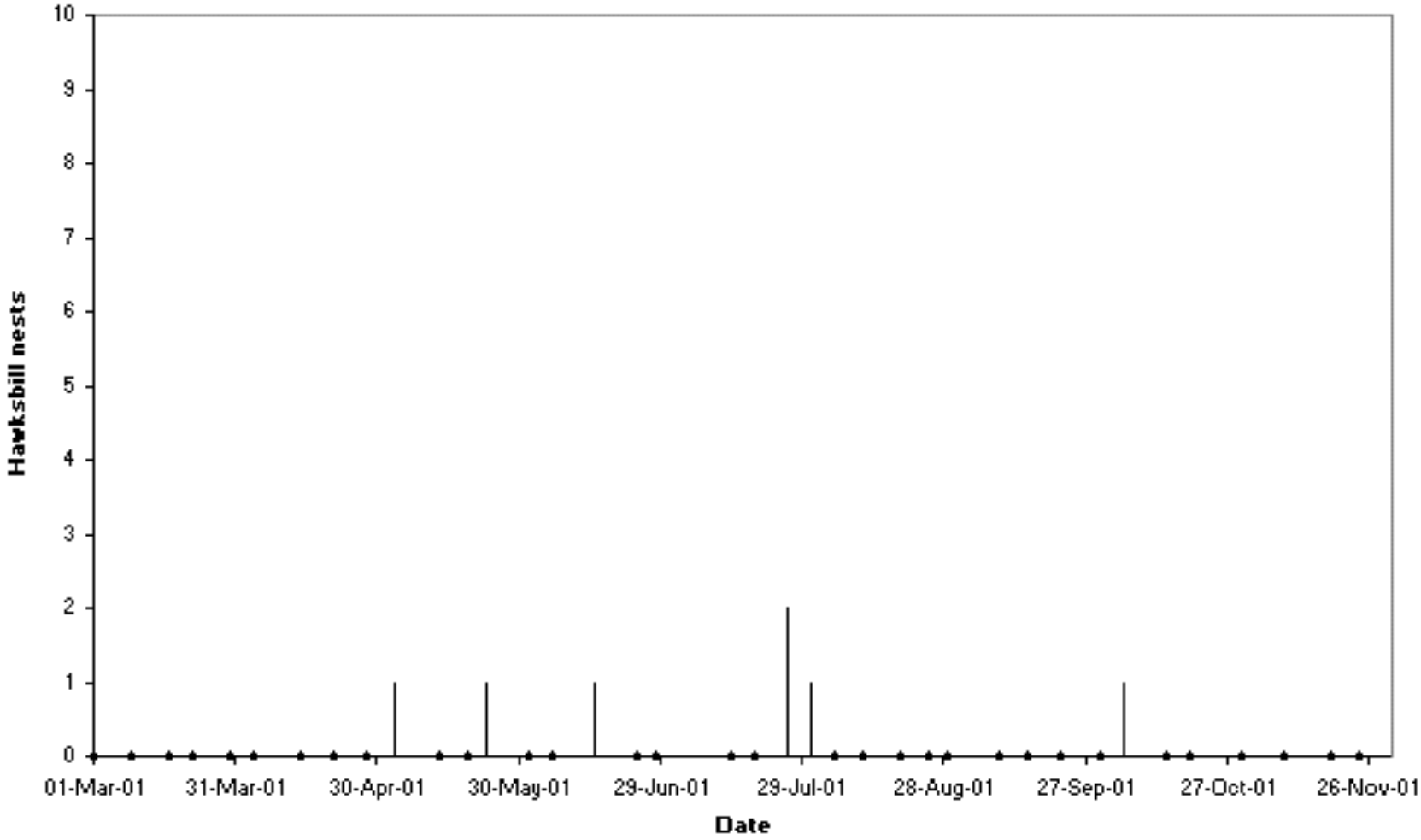
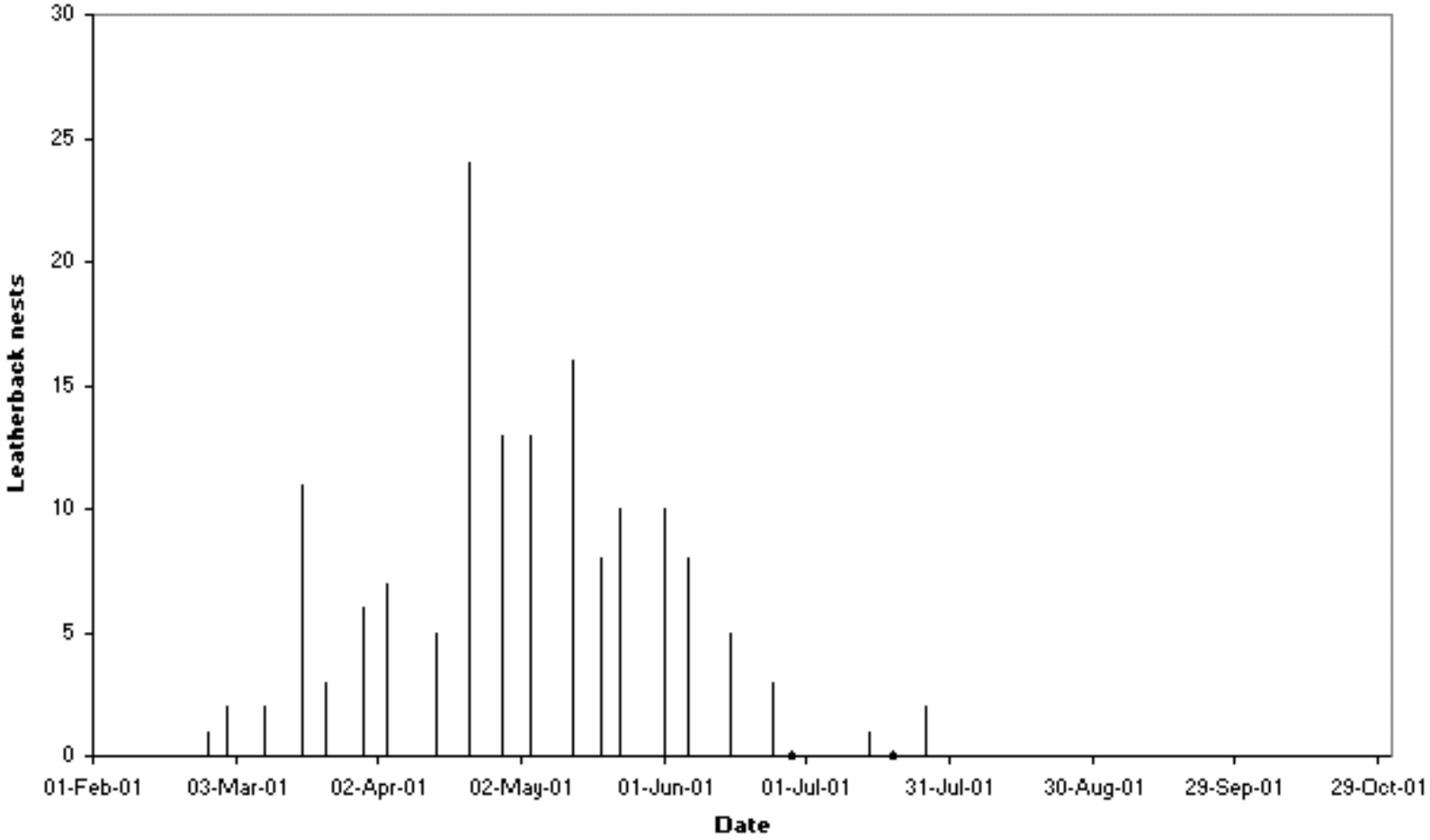


Figure 6. Seasonal distribution of leatherback nesting activity as determined by track surveys from Tortuguero river mouth (mile -3/8) to Jalova lagoon (mile 18).



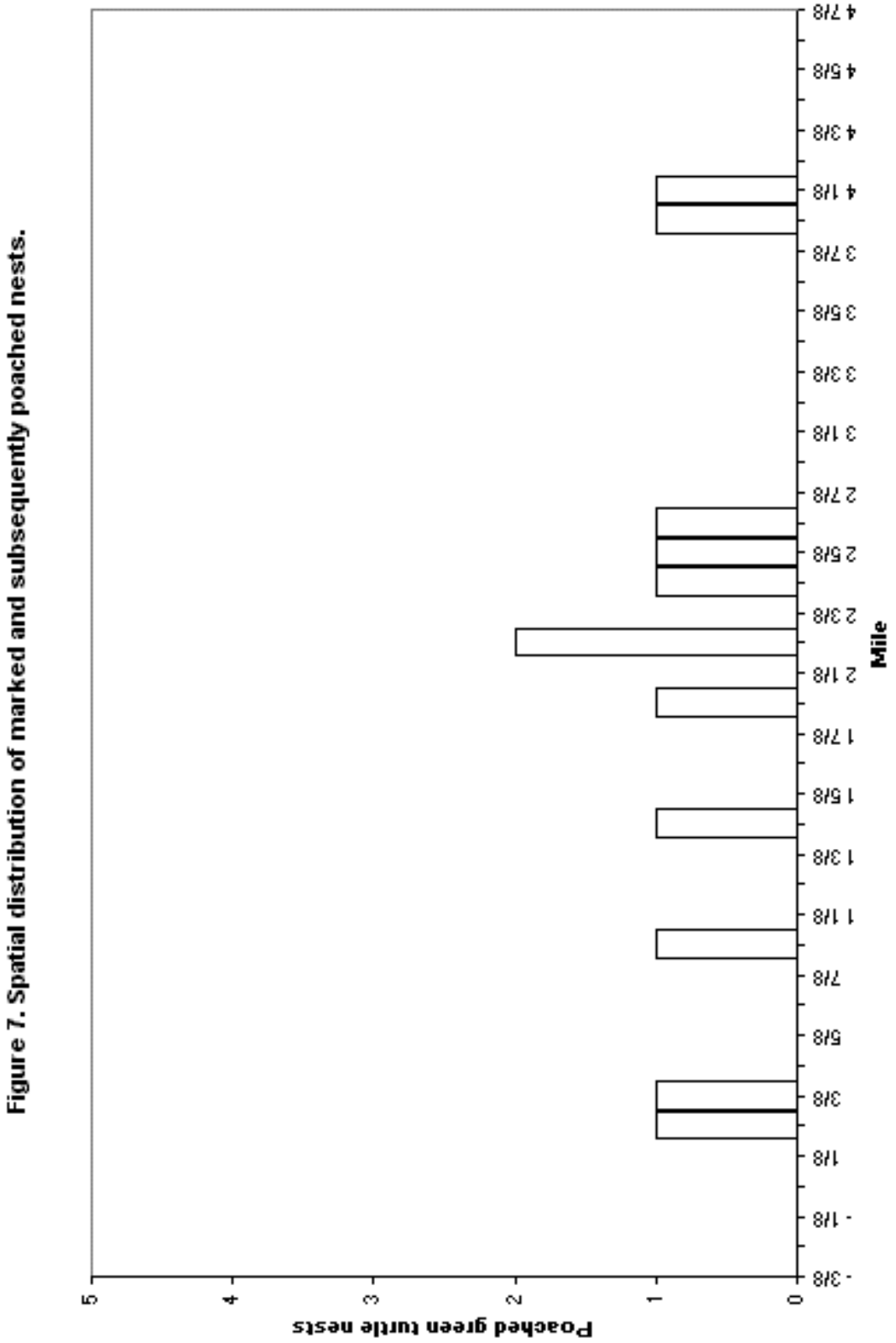


Figure 7. Spatial distribution of marked and subsequently poached nests.

Figure 8. Sand temperature at 70 cm depth.

Figure 8a. Sand temperature at 50 cm depth, open zone.

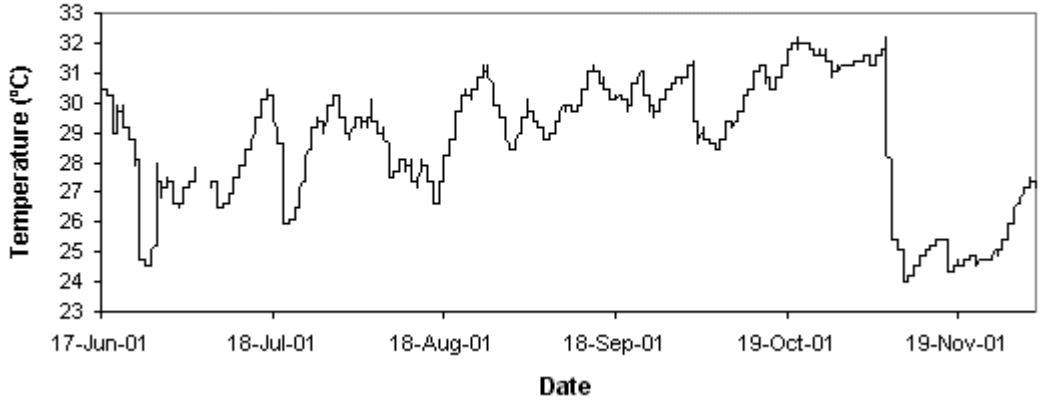


Figure 8b. Temperature at 70 cm depth, border zone.

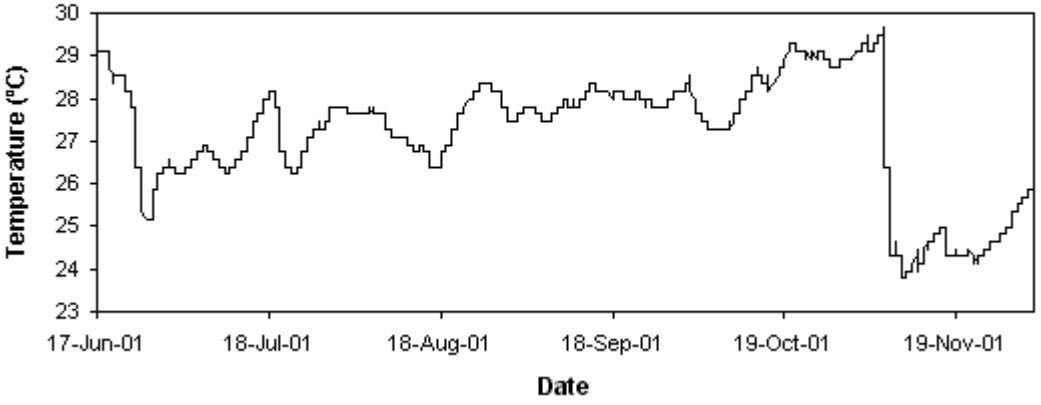


Figure 8c. Temperature at 70 cm depth, vegetation zone.

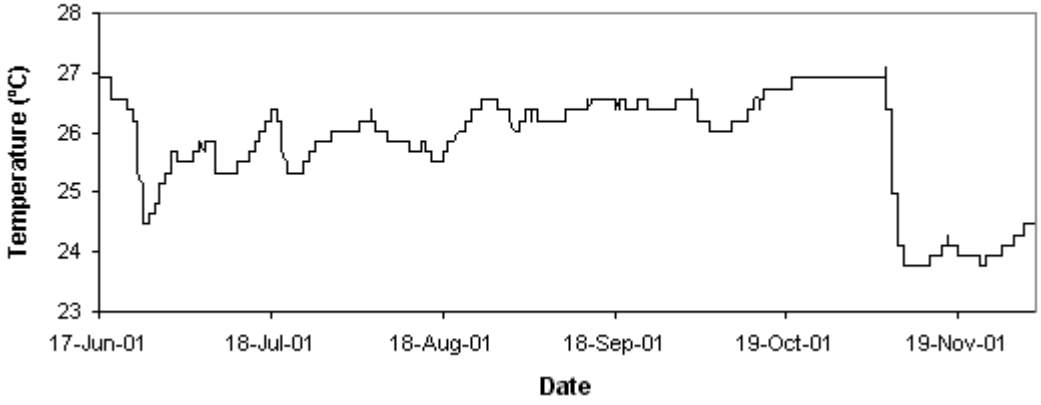
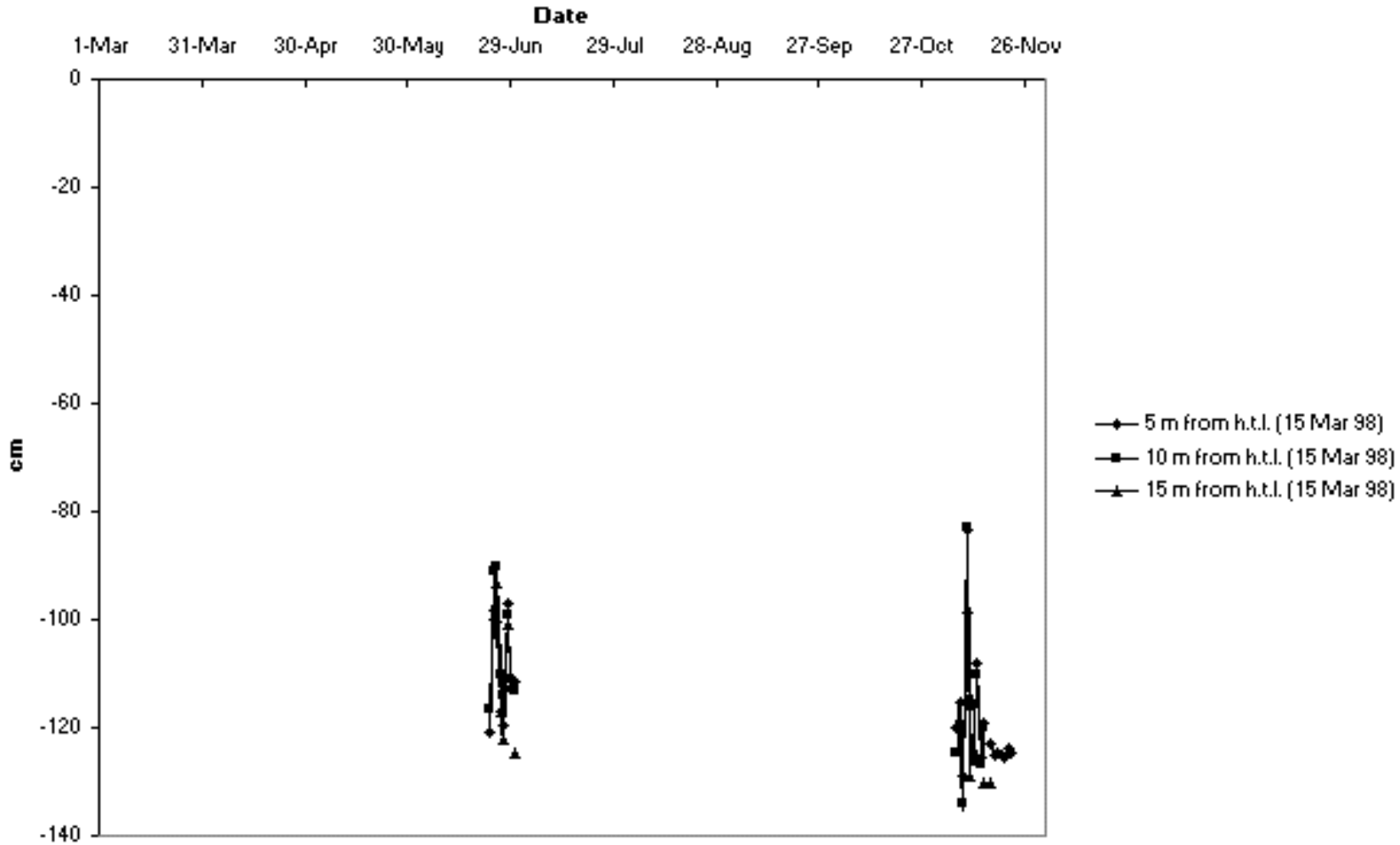


Figure 9. Ground water level.



APPENDIX 1. Sea Turtle Encounters During Regular Night Patrols

	Leatherbacks				Green turtles				Hawksbills			
Date	Newly tagged turtles	Previously tagged turtles	Renester	Total	Newly tagged turtles	Previously tagged turtles	Renesters	Total	Newly tagged turtles	Previously tagged turtles	Renesters	Total
17-Jun-01		1		1	1			1				0
18-Jun-01				1	2			3				0
19-Jun-01				1				3				0
20-Jun-01				1			1	4				0
21-Jun-01				1	2			6				0
22-Jun-01			1	2				6	1			1
23-Jun-01			1	3				6	1			2
24-Jun-01		1	1	5	2	1		9				2
25-Jun-01	1			6				9				2
26-Jun-01				6	1			10				2
27-Jun-01				6				10				2
28-Jun-01		1	1	8				10				2
29-Jun-01	1			9				10				2
30-Jun-01				9	1		1	12				2
1-Jul-01			1	10	3	4	1	20				2
2-Jul-01			1	11	3	2		25				2
3-Jul-01				11		1	2	28				2
4-Jul-01				11		1	1	30			1	3
5-Jul-01				11		2		32				3
6-Jul-01				11	8	1		41				3
7-Jul-01				11	2	3		46				3
8-Jul-01				11	17	1		64			1	4
9-Jul-01				11	8	3		75				4
10-Jul-01				11	9	1	1	86				4
11-Jul-01		1		12	10	5	4	105	2			6
12-Jul-01				12	10	1	3	119	1			7
13-Jul-01				12	8	2	3	132				7
14-Jul-01				12	4	5	1	142				7
15-Jul-01				12	8	3	2	155				7
16-Jul-01				12	12	2	2	171		1		8
17-Jul-01				12	7	7	1	186				8
18-Jul-01				12	4			190				8
19-Jul-01				12	10	4	1	205				8
20-Jul-01				12	10	4	2	221				8
21-Jul-01				12	11	1	6	239				8
22-Jul-01				12	14	6	2	261				8
23-Jul-01				12	11	3		275				8
24-Jul-01				12	8	3	1	287				8
25-Jul-01				12	17	3		307				8
26-Jul-01				12	14	3	1	325				8
27-Jul-01				12	20	3	2	350				8
28-Jul-01				12	11	3	5	369				8
29-Jul-01				12	21	3	6	399	1			9
30-Jul-01				12	12	5	7	423				9
31-Jul-01				12	14	4	8	449				9
1-Aug-01				12	14	2	5	470			1	10
2-Aug-01				12	16	5	3	494				10
3-Aug-01				12	18	4	6	522				10

4-Aug-01		12	22	8	6	558				10
5-Aug-01		12	14	11	7	590				10
6-Aug-01		12	18	3	7	618				10
7-Aug-01		12	23	1	4	646				10
8-Aug-01		12	17	5	5	673	2			12
9-Aug-01		12	8	4	2	687				12
10-Aug-01		12	22	7	6	722				12
11-Aug-01		12	19	14	6	761				12
12-Aug-01		12	18	4	6	789				12
13-Aug-01		12	15	7	7	818				12
14-Aug-01		12	22	4	9	853				12
15-Aug-01		12	25	4	10	892				12
16-Aug-01		12	19	5	10	926			1	13
17-Aug-01		12	15	3	8	952				13
18-Aug-01		12	19	6	5	982				13
19-Aug-01		12	9	6	5	1002				13
20-Aug-01		12	17	3	4	1026				13
21-Aug-01		12	15	5	8	1054				13
22-Aug-01		12	24	5	3	1086			1	14
23-Aug-01		12	11	2	5	1104				14
24-Aug-01		12	26	4	6	1140				14
25-Aug-01		12	27	5	15	1187				14
26-Aug-01		12	17	5	9	1218				14
27-Aug-01		12	15	6	7	1246				14
28-Aug-01		12	24	3	10	1283				14
29-Aug-01		12	20	1	5	1309				14
30-Aug-01		12	23	2	8	1342				14
31-Aug-01		12	23	4	9	1378				14
1-Sep-01		12	27	2	7	1414				14
2-Sep-01		12	23	5	11	1453				14
3-Sep-01		12	8	5	12	1478				14
4-Sep-01		12	7	5	6	1496				14
5-Sep-01		12	5	4	15	1520				14
6-Sep-01		12	6	8	14	1548				14
7-Sep-01		12	5	9	15	1577				14
8-Sep-01		12	8	4	7	1596				14
9-Sep-01		12	14	5	16	1631				14
10-Sep-01		12	5	3	20	1659				14
11-Sep-01		12	10	4	14	1687				14
12-Sep-01		12	3	3	17	1710				14
13-Sep-01		12	3	4	9	1726				14
14-Sep-01		12	1	4	12	1743				14
15-Sep-01		12	1	1	1	1746				14
16-Sep-01		12	1	6	12	1765				14
17-Sep-01		12	5		7	1777				14
18-Sep-01		12	1	6	12	1796				14
19-Sep-01		12	3	5	12	1816				14
20-Sep-01		12	1	2	10	1829				14
21-Sep-01		12	1	6	12	1848				14
22-Sep-01		12	3	3	6	1860				14
23-Sep-01		12	3	3	14	1880				14
24-Sep-01		12	3	6	3	1892				14

25-Sep-01				12	3	3	6	1904			14
26-Sep-01				12	4	5	7	1920			14
27-Sep-01				12	3	1	3	1927			14
28-Sep-01				12	1	4	11	1943			14
29-Sep-01				12	4	2	7	1956			14
30-Sep-01				12	1	3	5	1965			14
1-Oct-01				12	1	2	13	1981			14
2-Oct-01				12	2	2	9	1994			14
3-Oct-01				12	1	3	8	2006			14
4-Oct-01				12	2		4	2012			14
5-Oct-01				12		1	3	2016			14
6-Oct-01				12		2	5	2023			14
7-Oct-01				12		1	13	2037			14
8-Oct-01				12		1	12	2050			14
9-Oct-01				12			8	2058			14
10-Oct-01				12		3	6	2067	1		15
11-Oct-01				12		1	4	2072			15
12-Oct-01				12	1	1	6	2080			15
13-Oct-01				12				2080			15
14-Oct-01				12	1		8	2089			15
15-Oct-01				12		1	4	2094			15
16-Oct-01				12			6	2100			15
17-Oct-01				12				2100		1	16
18-Oct-01				12			6	2106			16
19-Oct-01				12			3	2109			16
20-Oct-01				12			2	2111			16
21-Oct-01				12			3	2114			16
22-Oct-01				12			2	2116			16
23-Oct-01				12		1	3	2120			16
24-Oct-01				12			1	2121			16
25-Oct-01				12		1	1	2123			16
26-Oct-01				12		1	3	2127			16
27-Oct-01				12		1	4	2132			16
28-Oct-01				12	20		3	2155			16
29-Oct-01				12	7		1	2163			16
30-Oct-01				12			2	2165			16
31-Oct-01				12				2165			16
1-Nov-01				12				2165			16
2-Nov-01				12				2165			16
3-Nov-01				12				2165			16
4-Nov-01				12				2165			16
5-Nov-01				12				2165			16
6-Nov-01				12				2165			16
7-Nov-01				12				2165			16
8-Nov-01				12				2165			16
9-Nov-01				12				2165			16
10-Nov-01				12	1			2166		1	17
											17
Total	**2**	**4**	**6**	**12**	**1069**	**380**	**717**	**2166**	**8**	**2**	**7**	**17**

APPENDIX 2. Sea Turtle Encounters During Additional Night Patrols

Date	Section	Green Turtles				Hawksbills			
		Newly tagged turtles	Previously tagged turtles	Renesters	Total	Newly tagged turtles	Previously tagged turtles	Renesters	Total
20-Jun-01	Mile 6-8	5			5				0
21-Jun-01	Mile 6-9	3	1		9				0
30-Jun-01	Mile 5-6		1		10				0
5-Jul-01	Mile 5-6 4/8	3			13				0
6-Jul-01	Mile 5-6	2			15				0
7-Jul-01	Mile 5-6 4/8	3			18				0
8-Jul-01	Mile 5-6 4/8			1	19				0
24-Jul-01	Mile 8-10	14		1	34				0
25-Jul-01	Mile 8-10	8	2		44				0
26-Jul-01	Mile 8-11	14	1	1	60				0
27-Jul-01	Mile 9-11	13			73				0
30-Jul-01	Mile 15-18	13	2	1	89				0
31-Jul-01	Mile 15-18	16			105				0
2-Aug-01	Mile 10-18	19	1		125	1			1
TOTAL		**113**	**8**	**4**	**125**	**1**	**0**	**0**	**1**

APPENDIX 3. Notes and Anecdotal Information on Illegal Harvest.

CCC personnel recorded 31 poaching incidents from June to November 2001. Ten incidents involved poaching or attempted poaching of turtle eggs, 21 incidents involved poaching or attempted poaching of a total of 21 nesting turtles. Five of the 21 turtles poached were discovered alive and released by CCC research assistants, tour guides or park rangers. There were also unconfirmed reports that individuals from the city of Limón, or from villages located between Limón and Tortuguero, poached turtles from inside the National Park at a number of occasions. Detailed records of poacher arrests were kept by the Tortuguero Conservation Area.