

REPORT
ON THE 2001 LEATHERBACK PROGRAM
AT TORTUGUERO, COSTA RICA



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and
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EXECUTIVE SUMMARY

Monitoring and Research Activities Conducted

1. A total of 25 track surveys between Tortuguero river mouth and Jalova lagoon were carried out by the CCC track surveyor Eddy Rankin between February and July 2001.
2. Peak leatherback nesting was recorded 24 April when 24 leatherback nests were counted.
3. The Field Coordinator and the RAs conducted 28 track surveys between Tortuguero river mouth and Parismina during the time period from 19 March to 8 June 2001. They recorded minimum poaching levels of 14.2 % for leatherback nests and 10.6 % for green turtle nests.
4. A comparison between track surveys conducted by the CCC track surveyor and RAs shows that the track surveyor recorded fewer leatherback nests along the northern 5 miles of beach and more leatherback nests during the beach sections between mile 5 and Jalova lagoon than did the RAs.
5. A total of 70 leatherback turtles were newly tagged, 50 leatherbacks with tags from previous years and/or other projects and 42 renesting leatherback turtles were encountered during 1,013 hours of night patrols between 11 March and 13 June 2001. In addition, 26 green turtles, five hawksbill turtles and one loggerhead turtle were newly tagged and 3 renesting green turtles were encountered during the night patrols.
6. A total of 42 % of encountered leatherback females were previously tagged. The previously tagged leatherbacks (n=50) were originally tagged on the beaches of Tortuguero (n=26), Pacuare/Mondonguillo (n=18), Gandoca/Manzanillo (n=4), Playa Negra (n=1) and Parismina (n=1).
7. A total of 11 % (n=8) of the newly tagged leatherbacks (n=70) showed evidence of old tag holes or notches when they were encountered the first time during the program.
8. A total of 87.7 % of the encountered leatherback females laid eggs in the open beach section (n=142), 1.2 % nested in the border zone (n=2) and 11.1 % did not lay eggs (n=18).
9. There was no significant difference in carapace length between leatherback turtles with complete and incomplete caudal projections.
10. Mean carapace length (CCL_{min}) for leatherback turtles (n=118) was 151.8 cm and mean leatherback clutch size was 77.5 normal sized eggs and 20 yolkless eggs.
11. Mean carapace length (CCL_{min}) for green turtles (n=24) was 105.1 cm, for hawksbill turtles (n=5) 88.4 cm and the one loggerhead measured 100.7 cm.
12. The precision of the CCL_{min} measurements during the same encounter was 0.3 cm for leatherback turtles and 0.2 cm for green turtles.
13. The precision of the carapace measurement for leatherbacks encountered more than once was 1.4 cm for two encounters, 1.8 cm for three encounters and 2.4 cm for five encounters.
14. A total of 71 leatherback nests were marked and monitored. Two nests were excluded from analysis as the flagging tapes were lost and their fate could not be determined.
15. Overall hatching success for monitored leatherback nests was 22-6-28.0 % and overall emerging success was 19.2-24.6%.
16. Mean distance between the sand surface and the top egg at the time of excavation for

undisturbed leatherback nests (n=11) was 54 cm and the mean distance between the sand surface to the bottom of the eggchamber was 74 cm for the same nests.

17. The incubation period for monitored leatherback nests for which emerging was observed (n=13) varied between 58-68 days with a mean of 63 days.
18. Eggs containing deformed embryos accounted for 0.03 % of leatherback eggs in nests that were not poached, partly washed out or washed out.
19. Rainfall was heaviest in June (1051.9 mm). May (89.3 mm) was the month with least rain.
20. Mean minimum air temperature was lowest in January (22.4°C) and mean maximum air temperature was lowest in December (28.6°C). Mean minimum air temperature and mean maximum air temperature was highest in May (26.4°C and 33.5°C respectively).
21. Mean monthly sand temperatures were lowest in January and highest in May.
22. The number of paying visitors to Tortuguero National Park totalled 41,897 in 2000.
23. Visitation to the CCC Natural History and Visitors Center was slightly lower for the first nine months of 2001 (17,986) in comparison with the first nine months of 2000 (18,649).
24. The hotels in the Tortuguero area did not increase their capacity in terms of rooms and beds in 2001. However, there are now more cabinas in the Tortuguero area.
25. New buildings in Tortuguero village and behind the airport have increased the number and intensity of lights in the beach sections between mile 1 1/8-mile 1 2/8 and between mile 2 7/8-mile 3 2/8.
26. Dead turtles encountered during the 2001 leatherback program were turtles killed by jaguars (n=21) or poachers (n=1) or dead turtles washed up on the beach (n=1).

Conclusions

1. The mean lifespan of a mobil radio unit can be expected to be approximately one year (if used on a nightly basis).
2. The lower number of nests recorded along the northern 5 miles by the CCC track surveyor in comparison with RAs could be the result of the track surveyor walking the Tortuguero river mouth-mile 3 section in the afternoon when it is more difficult to determine the freshness of the tracks.
3. The low levels of poaching observed may be explained by the increased park ranger patrols and also by poachers covering their tracks in order to make it more difficult to monitor poaching.
4. It is clear that increased enforcement during the leatherback nesting season, especially towards the southern end of the Tortuguero beach is a must to decrease poaching.
5. The extension of the night patrols to include the period from mid-May to mid-June resulted in a higher number of leatherback encounters being recorded as well as an increase in the number of hawksbill encounters logged.
6. The relatively large number of sea turtle encounters recorded is a result of the dedicated efforts of the Field Coordinator and the RAs.
7. Metal flipper tags are appropriate for tagging leatherbacks at Tortuguero.
8. Female leatherbacks with complete and incomplete caudal projections were not significantly different in carapace length.
9. A major reason for the low hatching success for monitored leatherback nests were the high tides and rough seas in late June that washed out 29.0 % of leatherback nests and washed over 34.8 % of the nests.
10. Undisturbed leatherback nests were shallower than previous years. It is possible that the

high tides and rough seas in late June resulted in beach erosion that removed sand from the leatherback nests.

11. The distance between the nest and the high tide line at the time of laying can not be used exclusively to predict the fate of a leatherback nest at Tortuguero.
12. The number of foreign visitors to Tortuguero National Park continued to increase during 2000. It is likely that tourism in 2001 may decrease as a result of a decrease in tourism following the events of 11 September in New York.
13. The increase in the capacity of cabins in the Tortuguero area will hopefully benefit conservation as local people seek to protect their ecotourism investments from the impacts of outsiders that come to Tortuguero with the intent to profit from extractive use of the area's natural resources.
14. The number of sea turtles killed by jaguars increased during the 2001 Leatherback Program in comparison to previous years' leatherback programs.
15. It is apparent that the jaguars prefer eating green turtles and hawksbills to leatherback turtles.

Recommendations

1. Mile markers should be renovated each leatherback program. One marker should be placed close to the vegetation line.
2. Each tagging team should be equipped with a functioning radio during night patrols.
3. RAs should conduct additional track surveys during the months of heaviest leatherback nesting.
4. Increased enforcement is needed to further decrease poaching.
5. Night patrols should be conducted between mid-March until the onset of the green turtle program in mid-June.
6. Metal flipper tags should be used in future leatherback programs.
7. The practise to classify the caudal projection as complete or incomplete should be continued.
8. Leatherback nests should not be relocated.
9. An alternative data logger that can sustain both high temperatures and high humidity should be aquired for placement in the open beach zone.
10. The local community should be encouraged to invest in cabins.
11. Monitoring of turtles killed by jaguars should be continued.
12. At least one person from the Tortuguero community should be selected for a RA position during future leatherback programs.

1. INTRODUCTION

Caribbean Conservation Corporation (CCC) has organized an annual leatherback (*Dermochelys coriacea*) program in Tortuguero since 1995. CCC staff and Scientific Advisory Committee revised the monitoring protocol in 1998. The 2001 Leatherback Program represents the seventh consecutive nesting season of leatherback monitoring and the fourth year of implementing the new monitoring protocol. The leatherback program 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*".

This report summarizes the methods and results of the 2001 Leatherback Program. The results are discussed and recommendations for future leatherback programs and for research and conservation activities in Tortuguero are given.

2. METHODS

2.1 Preparations

The Research Assistants (RAs) arrived in Tortuguero 11-12 March 2001. During the first week the RAs were given lectures in sea turtle biology and the monitoring protocol was explained in detail by the research and field coordinators. The RAs also received training in nest marking, tagging and data collection during the first week of the program. Most of the nightly training was conducted on the beach section between mile 14 and Jalova lagoon (=mile 18) in order to maximize the number of encounters with leatherbacks.

The positions of the mile markers along the 22 miles of beach (Tortuguero river mouth to Parismina river mouth) were verified using a 300 feet fiberglass measuring tape. Mile markers were posted every 1/8 of a mile between Tortuguero river mouth (mile -3/8) and mile 5. Between mile 5 and Parismina (mile 21 4/8) mile markers were posted every 4/8 of a mile. Three posts were put up at each mile marker position to ensure the mile markers could be seen during dark and cloudy nights.

2.2 Track Surveys

Track surveys between the Tortuguero river mouth and Jalova lagoon were conducted approximately weekly by CCC track surveyor Eddy Rankin. These track surveys started at Tortuguero village at 4:30 AM - 5:00 AM and were completed at Jalova lagoon at 9:30 AM. The section between the Tortuguero river mouth and village was surveyed the same afternoon (3:00 PM - 5:00 PM), by the same track surveyor. Only tracks from the previous night were counted. Notes were also kept on the number of turtles depredated by jaguars.

Track surveys were also conducted between the Tortuguero and Parismina river mouths, every 3 days from 19 March to 8 June by the FC and the RAs. The beach was divided into four sections: Tortuguero river mouth - CCC station (mile 2 5/8), CCC station-Juana López path (close to the mile 15 marker), Juana López path-Jalova lagoon (mile 18) and Jalova lagoon-Parismina river mouth (mile 21 4/8). All tracks since the previous track survey were counted. The tracks were marked with double lines and plastic debris in order to avoid

counting the same track at more than one survey. Notes were also kept on jaguar depredation, turtles turned by poachers and the number of poached fresh nests.

2.3 Tagging of Nesting Sea Turtles

Nightly tagging patrols were conducted 11 March-13 June 2001 (with the exception of 18 March, 26 May, 1, 4, 7, 9, 11-12 June). Three beach sections were patrolled with varying frequency: Tortuguero river mouth-CCC station, CCC station-mile 7 and Jalova lagoon (mile 18)-mile 14.

Turtles were tagged after finishing oviposition or when returning to the sea. Leatherbacks were tagged in the rear flippers. Green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*) turtles were tagged axillary, close to the first scale on the front flippers. Tag numbers, evidence of old tag holes or notches, species, date, time and activity when encountered were noted for each encounter. The location of the nest was defined as open (=open beach without any vegetation), border (=vines or other sparse vegetation partly shading the nest) or vegetation (=continuous vegetation behind the beach with complete shading of the nest).

Tags used during the 2001 Leatherback Program include National Band&Tag Company (NBTC) Monel #49 tags no. 79632-34, 79651-55, 79658-64, 79666-68, 79670-702, 79704-26, 79728-68, 79770, 79772-74, 79776-85, 79788-93, 79795-800, 79802-06, 79813-17, 79819, 79821-23, 79826-27 and Inconel #681 tags no. 89002, 89007, 89009-12, 89014-15, 89017-18, 89020-89024, 89027-29, 89031-33, 89035-89036, 89038-39, 89041-89046, 89049, 89051-57, 89059-61, 89063-89067, 89070, 89072-81, 89085-86, 89088-90.

2.4 Biometric Data Collection

If the turtle was encountered before oviposition, the eggs were counted as they were laid into the egg chamber. The eggs were counted by a person wearing a plastic glove to avoid contamination of the nest. Normal sized and yolkless eggs were counted separately.

CCLmin (=from the nuchal notch to the end of the caudal projection NEXT TO the central ridge) was recorded for leatherbacks. For leatherbacks, the caudal projection was classified as complete if no irregularities occurred and incomplete if the caudal projection was irregular or parts of it was missing. CCLmin (=from where the skin meets the carapace by the nuchal notch to the posterior notch between the supracaudals, along the midline) was recorded for green, hawksbill and loggerhead turtles. Measurements were recorded to the closest millimeter. All measurements were repeated three times in order to determine precision. Precision for one encounter is defined as the difference between the shortest and the longest of the three measurements. Precision for turtles encountered more than once is defined as the difference between the shortest and the longest of all measurements collected from the same individual.

2.5 Determination of Nest Survivorship and Hatching Success

For leatherbacks encountered previous to covering the eggs, three pieces of flagging tape attached to the vegetation behind the nest were used to mark the nest. The location of the nest could therefore be determined by triangulation. The third piece of flagging tape ensured that nests could be located if one piece of flagging tape went missing. Each morning the marked 10

nests were inspected so that the fate of the nest could be determined. Depredation and poaching was noted and resulted in termination of monitoring the nest. Nests were only marked along the beach section between the Tortuguero river mouth and the mile 5 marker.

Marked nests were excavated two days after hatching or 75 days after oviposition, to determine hatching and emerging success. The number of empty eggshells, pipped eggs, live and dead hatchlings, unhatched eggs without embryo, unhatched eggs with embryo, unhatched eggs with fully developed embryo, depredated eggs, yolkless eggs, twins, deformed and albino embryos were determined for each excavated nest. Only egg shells amounting to more than 50% of an egg were recorded as an egg. The distances from the sand surface to the top egg as well as to the bottom of the eggchamber were recorded for each excavated nest.

2.6 Physical Data Collection

Rainfall (to the closest 0.1 mm) and temperature (current, minimum and maximum, to the closest 0.5°C) were recorded daily at 9 AM.

The level of the ground water was measured daily at 9 AM. The water level was determined to the closest millimeter from three PVC pipes (8.5 cm x 160 cm) inserted in the sand 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).

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 CCC station.

2.7 Collection of Human Impact Data

Staff at the ACTo office in Tortuguero provided data on the number of visitors to Tortuguero National Park 1998-2000.

Alexander Castillo recorded the number of visitors at the CCC Natural History and Visitors Center.

Victor Barrantes contacted the owners or managers of the lodges and cabinas in Tortuguero and the name of the lodge/cabinas, number of beds and number of rooms were recorded.

Light surveys were conducted 23 March, 20 April and 27 May 2001. The beach was surveyed from the Tortuguero river mouth to the mile 5 marker. Each artificial light visible from the beach was noted and the light source was identified. The location of the light source, i.e. Tortuguero (=beach) side or mainland (=lagoon) side was also noted for each light.

2.8 Dead Turtles

Dead turtles encountered during track surveys or other monitoring activities were recorded and an attempt was made to determine the cause of death.

2.9 Environmental Education Activities

Students from the Tortuguero school and high school were encouraged to participate in nightly beach patrols. Other awareness activities were conducted opportunistically when time and special events allowed.

3. RESULTS

3.1 Preparations

In late June, high tides and rough seas washed out many of the renovated mile markers.

3.2 Track Surveys

Leatherback nesting was recorded from late February to late July (Figure 1) with peak nesting occurring in late April. March-June was the period when leatherback nesting was most intense.

Table 1. Number of nests and poached nests as determined from total counts by RAs and FC.

Date	Leatherback Nests	Minimum Poached Leatherback Nests	Min. % Poached	Green Turtle Nests	Minimum Poached Green Turtle Nests	Min. % Poached
19 March	33	4	12.1	3	1	33.3
22 March	14	0	0	14	1	7.1
25 March	23	0	0	9	0	0
28 March	26	4	15.4	12	2	16.7
31 March	26	0	0	7	0	0
3 April	33	2	6.1	6	0	0
6 April	23	2	8.7	15	1	6.7
9 April	33	10	30.3	21	2	9.5
12 April	46	11	23.9	16	1	6.3
15 April	37	0	0	15	1	6.7
18 April	49	2	4.1	29	3	10.3
21 April	51	8	15.7	22	4	18.2
24 April	40	2	5.0	17	0	0
27 April	64	12	18.8	22	0	0
30 April	53	10	18.9	17	2	11.8
3 May	58	12	20.7	22	3	13.6
6 May	60	9	15.0	20	0	0
9 May	53	15	28.3	16	2	12.5
12 May	43	9	20.9	14	0	0
15 May	34	8	23.5	15	0	0
18 May	48	4	8.3	12	0	0
21 May	35	0	0	7	0	0
24 May	39	7	17.9	10	2	20.0
27 May	55	6	10.9	18	2	11.1
30 May	43	3	7.0	13	1	7.7
2 June	26	4	15.4	8	0	0
5 June	34	2	5.9	25	8	32.0
8 June	28	11	39.3	27	10	37.0
Total	1107	157	14.2	432	46	10.6

All nests laid and poached since previous track surveys were recorded.

A minimum of 14.2 % of leatherback nests and 10.6 % of the green turtle nests were poached (Table 1). The beach section outside of the National Park, between Jalova lagoon (mile 18) and the Parismina river mouth (mile 21 4/8), was most affected by poaching (Figure 2a-2d).

A comparison between the total track counts carried out by the FC and the RAs and extrapolations from Eddy Rankin's approximately weekly surveys show some differences

(Figure 2a-2d). Fewer nests were recorded along the northern 5 miles but more nests were recorded between mile 5 and Jalova lagoon during Eddy Rankin's surveys in comparison with the tracks surveys conducted by the FC and RAs (Figure 2a-2d).

Observations and anecdotal information regarding illegal harvest are summarized in App. 2.

3.3 Tagging of Nesting Sea Turtles

A total of 1,013 teamhours were spent on night patrols from 11 March to 13 June. During this time a total of 162 leatherbacks, 29 green turtles, 5 hawksbills and one loggerhead were recorded (Appendix 1). This is equal to 0.160 leatherbacks, 0.029 green turtles, 0.005 hawksbills and 0.001 loggerheads encountered per team hour on the beach.

The encountered turtles correspond to 120 individual female leatherbacks, 26 female green turtles, 5 females hawksbills and one female loggerhead. A total of 42 % of the leatherbacks were previously tagged. The previously tagged leatherbacks (n=50) were originally tagged on the beaches of Tortuguero (n=26), Pacuare/ Mondonguillo (n=18) (B. Dick pers. comm., C. Fernández pers. comm.), Gandoca/Manzanillo (n=4) (D. Chacón pers. comm.), Playa Negra (n=1) (D. Chacón pers. comm.) and Parismina (n=1) (C. Castro pers. comm.). A total of 11 % (n=8) of the newly tagged leatherbacks (n=70) showed evidence of old tag holes or notches when they were encountered for first time during the program.

A total of 87.7 % of the encountered leatherback females laid eggs in the open beach section (n=142), 1.2 % nested in the border zone (n=2) and 11.1 % did not lay eggs (n=18).

3.4 Biometric Data Collection

The mean clutch size and carapace length (CCLmin) for leatherbacks are shown in Table 2. Leatherbacks with incomplete caudal projections are not significantly shorter in terms of carapace length in comparison with leatherbacks with complete caudal projection (one tailed t-test $p < 0.05$; one tailed Mann-Whitely test $p < 0.05$). Hence, data from leatherbacks with incomplete and complete caudal projections have been pooled. Mean carapace length (CCLmin) for leatherbacks was 151.8 cm (Table 2).

Table 2. Mean carapace length and clutch size of leatherbacks.

Caudal projection	Carapace length		Clutch size		
	n	× CCLmin (cm) ± S.D.	n	× eggs ± S.D.	× yolkless eggs ± S.D.
Complete	113	151.9 ± 8.0	45	76.1 ± 19.8	25.5 ± 12.1
Incomplete	5	149.6 ± 6.6	4	92.8 ± 24.0	21.8 ± 9.1
Total	118	151.8 ± 7.9	49	77.5 ± 20.4	25.1 ± 11.8

Female leatherbacks measured at more than one encounter (n=34) were consistently diagnosed as having complete caudal projections in 91 % of cases (n=31), consistently with incomplete caudal projection in 6 % of cases (n=2) and with the caudal projection varyingly as complete and incomplete in 3 % of cases (n=1).

The mean carapace length (CCLmin) for green turtles was 105.1 cm and the one clutch that was counted contained 142 eggs (Table 3).

Table 3. Mean carapace length and clutch size of green, hawksbill and loggerhead turtles.

Species	Carapace length		Clutch size	
	n	× CCLmin (cm) ± S.D.	n	× eggs ± S.D.
Green	24	105.1 ± 5.7	1	142 ± N/A
Hawksbill	5	88.4 ± 2.5	1	187 ± N/A
Loggerhead	1	100.7 ± N/A		N/A

The precision of the CCLmin carapace measurement for leatherbacks was 0.3 cm and for green turtles 0.2 cm (Table 4a).

Table 4a. Precision of carapace measurements.

Species	n	× precision for CCLmin (cm) ± S.D.
Leatherback	156	0.3 ± 0.2
Green	27	0.2 ± 0.1

The precision of the carapace measurement for leatherbacks encountered more than once was 1.4 cm for two encounters, 1.8 cm for three encounters and 2.4 cm for five encounters (Table 4b).

Table 4b. Precision of carapace measurements for leatherbacks encountered more than once.

Encounters	n	× precision for CCLmin (cm) ± S.D.	Range (cm)
2	24	1.4 ± 0.9	0.1-3.2
3	5	1.8 ± 1.6	0.6-4.5
4	-	-	-
5	1	2.4 ± N/A	-

3.5 Determination of Nest Survivorship and Hatching Success

A total of 71 leatherback nests were marked between 20 March and 29 June 2001. For two monitored nests all flagging tapes were lost. As the fate of those nests cannot be determined with certainty, they have been excluded from further analysis. Four leatherback nests were poached. Fate, hatching and emerging success of marked nests are shown in Table 5.

Table 5. Fate, hatching and emerging success of marked leatherback nests.

Fate	n	% of total	Hatching success (%)	Emerging success (%)
<i>Undisturbed</i>				
1. Undisturbed	11	15.9	45.3	31.2
<i>Disturbed</i>				
2. Poached	4	5.8	1.0	1.0
3a. Disturbed after hatching – dogs	6	8.7	32.8 (79.1)*	31.5 (77.8)*
3b. Disturbed after hatching – guides	2	2.9	42.6 (49.2)*	34.1 (40.6)*
4. Invaded by roots	1	1.4	16.0	16.0
5. Partly washed out	1	1.4	0 (82.6)*	0 (82.6)*
6. Washed out	20	29.0	0	0
7. Washed over	24	34.8	31.9	29.4
TOTAL		99.9	22.6 – 28.0	19.2 – 24.6
(7. Flagging lost	2)			

*Based on $\times=76.3$ eggs/nest, numbers in brackets refer to hatching and emerging success in the unlikely event of all eggs that could not be accounted for, hatched and the resulting hatchlings emerged

Table 6a. Results of nest excavations.

Fate	Empty Shells	Pipped eggs	Live hatchlings	Dead hatchlings	Unhatch. no embryo	Unhatch. Embryo	Unhatch. Full embryo	Depredated	Total eggs	× eggs/nest
Marked nests										
1	380	101	27	91	111	72	141	34	839	76.3
2	3	1	0	0	0	1	0	0	?	?
3a	150(362) *	32	2	4	9	6	43	6	?	?
3b	65(75) *	33	5	8	7	0	29	9	?	?
4	17	0	0	0	86	1	2	0	106	106
5	0(63) *	7	0	0	0	0	6	0	?	?
7	584	116	9	37	616	221	194	101	1832	76.3
ALL	1199(1484) *	290	43	140	829	301	415	150	?	76.3

Fate 1=Undisturbed, 2=Poached, 3a=Disturbed after hatching – dogs, 3b=Disturbed after hatching - guides , 4=Invaded by roots, 5=Partly washed out, 7=Washed over

*Numbers in brackets refer to number of shells in the unlikely event of all unaccounted for eggs, hatched and the resulting hatchlings emerged

It is assumed that all leatherback nests had the same mean number of eggs as the excavated undisturbed nests (×=76.3 eggs/nest) hence the total number of eggs for all marked nests = 5,294 eggs (68 x 76.3 + 106). Therefore, the overall hatching success was 22.6-28.0 % for monitored leatherback nests (1,199-1,484 empty shells from 5,294 eggs). It is worth noting that if poaching had been completely eliminated the overall hatching success would have been 24.0-29.7 % (i.e.1,196-1,481 empty shells from 4,989 eggs from 65 nests).

Emerging success for monitored leatherback nests, using the same assumption as above, was between 19.2 % and 24.6 % (1,016-1,301 hatchlings emerged from 69 nests with a total of 5,294 eggs).

The distance from the sand surface to the top egg at the time of excavation for undisturbed nests (n=11) varied between 22-63 cm with a mean of 54 cm. The distance from the sand surface to the bottom of the egg chamber for the same nests varied between 61-88 cm with a mean of 74 cm.

The incubation period for monitored leatherback nests for which emerging was observed (n=13) varied between 58-68 days with a mean of 63 days.

The washed out and partly washed out leatherback nests (for which was noted the distance between the nest and the high tide line at the time of laying) were located less than 18.6 meters from the high tide line. However, 11 leatherback nests laid within 18.6 meters of the high tide line hatched undisturbed, including one nest that was located only 2.9 m from the high tide line at the time of oviposition.

Table 6b. Incidence of deformed leatherback embryos.

	n	% of eggs
Deformed embryos	1	0.03
TOTAL	1	0.03

Eggs containing deformed embryos accounted for 0.03 % of leatherback eggs in nests that were not poached, partly washed out or washed out (Table 6b).

3.6 Physical Data Collection

Rainfall was heaviest in June. May was the month with least rain (Table 7).

Table 7. Rainfall, December 2000-September 2001.

Month	Total rainfall (mm/month)	× rainfall (mm/24hrs)
December	505.2	17.4
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

*Data for 48 hours for 6-7 December, 24-25 December, 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 16-19 December, 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

Mean minimum air temperature was lowest in January and mean maximum air temperature was lowest in December (Table 8). Mean minimum air temperature and mean maximum air temperature was highest in May (Table 8).

Table 8. Air temperature, December 2000-September 2001.

Month	× minimum temp. (°C) *	× maximum temp. (°C) *
December	24.3	28.6
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

*No data for 16-18, 24, 30-31 December, 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

High tides washed out the dataloggers located in the open zone on 5 July. The dataloggers were collected by unknown persons and only two dataloggers could be recovered, they were relocated in the open zone, 5 m closer to the vegetation on 7 July.

Increased shading caused a decrease in the mean monthly sand temperature. Shallow dataloggers (30 cm depth) registered a higher mean temperature in comparison with dataloggers located at 50 cm and 70 cm depth (Table 9). The sand temperature at 70 cm depth in the border zone is shown in Figure 3.

Table 9. Mean monthly sand temperatures.

Zone	Field station			Field station			Field station		
	Open	Open	Open	Bord.	Bord.	Bord.	Veg.	Veg.	Veg.
<i>Depth (cm)</i>	30 ^a	50 ^a	70 ^a	30	50	70	30	50	70
December, × temp (°C)	27.8	27.9	28.1	26.3	26.6	26.7	25.3	25.5	25.8
January, × temp (°C)	25.8	25.5	25.4 ^d	24.3	24.2	24.2	23.6	23.5	23.7
February, × temp (°C)	28.0	27.5	-	26.4	26.3	26.1	25.5	25.2	25.1
<i>Retrieval depth (cm) 8 March</i>	50	69	91	31	50	70	30	49	70
<i>Depth (cm) 8 March</i>	30	50	70	30	50	70	30	50	70
March, × temp (°C)	30.4	29.4 ^c	29.7 ^d	27.8	27.9	27.8	26.7	26.6	26.5
April, × temp (°C)	30.3	30.8 ^c	29.8	28.1	28.2	28.1	26.9	26.8	26.9
May, × temp (°C)	32.8	32.5	31.7	30.8	30.3	29.8	27.8	27.7	27.6
June, × temp (°C)	30.4 ^b	29.6	29.7	28.3	28.5	28.5	26.2	26.4	26.7
<i>Retrieval depth (cm) 20 June</i>	31	48	71	29	48	72	29	48.5	68.5
<i>Depth (cm) 20 June</i>	30	50	70	30	50	70	30	50	70
July, × temp (°C)	N/A	28.2 ^c		27.3	27.1	26.9	25.5	25.6	25.7
August, × temp (°C)	N/A	28.9		27.6	27.6	27.5	25.9	26.0	26.0
<i>Retrieval depth (cm) 24 Sept.</i>	N/A	55	72	31	50	68	30	51	73

^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

After heavy rains the ground water reached levels that could be detected in the PVC pipes (Figure 4). In late June ground water levels reached levels that may have interfered with leatherback nests (Figure 4).

3.7 Collection of Human Impact Data

The number of paying visitors coming to Tortuguero National Park has continuously increased since 1998 and totalled 41,897 paying visitors in 2000 (Table 10).

Table 10. Number of Paying Visitors to Tortuguero National Park, 1998-2000.

Year	CR Visitors	Foreign Visitors	Total
1998	2,685	12,313	14,998
1999	5,767	32,863	38,630
2000	5,543	36,354	41,897

Information from ACTo.

The number of visitors to the CCC Natural History and Visitors Center has remained stable over the last two years. May and June are the months with least visitors arriving to Tortuguero (Table 11). During the first nine months of 2001, fewer tourists have visited the Visitors Center than during the first nine months of 2000 (Table 11). There was a marked drop in visitation to the CCC Natural History and Visitors Center in September 2001, following the tragic events in New York on 11 September.

Table 11. Visitors to the CCC Natural History and Visitors Center, January 1999-September 2001.

Month	1999		2000		2001	
	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		
November	1984	66	2215	74		
December	1163	38	1964	63		
TOTAL	21559	59	24574	68	17986	66

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

The hotels in the Tortuguero area did not increase their capacity in terms of rooms and beds in 2001 (Table 12). However, there are now more cabinas in the Tortuguero area (Table 12).

Table 12. 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
<i>Total – Hotels</i>	<i>295</i>	<i>716</i>	Tortuguero	5	15
Cabinas	Rooms	Beds	(CCC)	7	32)
Pisulin/Tropical Lodge*	-	-	<i>Total – Cabinas</i>	<i>110</i>	<i>248</i>
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

Mile sections with artificial lights did not increase between the end of 2000 Green Turtle Program and the end of the 2001 Leatherback Program (Table 13). However, new buildings in the Tortuguero village and behind the airport have increased the number and intensity of lights in the beach sections between mile 1 1/8-mile 1 2/8 and between mile 2 7/8-mile 3 2/8 (pers. obs.).

Table 13. Artificial lights visible from the beach, Tortuguero river mouth to Mile 5.

Mile	Light source	Beach side	Lagoon side	March	April	May
6/8	Tortuga Lodge		X	X	X	
1 1/8	Ilan-Ilan Lodge		X	X		
1 1/8	House	X		X	X	
1 2/8	Ilan-Ilan Lodge + House	X	X	X	X	
1 3/8	Manati + Laguna Lodge	X	X	X	X	X
1 4/8	Laguna Lodge	X			X	X
1 7/8	House?		X	X		
2 2/8	Mawamba Lodge			X	X	X
2 3/8	Mawamba Lodge	X			X	
2 4/8	CCC	X				X
2 5/8	CCC	X		X		
2 6/8	Houses	X		X	X	X
2 7/8	Houses + Street Lights	X		X	X	X
3	Houses + Street Lights	X		X	X	X
3 1/8	Houses + Street Lights	X		X	X	X
3 2/8	Houses + Street Lights	X		X	X	X
3 3/8	House	X		X		
1/8-6/8, 1 1/8-4 6/8	Street lights (m2 7/8-3 2/8)	X		X	X	X

3.8 Dead Turtles

The dead turtles encountered during the 2001 Leatherback Program were turtles killed by jaguars (n=21) or poachers (n=1) or dead turtles washed up on the beach (n=1).

Table 14. Dead turtles.

Date	Species	Sex	CCLmin	Comments
25-Mar-01	Dc	F	152.2	Killed by jaguar/s.
31-Mar-01	Cm	F	113.0	Killed by jaguar/s.
3-Apr-01	Cm	F	105.9	Washed up dead.
15-Apr-01	Cm	F		Killed by jaguar/s.
18-Apr-01	Cm	F		Flippers cut off by poachers but turtle still alive. Killed by park rangers and buried behind the beach.
18-Apr-01	Cm	F		Tracks indicating that turtle was killed by jaguar/s.
19-Apr-01	Cm	F	108.8	Killed by jaguar/s.
27-Apr-01	Cm	F	117.4	Killed by jaguar/s.
30-Apr-01	Cm	F		Killed by jaguar/s.
30-Apr-01	Cm	F	105.1	Killed by jaguar/s.
3-May-01	Cm	F		Killed by jaguar/s.
3-May-01	Cm	F		Killed by jaguar/s.
6-May-01	Cm	F	97.0	Killed by jaguar/s.
12-May-01	Cm	F	118.2	Killed by jaguar/s.
18-May-01	Ei	F	88.0	Killed by jaguar/s.
21-May-01	Cm	F	111.0	Killed by jaguar/s.
27-May-01	Cm	F	108.0	Killed by jaguar/s.
30-May-01	Cm	F	108.2	Killed by jaguar/s.
5-Jun-01	Cm	F		Killed by jaguar/s.
5-Jun-01	Cm	F		Killed by jaguar/s.
9-Jun-01	Ei	F	91.6	Killed by jaguar/s.
10-Jun-01	Cm	F		Killed by jaguar/s.
16-Jun-01	Cm	F		Killed by jaguar/s.

Cm=green turtle, Dc=leatherback, Ei=hawksbill

3.9 Environmental Education Activities

Students from the Tortuguero school and high school occasionally participated in tagging patrols during the leatherback program.

4. DISCUSSION

4.1 Preparations

Repairing mile markers at the beginning of each leatherback program is of the utmost importance as the mile markers help both RAs and the track surveyor orient on the beach. At least three markers should be placed at each location. One mile marker should be placed at the vegetation line so that there are high probabilities of the mile marker withstanding high tides and rough seas.

On 19 and 21 April, RAs on night patrols along the Jalova lagoon-Mile 14 beach section sighted jaguars. Although jaguars are known not to attack humans (E. Carillo pers. comm., C. Miller pers. comm.), it is understandable that the RAs were feeling nervous about conducting night patrols along the Jalova lagoon-Mile 14 beach section following the nightly jaguar encounters. It is suggested that radios be used by all beach teams during night patrols in order to provide communication in the event of an emergency and also to alleviate the fear of those participating in night patrols. Due to the extremely corrosive and humid conditions on the Tortuguero beach the average lifespan of a mobil radio unit can be expected to be approximately one year (if used on a nightly basis).

4.2 Track Surveys

Leatherback nesting was observed from late February to late July with peak nesting in April (Figure 1). The additional track surveys conducted by RAs (19 March-8 June) coincided with the period of the heaviest leatherback nesting.

The lower number of nests recorded along the northern 5 miles by the CCC track surveyor Eddy Rankin in comparison with RAs could be the result of the track surveyor walking the Tortuguero river mouth- mile 3 section in the afternoon. Later in the day it is more difficult to determine the freshness of the tracks and the number of nests may therefore be underestimated. It is suggested that additional track surveys by RAs be continued during future leatherback programs.

The minimum percentage of poaching was lower than during previous leatherback programs (Table 1). There may be several reasons for this observation. Firstly, increased patrols by park rangers may have discouraged poaching. However, the poachers may also have become more careful and there is a possibility that they now fill in poached nests and cover their tracks in order to make it more difficult for CCC staff and park rangers to monitor poaching. It is clear that increased enforcement during the leatherback nesting season, especially along the southern section of the Tortuguero beach (Figures 2a-2d) is instrumental in decreasing poaching.

4.3 Tagging of Nesting Sea Turtles

Night patrols were carried out from mid-March to mid-June and coincide with the majority of the leatherback nesting season. The extension of the night patrols to include the period from mid-May to mid-June resulted in a higher number of leatherback encounters recorded as well as an increase in the number of hawksbill encounters logged (Appendix 1). It is suggested that night patrols be conducted mid-March to mid-June during future leatherback programs.

The relatively large number of sea turtle encounters recorded during the 2001 Leatherback Program was the result of the dedicated efforts of the Field Coordinator and the RAs whom together logged more than 1,000 teamhours of night patrols.

The 11% of newly tagged leatherback females that showed evidence of previous tagging indicate that tag loss may be a problem. However, there is a large proportion of leatherback females changing nesting beaches along the coast (as indicated by the 24 leatherback females tagged on beaches other than Tortuguero). If the tagging system be changed, it would need to be consistently changed on all tagging projects along the coast. Metal flipper tags are visible and easily registred by fishermen or others that may encounter live or dead leatherback turtles. This gives them a distinct advantage to PIT tags and it is therefore suggested that metal Monel tags are used in future leatherback programs.

4.4 Biometric Data Collection

Female leatherbacks with complete and incomplete caudal projections were not significantly different in carapace length (Table 2). However, this may not be true in future programs and it is suggested that the practise to classify the caudal projection as complete or incomplete be continued.

4.5 Determination of Nest Survivorship and Hatching Success

The overall hatching success for leatherback nests during the 2001 Leatherback Program was relatively low at 22.6-28.0% (Table 5). A major reason may have been the high tides and rough seas in late June (Figure 4) that washed out many of the leatherback nests and washed over even more nests (Table 5). It is encouraging to see that poaching was limited to 5.8 %, no doubt as a result of the enforcement efforts by the park rangers.

Undisturbed leatherback nests were more shallow (mean distance sand surface-top egg of 54 cm) than in previous years. It is possible that the high tides and rough seas in late June resulted in beach erosion that removed sand from the top of the leatherback nests.

Again, it was observed that the distance between the nest and the high tide line at the time of laying can not be used as an exclusive cue to predict the fate of a leatherback nest at Tortuguero.

4.6 Physical Data Collection

A total of 70 of the 71 marked leatherback nests were located in the open beach zone with no shading of the nest. Unfortunately, the data loggers in the open zone seem to have been affected by a combination of high temperature (30°C+) and high humidity that resulted in the failure of the datalogger. For this reason the data in Figure 3 is from the border zone.

Currently, we are working with the providers of the dataloggers (Onset Computer Corp.) to identify alternative data loggers that are able to sustain both high temperatures and high humidity.

The pivotal temperature for leatherback turtles nesting at Tortuguero has not been determined. However, Tortuguero leatherbacks are not significantly different in terms of mtDNA from leatherback turtles nesting in French Guiana (Dutton et al. 1999). Therefore, the pivotal temperature and TRT_{5%} for French Guiana leatherbacks (Girondot 1999) are shown in Figure 3.

4.7 Collection of Human Impact Data

The number of foreign visitors to Tortuguero National Park continued to increase during 2000 (Table 10). It is likely that tourism in 2001 may decrease as a result of a decrease in tourism following the events of 11 September in New York.

It is encouraging to see the increase in the capacity of cabins in the Tortuguero area (Table 12). This indicates that members of the local community are investing their savings in order to increase their share of the Tortuguero tourism profits. Hopefully, this will also benefit conservation in the area as local people seek to protect their ecotourism investments from the impacts of outsiders that come to Tortuguero with the intent to profit from extractive use of the area's natural resources.

4.8 Dead Turtles

The number of sea turtles killed by jaguars increased during the 2001 Leatherback Program in comparison to previous years' leatherback programs (Table 14). From the dead turtles encountered, it is apparent that the jaguars prefer green and hawksbill turtles to leatherback turtles. The hawksbill is critically endangered and that hawksbill nesting has declined in Tortuguero since monitoring was initiated in 1955 (Troëng, in press). Therefore it is discouraging to observe that the jaguars killed two hawksbill turtles. The monitoring of the number of sea turtles killed by jaguars need to be continued to determine if jaguars are a threat to the nesting population of hawksbill turtles.

Several of the heads of green turtles and also a hawksbill turtle killed by the jaguars have been skillfully conserved by the park rangers and are now on display at the Tortuguero park ranger station.

4.9 Environmental Education Activities

It is suggested that, if possible, at least one person from Tortuguero be selected as a RA during future leatherback programs. However, the person should be chosen with care so that his/her participation does not compromise any family income or studies at high school level.

5. REFERENCES

- Dutton, P.H., B.W. Bowen, D.W. Owens, A. Barragan, and S.K. Davis. 1999. Global phylogeny of the leatherback turtle (*Dermochelys coriacea*). *J. Zool. Lond.* **247**: 397-409.
- Girondot, M. 1999. Statistical description of temperature-dependent sex determination using maximum likelihood. *Evol. Eco. Res.* **1**:479-486.
- Troëng, S. In press. Decline of the hawksbill turtle *Eretmochelys imbricata* in Caribbean Costa Rica. Proceedings of the 21th Annual Sea Turtle Symposium, Philadelphia, Pennsylvania.

6. RECOMMENDATIONS

6.1 Preparations

- ⇒ Mile markers should be renovated each leatherback program. One marker should be placed close to the vegetation line.
- ⇒ Each tagging team should carry a radio during night patrols.

6.2 Track Surveys

- ⇒ RAs should conduct additional track surveys during the months of heaviest leatherback nesting.
- ⇒ Increased enforcement is needed to further decrease poaching.

6.3 Tagging of Nesting Sea Turtles

- ⇒ Night patrols should be conducted between mid-March until the onset of the green turtle program in mid-June.
- ⇒ Metal flipper tags should be used in future leatherback programs.

6.4 Biometric Data Collection

- ⇒ The practise to classify the caudal projection as complete or incomplete should be continued.

6.5 Determination of Nest Survivorship and Hatching Success

- ⇒ Leatherback nests should not be relocated.

6.6 Physical Data Collection

- ⇒ An alternative data logger that can sustain both high temperatures and high humidity should be identified for the open beach zone.

6.7 Collection of Human Impact Data

- ⇒ The local community should be encouraged to invest in own businesses such as cabinas.

6.8 Dead Turtles

- ⇒ Monitoring of turtles killed by jaguars should be continued.

6.9 Environmental Education Activities

- ⇒ At least one person from Tortuguero should be selected as a RA during future leatherback programs.

Figure 1. Seasonal distribution of leatherback nesting activity as determined from track surveys, Tortuguero rivermouth (mile -3/8) - Jalova lagoon (mile 18).

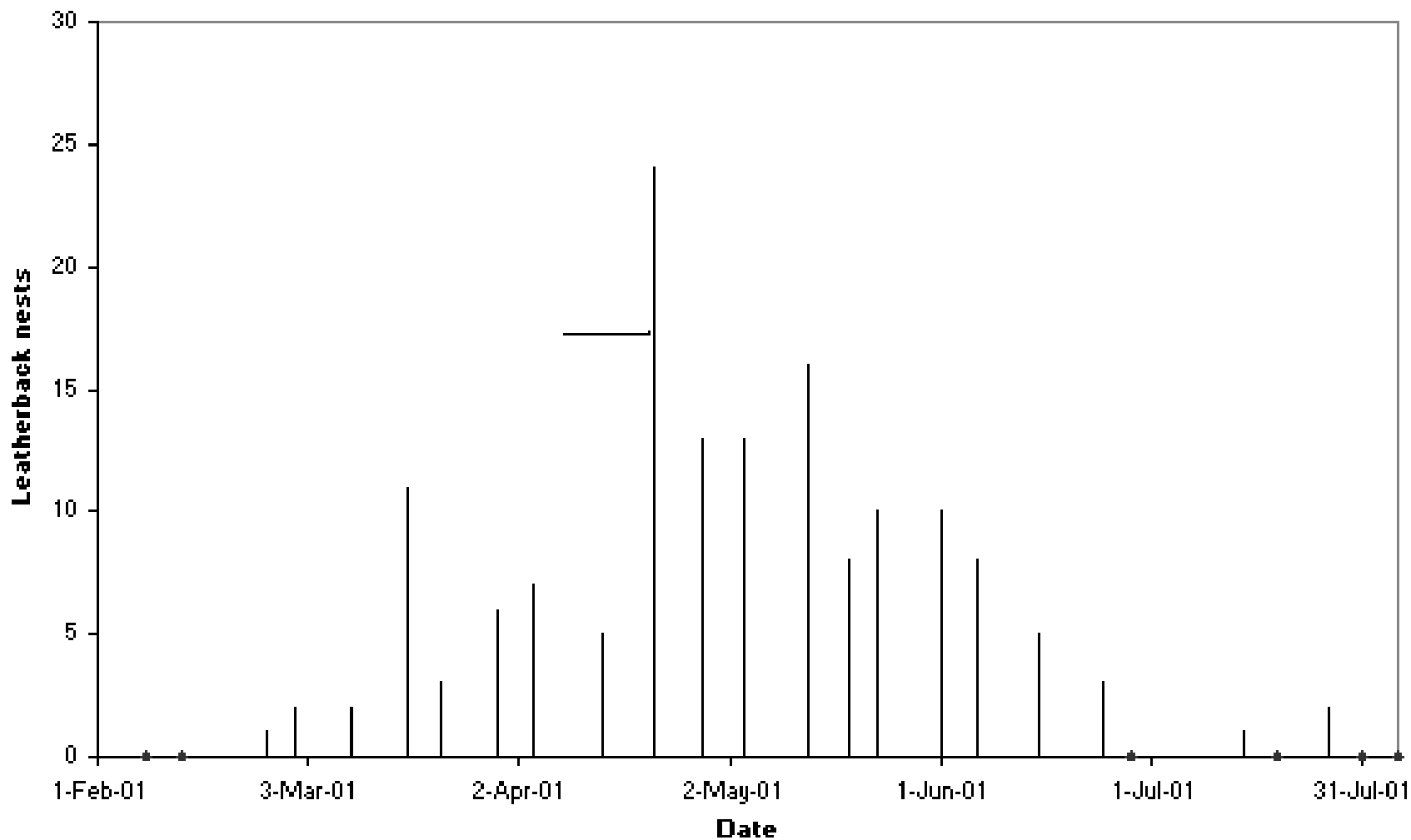


Figure 2a. Leatherback nesting activity from Tortuguero river mouth to the mile 5 marker.

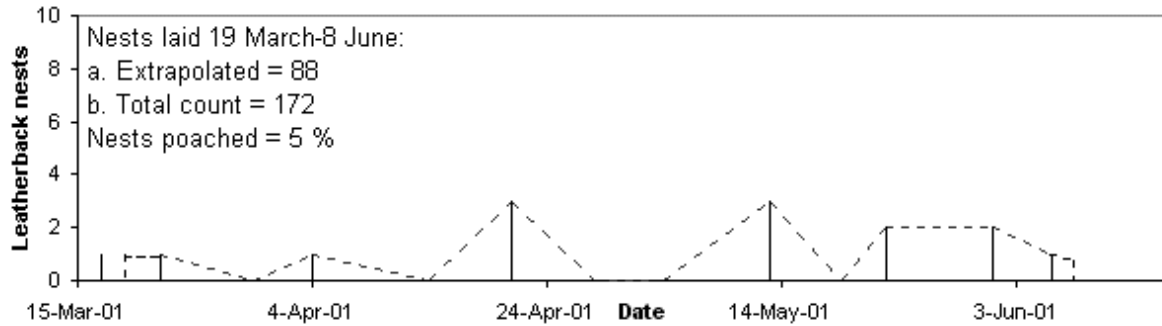


Figure 2b. Leatherback nesting activity from the mile 5 marker to Juana López path.

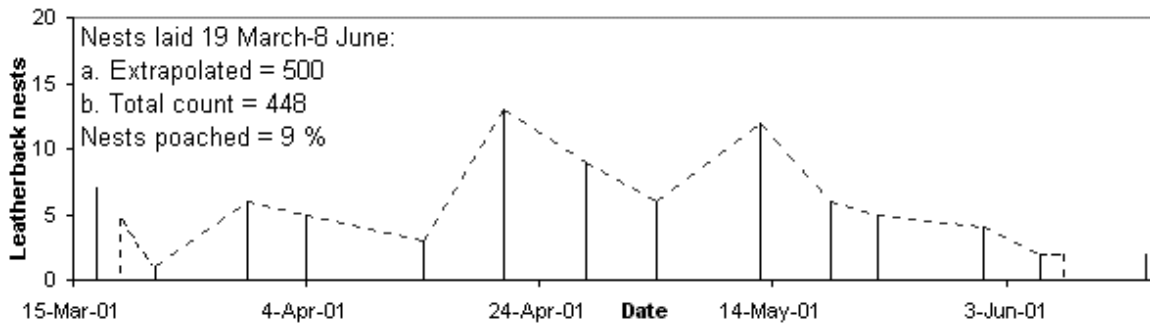


Figure 2c. Leatherback nesting activity from Juana López path to Jalova lagoon.

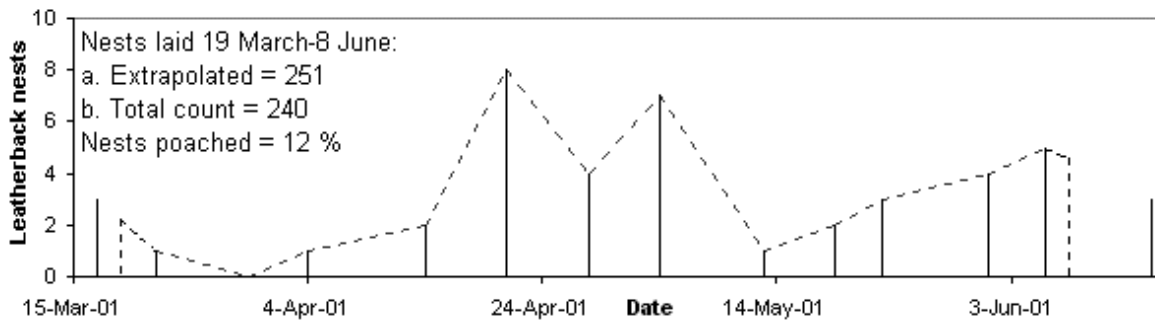


Figure 2d. Leatherback nesting activity from Jalova lagoon to Parismina river mouth.

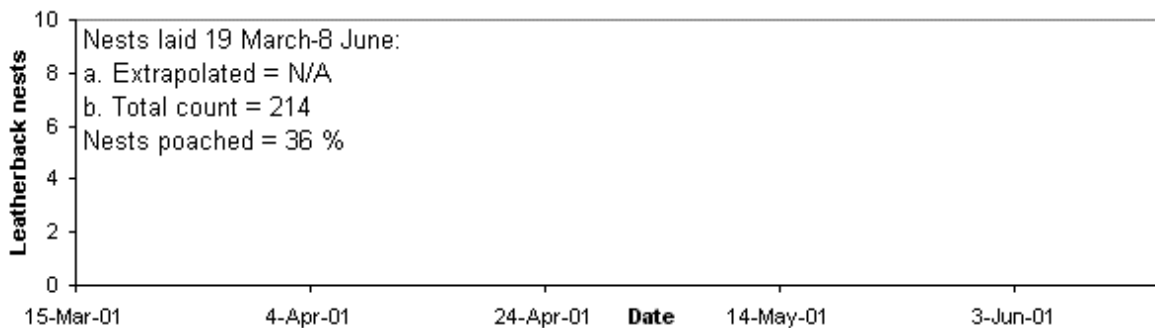


Figure 3. Temperature (°C) at 70 cm depth, border zone.

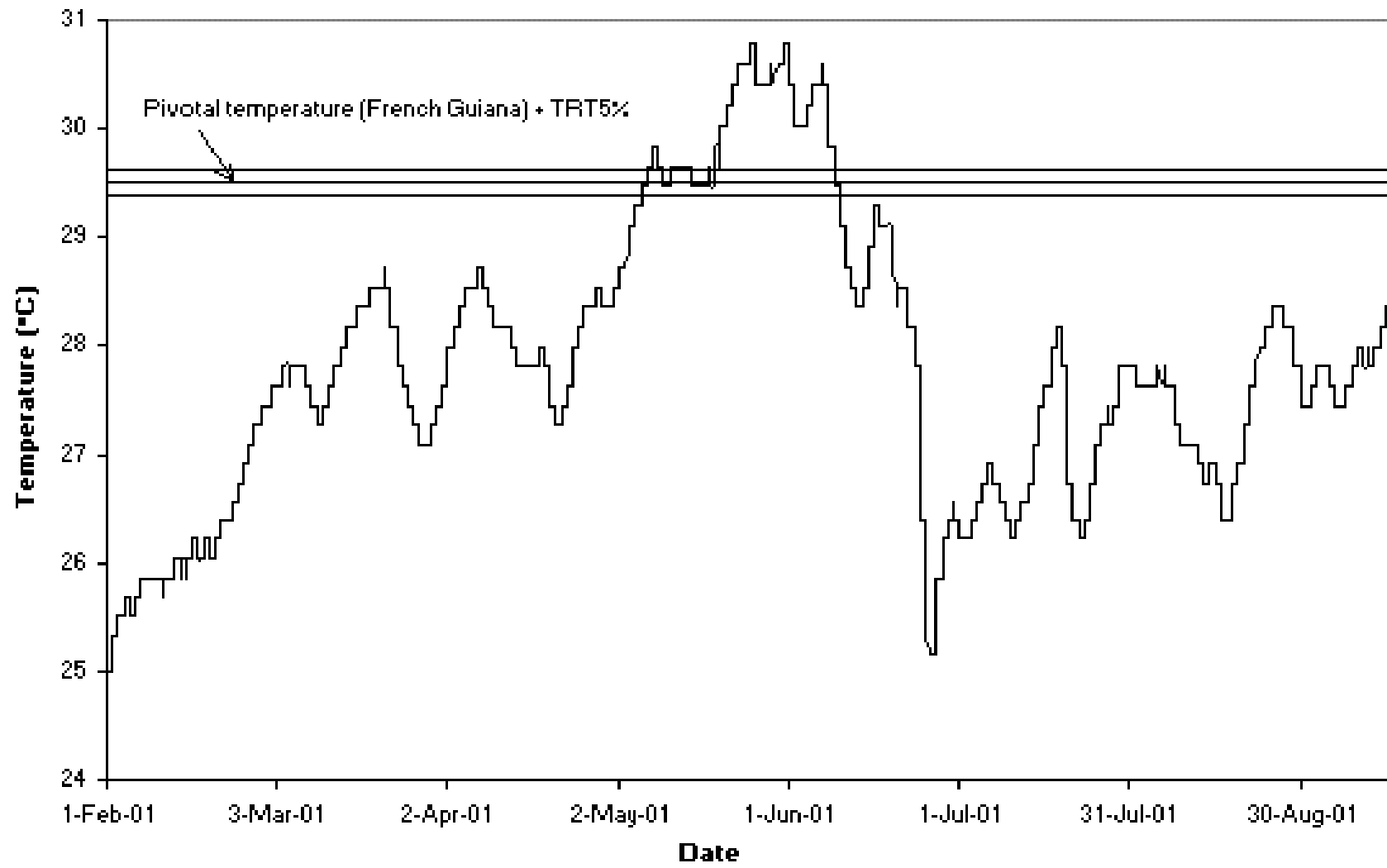
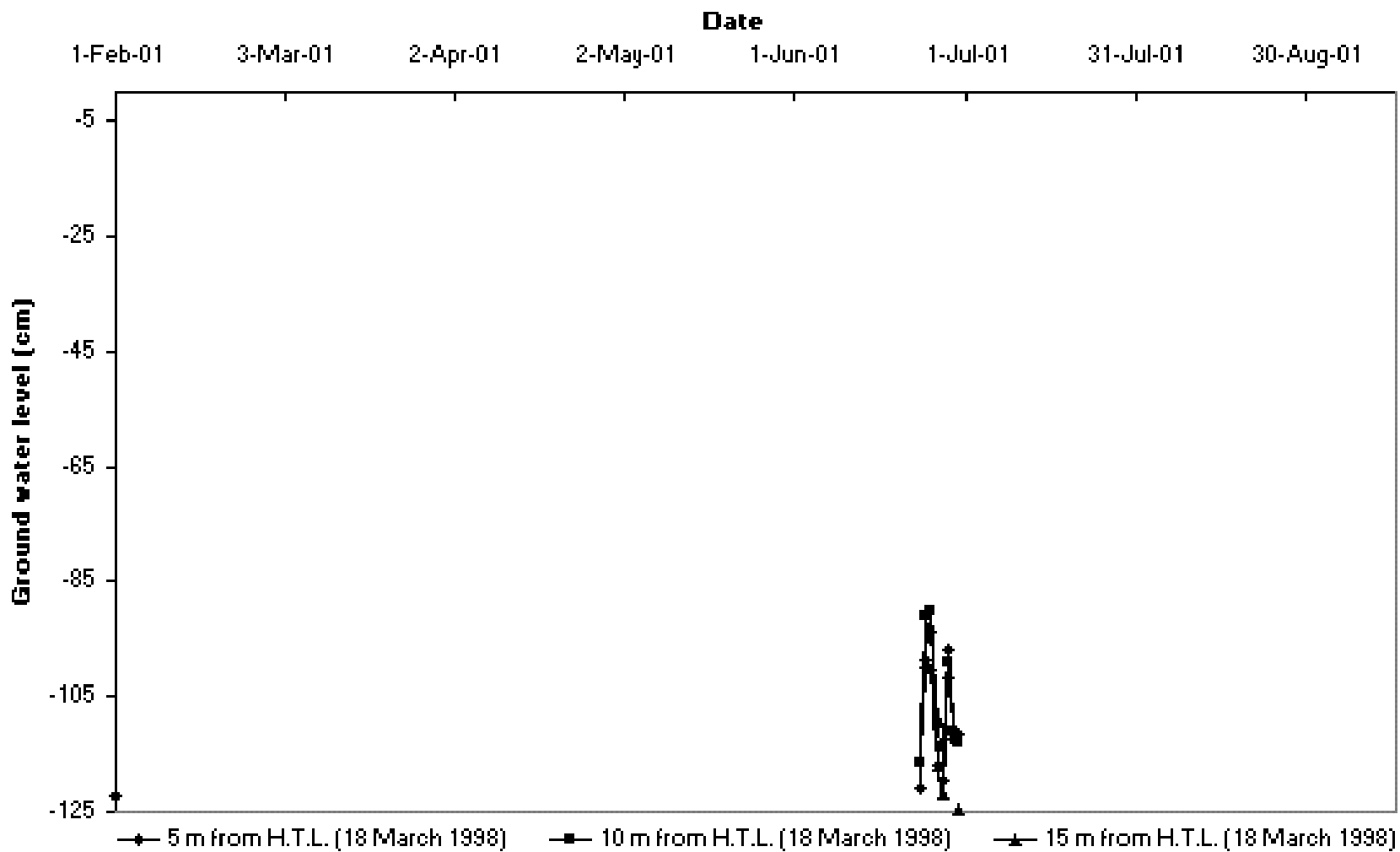


Figure 4. Ground water level.



APPENDIX 1. SEA TURTLE ENCOUNTERS.

Date	Leatherbacks				Greens			Hawksbills		Loggerhead	
	Newly tagged turtles	Previously tagged turtles	Renesters	Total	Newly tagged turtles	Renesters	Total	Newly tagged turtles	Total	Newly tagged turtles	Total
13-Mar-01	1			1			0		0		0
14-Mar-01				1	1		1		0		0
15-Mar-01				1			1		0		0
16-Mar-01				1			1		0		0
17-Mar-01				1			1		0		0
18-Mar-01				1			1		0		0
19-Mar-01		1		2	1		2		0		0
20-Mar-01		1		3			2		0		0
21-Mar-01				3			2		0		0
22-Mar-01		1		4	2		4		0		0
23-Mar-01		2		6	1		5		0		0
24-Mar-01	1			7			5		0		0
25-Mar-01		1		8			5		0		0
26-Mar-01	5	2		15			5		0		0
27-Mar-01				15			5		0		0
28-Mar-01	2			17	2		7		0		0
29-Mar-01				17			7		0		0
30-Mar-01				17			7	1	1		0
31-Mar-01	1			18			7		1		0
01-Apr-01		1	1	20			7		1		0
02-Apr-01		2		22			7		1		0
03-Apr-01	1	2		25		1	8		1		0
04-Apr-01	2			27	4		12		1		0
05-Apr-01			1	28	1		13		1		0
06-Apr-01	2	2		32		1	14		1		0
07-Apr-01	2	2		36	1		15		1		0
08-Apr-01	4	1		41			15		1		0
09-Apr-01	1	1	1	44	1		16		1		0
10-Apr-01		3	1	48	1		17		1		0
11-Apr-01				48			17		1		0
12-Apr-01	2			50			17		1		0
13-Apr-01		1	1	52			17		1		0
14-Apr-01				52			17		1		0
15-Apr-01	3			55			17		1		0
16-Apr-01	5	1	2	63	2		19		1		0
17-Apr-01	1			64			19		1		0
18-Apr-01	1	1		66	3		22		1		0
19-Apr-01		1	1	68			22		1		0
20-Apr-01	1			69			22		1		0
21-Apr-01	2	3	1	75			22		1		0
22-Apr-01	2		1	78			22		1		0
23-Apr-01	2	3		83			22		1		0
24-Apr-01	2		2	87			22		1		0
25-Apr-01	1	1		89			22		1		0
26-Apr-01		1		90			22		1		0
27-Apr-01			1	91			22		1		0

28-Apr-01	1		1	93			22		1		0
29-Apr-01			1	94			22		1		0
30-Apr-01	1		1	96			22		1		0
01-May-01		1		97			22		1		0
02-May-01			2	99			22		1		0
03-May-01	1		1	101			22		1		0
04-May-01	2	1		104		1	23		1		0
05-May-01	1			105			23		1		0
06-May-01	5	1	1	112			23		1		0
07-May-01	3	2		117			23		1		0
08-May-01	1			118			23		1		0
09-May-01	2	3		123	1		24		1		0
10-May-01				123			24		1		0
11-May-01			1	124			24		1		0
12-May-01		1	3	128			24		1		0
13-May-01	1			129			24		1		0
14-May-01				129			24		1		0
15-May-01		1	1	131			24		1		0
16-May-01	1	4	2	138			24		1		0
17-May-01			1	139			24		1		0
18-May-01		1	2	142			24		1		0
19-May-01			1	143			24		1		0
20-May-01				143			24		1		0
21-May-01			1	144			24		1		0
22-May-01	1		1	146	1		25		1		0
23-May-01			1	147			25		1		0
24-May-01	3			150			25		1	1	1
25-May-01				150			25	1	2		1
26-May-01				150			25		2		1
27-May-01	2		1	153			25		2		1
28-May-01	1			154			25		2		1
29-May-01		1		155			25		2		1
30-May-01			1	156			25		2		1
31-May-01			1	157			25		2		1
01-Jun-01				157			25		2		1
02-Jun-01			1	158	1		26		2		1
03-Jun-01			2	160			26	1	3		1
04-Jun-01				160			26		3		1
05-Jun-01			1	161			26		3		1
06-Jun-01				161			26		3		1
07-Jun-01				161			26		3		1
08-Jun-01				161			26		3		1
09-Jun-01				161			26		3		1
10-Jun-01				161	1		27	1	4		1
11-Jun-01				161			27		4		1
12-Jun-01				161			27		4		1
13-Jun-01			1	162	2		29		4		1
14-Jun-01				162			29		4		1
15-Jun-01				162			29		4		1
16-Jun-01				162			29	1	5		1
Total	70	50	42	162	26	3	29	5	5	1	1

APPENDIX 2: Observations and Anecdotal Information on Illegal Harvest

Information from several sources indicate that most poaching of eggs and nesting turtles during the 2001 Leatherback Program was carried out by an organized group based somewhere between Parismina and Jalova lagoon. The presence of Coast Guards along the beach section south of the Parismina river mouth clearly discouraged poaching and may have forced poachers to the north, to the beach section between Parismina and Jalova lagoon. According to reports, most of the leatherback and green turtle eggs as well as green turtle meat is being sold outside of the Tortuguero-Parismina area, in towns such as Matina, Siquirres and Limón.