

REPORT
ON THE 2002 LEATHERBACK PROGRAM
AT TORTUGUERO, COSTA RICA



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EXECUTIVE SUMMARY

Monitoring and Research Activities Conducted

1. A total of 21 track surveys between the Tortuguero river mouth and Jalova lagoon were conducted by CCC track surveyors between February and July 2002.
2. Peak nesting was registered 11 June when 15 fresh leatherback nests were recorded.
3. The Field Coordinator and the RAs conducted a total of 30 track surveys between the Tortuguero and Parismina rivermouths between 18 March and 13 June 2002. Minimum poaching levels were estimated at 13.0 % for leatherback nests and 1.6 % for green turtle nests.
4. Comparison between the leatherback nest estimate extrapolated from approximately weekly track surveys by the CCC track surveyor and total counts by the Field Coordinator and RAs shows that both methodologies result in very similar estimates, 782 and 779 leatherback nests respectively laid between Tortuguero rivermouth and Jalova lagoon between 18 March and 13 June 2002.
5. A total of 46 leatherback turtles were newly tagged, 72 leatherback turtles with tags from previous years and/or other nesting beaches and 54 renesting leatherback turtles were encountered during 1,181 hours of night patrols between 6 March and 14 June 2002. In addition, 99 green turtles were newly tagged, 8 previously tagged green turtles, 3 green turtle reneesters and 4 hawksbill turtles were newly tagged during the night patrols.
6. A total of 61 % of female leatherback turtles were previously tagged. Previously tagged leatherbacks (n=72) were originally tagged on the beaches of Tortuguero (n=25), Parismina (n=1), Pacuare/Mondonguillo (n=35), Lagunas de Urpiano/Matina (n=3), Gandoca/Manzanillo (n=4), San San/Panama (n=1), Soroptka/Panama (n=2) and Playa Bluff/Playa Larga/Panama (n=1).
7. A total of 4 % (n=2) of newly tagged leatherback turtles (n=46) showed evidence of old tag holes or notches when they were encountered for the first time during the program.
8. A total of 91.8 % of encountered leatherback turtles laid eggs in the open beach zone (n=157), 0.6 % nested in the border zone (n=1) and 7.6 % did not lay eggs (n=13).
9. Mean carapace length (CCL_{min}) for leatherback turtles (n=114) was 154.5 cm and mean clutch size was 81 normal eggs and 28 yolckless eggs.
10. Mean carapace length (CCL_{min}) for green turtles (n=107) was 105.5 cm and for hawksbill turtles (n=4) 87.0 cm.
11. Precision of the CCL_{min} measurement during the same encounter was 0.6 cm for leatherback turtles and 0.4 cm for green turtles.
12. Precision of the CCL_{min} measurement for leatherback turtles measured during more than one encounter was 1.3 cm for two encounters, 2.7 cm for three encounters and 2.2 cm for four and five encounters.
13. A total of 18 leatherback nests were marked and monitored. One nests was excluded from analysis as the fate of the nest could not be determined with certainty.
14. Overall hatching success for monitored leatherback nests was 24.4 % and overall emerging success was 18.0 %.
15. Mean distance between the sand surface and the top egg at the time of excavation for undisturbed leatherback nests (n=6) was 58 cm and mean distance between the sand surface and the bottom of the eggchamber for the same nests was 80 cm.

16. The incubation period for monitored leatherback nests for which emerging was observed (n=3) varied between 62-65 days with a mean of 63 days.
17. Eggs containing deformed embryos accounted for 0.18 % of leatherback eggs in undisturbed and washed over nests.
18. Rainfall was heaviest in May (721.2 mm) and March was the month with least rain (225.2 mm).
19. Mean minimum air temperature was lowest in January (24.2°C) and highest in June (25.8°C), mean maximum air temperature was lowest in August (29.8°C) and highest in April (33.6°C) and September (33.7°C).
20. Mean monthly sand temperatures were lowest in January and February and highest in April and June.
21. A total of 45,232 visitors paid to enter Tortuguero National Park in 2001.
22. Data from the CCC Natural History and Visitors Center indicate that visitation decreased after 11 September 2001 but that by June 2002 levels had returned to normal and may even have increased since.
23. Hotels and cabins in the Tortuguero area slightly increased their capacity in 2002.
24. The number of artificial lights visible from the beach has increased behind the airport (mile 1 1/8-1 2/8) and in front of the village (mile 2 6/8-3 3/8).
25. All dead turtles encountered during the 2002 Leatherback Program were green turtles killed by jaguars (n=18) or taken by poachers (n=2).

Conclusions

1. Protective plastic bags considerably increase the lifetime of handheld radios.
2. The two methods employed to calculate the number of leatherback nests laid between the Tortuguero rivermouth and Jalova lagoon result in very similar estimates.
3. Increased park rangers patrols by ATV and boat resulted in decreased poaching.
4. Poaching is higher outside than inside of Tortuguero National Park.
5. The Field Coordinator's and RAs' dedicated efforts resulted in more leatherback and green turtle encounters being logged during the 2002 Leatherback Program than during any previous leatherback nesting season.
6. It appears that metal flipper tags have an acceptable retention time in Tortuguero leatherback turtles.
7. Mean carapace length appears to have increased slightly in 2002.
8. High tides and rough seas washed out many leatherback nests but overall hatching success was similar to previous years.
9. The occurrence of deformed embryos is a cause for concern.
10. As a result of varying sand temperatures during the leatherback nesting season it is likely that both male and female hatchlings were produced.
11. Tourism in Tortuguero appears to be increasing, bringing economic benefits to more people.
12. Jaguars prefer killing and feeding on green turtles rather than on leatherback turtles.
13. A more formalized sea turtle education program aimed at the Tortuguero School and High School would be beneficial.

Recommendations

1. Protective plastic bags should be purchased for future programs.
2. Three mile markers should be placed at each beach section. Two should be painted with the mile number.
3. Beach sections with little institutional presence need increased park ranger or coast guard patrols during the leatherback nesting season.
4. A joint database for all leatherback tagging projects along the Caribbean coast of Costa Rica and Panama should be pursued.
5. Monitoring of carapace length of female leatherback turtles should be a priority.
6. Leatherback nests should not be relocated in Tortuguero.
7. Research is needed to determine any correlation between deformed embryos and agricultural chemicals in the beach.
8. TidBit dataloggers with protective casings should be bought when dataloggers need replacement.
9. The Costa Rican Electricity Institute should be encouraged to continue shading street lights in Tortuguero.
10. Any datasharing that can be provided to jaguar researchers should be encouraged.
11. An attempt should be made to have at least one Tortuguero youth participating as a research assistant in each future leatherback program.

1. INTRODUCTION

Sea turtle research and conservation was initiated in Tortuguero in 1955 (Carr *et al.* 1978). Caribbean Conservation Corporation (CCC) began an annual leatherback (*Dermochelys coriacea*) program in Tortuguero in 1995 (Campbell *et al.* 1996). 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*". CCC staff and Scientific Advisory Committee revised the monitoring protocol in preparation for the 1998 Leatherback Program. The 2002 Leatherback Program represents the eighth consecutive leatherback program and the fifth year of implementing the new monitoring protocol.

The objectives of this report are to summarize the results of the 2002 Leatherback Program and to provide recommendations for future sea turtle programs, conservation efforts and research activities in Tortuguero.

2. METHODS

2.1 Preparations

The Field Coordinator arrived in Tortuguero the first week of March to prepare for the 2002 Leatherback Program. The Research Assistants (RAs) arrived in Tortuguero on 11 March 2002. During the first week of the 2002 Leatherback Program, RAs received training in sea turtle biology and conservation, and the monitoring protocol was explained in detail. RAs also received practical training in sea turtle tagging, nest marking and other data collection from the Field Coordinator and the Scientific Director. In addition to practise night patrols along beach sections close to the field station, training was also conducted between Jalova lagoon and mile 14 on 15-16 March.

The positions of mile markers along the 22 miles of beach between the Tortuguero and Parismina river mouths were verified using a 300 feet fiberglass measuring tape. Mile markers were located every 1/8 of a mile between the Tortuguero river mouth (mile $-3/8$) and mile 5 and every 4/8 mile between mile 5 and the Parismina rivermouth (mile $21\ 4/8$). Three markers were put up in every location and the marker closest to the vegetation was painted white with the marker number in black.

2.2 Track Surveys

Track surveys between the Tortuguero river mouth and Jalova lagoon were conducted approximately weekly by CCC track surveyor Eddy Rankin. However, due to the track surveyor experiencing knee problems, the Scientific Director had to conduct two surveys and all surveys were conducted by new CCC track surveyor Roberto Rankin from 11 June onwards. Track surveys started at Tortuguero village at 4:30 AM - 5:00 AM and were completed at Jalova lagoon at approximately 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. Surveys conducted by the Scientific Director began at the Tortuguero rivermouth at 5:00 AM and terminated at Jalova lagoon at approximately 10:30 AM. Only sea

turtle tracks from the previous night were counted. Notes were also kept on the number of turtles depredated by jaguars or taken by poachers.

Track surveys were also conducted between the Tortuguero and Parismina river mouths, every 3 days from 18 March to 13 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. On request from the park rangers, marking nests with plastic debris was discontinued as it was felt it may aid poachers in spotting nests from the sea. Instead nests were marked using sticks found on the beach and put in a cross formation over the nest. Notes were also kept on jaguar predation, turtles turned by poachers and the number of poached fresh nests.

2.3 Tagging of Nesting Sea Turtles

Nightly tagging patrols were conducted 6 March-14 June 2002 (with the exception of 7-8, 10, 13-14, 17 March and 28 April). 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*) and hawksbill (*Eretmochelys imbricata*) 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 2002 Leatherback Program include National Band&Tag Company (NBTC) Monel #49 tags no. 79901-11, 79913-24, 79926-34, 79951- 53, 79955-67, 79969-76, 79979, 79981-85, 79987-96, 79998-80000, VA1901-09, VA1911-25, VA1927-28, VA1937-43, VA1951, VA1953-58, and VA1976-78, and Inconel #681 tags no. 92001, 92003-05, 92007-08, 92010-12, 92014-17, 92019-36, 92039-46, 92048, 92050, 92052-60, 92065-72, 92074-95, 92097, 92099-100, 92102, 92104, 92106-21, 92123-40, 92143-53, 92155-56, 92158-61, 92163-76, 92179-90, 92192-97, 92199-205, 92207-09, 92251-56, and 92276-85.

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 were 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 through triangulation even if one piece of flagging tape went missing. Each morning the marked nests were inspected so that the fate of the nest could be determined. Depredation and poaching were 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 (if no hatchling tracks were observed), 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). The PVC pipes were almost washed out by rough seas and had to be relocated to a wider beach section in front of the field station on 1 July 2002.

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

Rosi Valverde Charpentier at the ACTo office in Cuatro Esquinas, Tortuguero provided data on the number of visitors to Tortuguero National Park 1999-2001.

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 on 19 March, 15 April and 15 May 2002. 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

An effort was made to identify suitable candidates for RA positions in the Tortuguero community. 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

Heavy rainfall in early May and late June coupled with rough seas resulted in several of the mile markers being washed out to sea.

3.2 Track Surveys

Leatherback nesting was observed from late February to late June (Figure 1) but is likely to have continued at very low levels at least until early July (pers. obs.). Leatherback nesting was most intense during the month of May.

Poaching affected a minimum of 13.0 % of leatherback nests and 1.6 % of green turtle nests (Table 1) which is a decrease in comparison with poaching levels during previous years. Poaching levels for leatherback nests at all beach sections within Tortuguero National Park were kept at a minimum of 10 % or less (Figure 2a-c) but the beach section outside the National Park, between Jalova lagoon and the Parismina river mouth was heavily affected by poaching and a minimum of 44 % of recorded leatherback nests were poached (Figure 2d).

The total number of leatherback nests laid 18 March-13 June on each beach section (Figure 2a-d) was estimated by extrapolating the results of approximately weekly surveys to record fresh tracks from the night before, using the trapezoidal rule for approximate integration (Whittaker and Robinson 1967). A comparison of the extrapolated estimates and the results from total count surveys conducted by RAs and the FC every three days shows differences for all surveyed beach sections (Figure 2a-d). However, the total estimated number of leatherback nests laid 18 March-13 June for the three beach sections between Tortuguero river mouth and Jalova lagoon are similar for the two methods (782 nests and 779 nests respectively).

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

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
18 March	68	17	25.0	21	2	9.5
21 March	11	0	0	4	0	0
24 March	29	4	13.8	3	0	0
27 March	20	0	0	6	1	16.7
30 March	13	1	7.7	11	0	0
2 April	37	0	0	15	0	0
5 April	45	4	8.9	5	1	20.0
8 April	19	0	0	7	0	0
11 April	28	4	14.3	15	2	13.3
14 April	36	6	16.7	9	0	0
17 April	42	7	16.7	9	0	0
20 April	43	3	7.0	8	0	0
23 April	39	20	51.3	15	2	13.3
26 April	26	6	23.1	8	0	0
29 April	55	9	16.4	7	0	0
2 May	34	12	35.3	13	3	23.1
5 May	29	12	41.4	3	0	0
8 May	27	2	7.4	4	0	0
11 May	41	3	7.3	4	0	0
14 May	26	8	30.8	5	1	20.0
17 May	40	0	0	4	0	0
20 May	37	5	13.5	5	1	20.0
23 May	26	1	3.8	11	1	9.1
26 May	21	0	0	8	0	0
29 May	28	1	3.6	33	2	6.1
1 June	32	0	0	49	0	0
4 June	40	0	0	119	1	0.8
7 June	30	1	3.3	135	0	0
10 June	26	0	0	282	0	0
13 June	22	0	0	319	1	0.3
Total	970	126	13.0	1137	18	1.6

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

3.3 Tagging of Nesting Sea Turtles

In total, 1,181 team hours of night patrols were conducted between 6 March and 14 June 2002. During these patrols a total of 172 leatherback encounters, 110 green and 4 hawksbill turtle encounters were recorded (Appendix 1). This is equal to a mean of 0.146 leatherback, 0.093 green and 0.003 hawksbill turtles encountered per patrol hour.

The sea turtles encountered correspond to 118 individual female leatherback turtles, 107 female green turtles and four female hawksbill turtles. A total of 61 % of female leatherback turtles were tagged previously to being encountered for the first time during the 2002 nesting season. Previously tagged leatherback turtles (n=72) were originally tagged on the beaches of Tortuguero (n=25), Parismina (n=1), Pacuare/Mondonguillo (n=35), Lagunas de

Urpiano/Matina (n=3), Gandoca/Manzanillo (n=4), San San/Panama (n=1), Soroptka/Panama (n=2) (C. Ordoñez pers. comm.) and Playa Bluff/Playa Larga/Panama (n=1).

Only 4 % (n=2) of newly tagged leatherback turtles (n=46) showed evidence of holes or notches from lost tags when they were encountered for the first time during the 2002 Leatherback Program.

A total of 91.8 % of encountered leatherback turtles nested in the open beach zone (n=157), 0.6 % nested in the border zone (n=1) and 7.6 % did not lay eggs (n=13).

3.4 Biometric Data Collection

Leatherback turtles with complete and incomplete caudal projections were compared and found not to be significantly different (two-tailed t-test $p > 0.05$, Mann-Whitney test $p > 0.05$). Hence, data for the two categories were pooled to yield a total sample size of 114 female leatherback turtles with a mean carapace length (CCLmin) of 154.5 cm (Table 2).

Leatherback nests for which the eggs were counted during laying had a mean clutch size of 81 normal eggs and 28 yolkless eggs (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	110	154.7 ± 6.5	64	81 ± 18	28 ± 14
Incomplete	4	148.3 ± 5.6	3	80 ± 12	41 ± 12
Total	114	154.5 ± 6.6	67	81 ± 17	28 ± 14

Leatherback turtles sighted more than once (n=40) had their caudal projection consistently identified as complete (n=37) in 92.5 % of cases, and varyingly as complete and incomplete (n=3) in 7.5 % of cases.

The mean carapace length (CCLmin) for green turtles encountered during the 2002 Leatherback Program was 105.1 cm and 34 clutches for which egg counts were conducted contained a mean of 110 eggs (Table 3). The four hawksbill turtles that were measured had a mean carapace length (CCLmin) of 87.0 cm and the three hawksbill clutches that were counted had a mean of 149 eggs (Table 3).

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

Species	Carapace length		Clutch size	
	n	× CCLmin (cm) ± S.D.	n	× eggs ± S.D.
Green	107	105.1 ± 5.1	34	110 ± 31
Hawksbill	4	87.0 ± 4.8	3	149 ± 16

The precision of the CCLmin measurement during the same encounter was higher for green turtles (a mean of 0.4 cm) than for leatherback turtles (a mean of 0.6 cm) (Table 4a).

The precision of the CCLmin carapace measurements for leatherback turtles measured during more than one encounter was 1.3 cm for two encounters, 2.7 cm for three encounters and 2.2 cm for four and five encounters (Table 4b).

Table 4a. Precision of carapace measurements.

Species	n	\bar{x} precision for CCLmin (cm) \pm S.D.
Leatherback	159	0.6 \pm 0.6
Green	110	0.4 \pm 0.6

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

Encounters	n	\bar{x} precision for CCLmin (cm) \pm S.D.	Range (cm)
2	31	1.3 \pm 0.7	0.4 - 4.1
3	4	2.7 \pm 2.4	0.6 - 6.1
4	1	2.2 \pm N/A	N/A
5	1	2.2 \pm N/A	N/A

3.5 Determination of Nest Survivorship and Hatching Success

A total of 18 leatherback nests were marked between 16 March and 25 June 2002. The fate of one of the nests could not be determined with certainty and hence the nest was excluded from further analysis. The fate, hatching and emerging success of marked and monitored leatherback nests are summarized in Table 5.

The distance from the sand surface to the top egg at the time of excavation for undisturbed nests (n=6) varied between 33-105 cm with a mean of 58 cm. The distance from the sand surface to the bottom of the egg chamber for the same nests varied between 58-118 cm with a mean of 80 cm.

The incubation period for monitored leatherback nests for which emerging was observed (n=3) varied between 62-65 days with a mean of 63 days.

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

Fate	n	% of total	Hatching success (%)	Emerging success (%)
<i>Undisturbed</i>				
1. Undisturbed	6	35.3	53.3	44.1
<i>Disturbed</i>				
2. Washed over	2	11.8	48.1	23.4
3. Washed out	9	52.9	0	0
TOTAL	17	100	24.4	18.0
(4. Unknown	1)			

If it is assumed that the mean number of eggs per excavated nest (68.3 eggs/nest) is representative for all leatherback nests then the total number of eggs for all marked nests equals 1,161 eggs (68.3 x 17). Therefore, overall hatching success was 24.4 % for monitored leatherback nests (283 empty shells from 1,161 eggs). Using the same assumptions, emerging

success for monitored leatherback nests is estimated at 18.0 % (209 emerged hatchlings from 1,161 eggs in 17 nests).

All monitored leatherback nests that were washed out (n=9) were located within 11.55 m of the high tide line at the time of oviposition. However, 4 monitored leatherback nests laid within 11.55 m of the high tide line hatched and emerged undisturbed, including one nests that was located only 2.1 m from the high tide line at the time of oviposition.

Eggs containing deformed embryos accounted for 0.18 % of eggs in leatherback nests that were undisturbed or washed over (Table 6b).

Table 6a. Results of nest excavations.

Fate	Empty Shells eggs	Pipped hatchlings	Live hatchlings	Dead hatchlings	Unhatch. No embryo	Unhatch. Embryo	Unhatch. Full embryo	Depredated	Total eggs	\bar{x} eggs/nest
Marked nests										
1	209	17	1	35	70	39	54	3	392	65.3
2	74	0	2	36	63	8	9	0	154	77.0
3	0	0	0	0	0	0	0	0	?	?
ALL	283	17	3	71	133	47	63	3	?	68.3

Fate 1=Undisturbed, 2=Washed over, 3=Washed out

Table 6b. Incidence of deformed leatherback embryos.

	n	% of eggs
Deformed embryos	1	0.18
TOTAL	1	0.18

3.6 Physical Data Collection

Rainfall during the months with leatherback nesting (February-July) was heaviest in May (Table 7). March was the month with least rain (Table 7).

Table 7. Rainfall, December 2001-September 2002.

Month	Total rainfall (mm/month)	\bar{x} rainfall (mm/24hrs)
December	929.3	30.0
January	848.8	27.4
February	296.8	10.6
March	225.2	7.3
April	253.0	8.4
May	721.2	23.3
June	595.9	19.9
July	713.4	23.0
August	763.4	24.6
September	181.0	6.0

*Data for 48 hours for 3-4 January, 16-17, 18-19, 20-21 March, 16-17 April, 17-18 May, 29-30 June

**Data for 72 hours for 25-27 June

***Data for 96 hours for 23-26 February

Mean minimum air temperature was lowest in January and highest in June, mean maximum air temperature was lowest in December and highest in April and September (Table 8).

Table 8. Air temperature, December 2001-September 2002.

Month	× minimum temp. (°C) *	× maximum temp. (°C) *
December	24.4	29.1
January	24.2	30.3
February	24.6	32.8
March	25.4	33.2
April	24.9	33.6
May	25.4	31.6
June	25.8	33.2
July	25.0	31.4
August	25.0	29.8
September	25.5	33.7

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

In late June, high tides and rough seas almost washed out the temperature dataloggers located in the open beach zone. Therefore on July 1, the open zone dataloggers were relocated to a wider beach section but remained in the open zone without receiving any shading from the vegetation and at the same depth as before.

There is an inverse relationship between sand temperature and shading from vegetation. In the open zone, the shallow datalogger at 30 cm generally record higher mean temperatures than the dataloggers located at 50 and 70 cm (Table 9). This is not the case in the border and vegetation zones where there is little difference in temperatures recorded by shallow (30 cm) and deep (50 and 70 cm) dataloggers (Table 9). The sand temperature at 70 cm depth in the open beach zone where 91.8 % of leatherback nests were laid is shown in Figure 3.

Table 9. Mean monthly sand temperatures.

Zone	_ Open × temp (°C)			_ Border × temp (°C)			_ Vegetation × temp (°C)		
	30 ^{a,b}	50 ^{a,c}	70 ^a	30	50	70	30	50	70
<i>Depth (cm)</i>									
December	N/A	27.0	N/A	26.2	26.1	25.9	24.8	24.9	24.9
January	N/A	27.5	27.2	26.2	26.1	26.0	24.5	24.6	24.6
February	N/A	28.7	28.6	27.7	27.5	27.3	25.5	25.6	25.7
<i>Retrieval depth (cm) 7 March</i>	N/A	58	74	35	57	75	30	50	70
<i>Depth (cm) 7 March</i>	30	50	70	30	50	70	30	50	70
March	30.4	30.0	29.5	27.7	27.8	27.6	26.1	26.2	26.1
April	31.4	31.1	30.6	27.9	28.2	28.1	26.6	26.7	26.7
May	28.9	28.8	28.5	27.0	27.3	27.4	26.0	26.2	26.3
June	30.9	N/A	30.2	28.5	28.6	28.5	27.0	27.1	27.1
<i>Retrieval depth (cm) 15 June</i>	32	52	74	26	47	73	34	51	70
<i>Depth (cm) 15 June</i>	30	50	70	30	50	70	30	50	70
July	28.4	N/A	27.9	27.1	27.3	27.3	26.1	26.3	26.4
August	27.8	N/A	27.5	26.5	26.9	26.9	25.7	25.9	26.1
<i>Retrieval depth (cm) 25 August</i>	33	50	69						
<i>Retrieval depth (cm) 6 Sept.</i>				39	60	78	28	50	62

^a High tides almost washed out the dataloggers located in the open zone on 1 July so dataloggers were relocated to the open zone on a wider beach section.

^b Data from 7 March onwards

^c No data for 16 June-24 August

The PVC pipes used to measure the ground water level were almost washed out by high tides and rough seas and were relocated on 1 July 2002 to a wider beach section close to the field station. Heavy rains in early May (unusual!) and late June resulted in high ground water levels that could be noted in the PVC pipes (Figure 4). At these occasions, it is likely that the high ground water inundated some leatherback nests. Also, the high tides and rough seas washed out a large proportion of marked and monitored leatherback nests at the same time (Table 5).

3.7 Collection of Human Impact Data

The number of paying visitors coming to Tortuguero National Park has continuously increased since 1999 and totalled 45,232 paying visitors in 2001 (Table 10).

Table 10. Number of Paying Visitors to Tortuguero National Park, 1999-2001.

Year	CR Visitors	Foreign Visitors	Total
1999	5,767	32,863	38,630
2000	5,543	36,354	41,897
2001	6,175	39,057	45,232

Information from ACTo.

The number of visitors to the CCC Natural History and Visitors Center declined after 11 September 2001 but started to increase again in June 2002 (Table 11). August 2002 was the month with the highest mean daily visitation on record (Table 11).

Table 11. Visitors to the CCC Natural History and Visitors Center, January 2000-September 2002.

Month	2000		2001		2002	
	Total	× Per Day	Total	× Per Day	Total	× Per Day
January	1681*	67	1846	60	1756	57
February	2427	84	2277	81	2108	75
March	2582	83	2301	74	2581	83
April	1742	58	2002	67	1738	58
May	1365	44	1208	39	1239	40
June	1437	48	1334	44	1463	49
July	2899	94	2720	88	2673	86
August	2645	80	2858	92	3419	110
September	1871	62	1440	48	2043	68
October	1746	56	1597	52		
November	2215	74	1550	52		
December	1964	63	1472	47		
TOTAL	24574	68	22605	62	19020	70

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

The capacity of both hotels and cabins in the Tortuguero area increased slightly in 2002 (Table 12). The overall room and bed capacity of the hotels is approximately three times the capacity of the cabins.

Table 12. Room and bed capacity of the hotels and cabinas in the Tortuguero area.

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

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

** Located in Caño Palma, operating since 2001

*** Data from 2001

The beach sections with artificial lights remain the same but the number of lights behind the airport (mile 1 1/8-1 2/8) and in front of the village (mile 2 6/8-3 3/8) has increased. The Tortuguero representatives of the Costa Rican Electricity Institute (ICE) demonstrated considerable initiative when in August 2002, they shaded the majority of the village street lights located closest to the beach.

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

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

* Due to high tide the beach was unpassable by mile -1/8 so survey initiated at mile 0.

3.8 Dead Turtles

All dead sea turtles encountered during the 2002 Leatherback Program were female green turtles (Table 14). The majority were nesting turtles killed by jaguars on the beach section between the mile 5 marker and the Juana López path. Also, RAs and the FC registered the remains of two green turtles that had been slaughtered by poachers (Table 14).

Table 14. Dead turtles.

Date	Species	Sex	Mile	Comments
18 March	Cm	F	6 4/8	Jaguar kill (previous night).
21 March	Cm	F	11 4/8	Jaguar kill (previous night).
30 March	Cm	F	12 4/8	Jaguar kill (two nights before).
5 April	Cm	F	14	Jaguar kill (previous night).
8 April	Cm	F	12 4/8	Jaguar kill (previous night).
18 April	Cm	F	13	Jaguar kill reported by park rangers.
23 April	Cm	F	13	Jaguar kill (previous night).
26 April	Cm	F	7 4/8	Jaguar kill (previous night).
29 April	Cm	F	11	Jaguar kill (previous night).
2 May	Cm	F	10 4/8	Jaguar kill (previous night).
10 May	Cm	F	9	Carapace from poached green turtle close to vegetation.
14 May	Cm	F	12 4/8	Jaguar kill (one week before?).
23 May	Cm	F	9 4/8	Jaguar kill.
1 June	Cm	F	5 4/8	Jaguar kill (previous night).
4 June	Cm	F	12 4/8	Jaguar kill (two nights before).
7 June	Cm	F	13	Jaguar kill (previous night).
11 June	Cm	F	7 4/8	Jaguar kill (previous night).
11 June	Cm	F	13	Jaguar kill (previous night).
13 June	Cm	F	8 4/8	Jaguar kill (two nights before).
13 June	Cm	F	0	Poached turtle.

Cm=green turtle

3.9 Environmental Education Activities

One of the RAs in the 2002 Leatherback Program was from the Tortuguero community. Students from the Tortuguero school and high school occasionally participated in tagging patrols during the leatherback program.

4. DISCUSSION

4.1 Preparations

High tides and rough seas washed out many of the mile markers that were put up in March 2002. For future programs, it is therefore suggested that one marker be located at the vegetation line and that the two markers closest to the vegetation are numbered with the respective mile. This arrangement would ensure that at least one marker is located far from the high tide line and at the same time, that there are markers located away from the vegetation line where termites may shorten the lifetime of the wooden posts.

Radio communication with the team working between Jalova lagoon and mile 14 was often difficult. Clear communication with the Jalova ranger station could only be undertaken very close to the river mouth in spite of using new walkie-talkie units. As a long-term goal, it is suggested that taller antennas be installed at the Jalova park ranger station and at the CCC

Field Station in Tortuguero in order to improve communication between beach teams and station personnel. The special plastic radio bags purchased to protect the handheld walkie-talkies from corrosion wore out toward the end of the program. However, the bags served the purpose of protecting the units and it is suggested that new bags are bought for use during the 2003 programs.

4.2 Track Surveys

Leatherback nesting was observed from February through July with peak nesting during the March-June period (Figure 1, pers. obs.). Track surveys conducted by RAs and the FC coincide with the period of heaviest leatherback nesting (Table 1).

The two methods used for estimating the number of leatherback nests show differences for individual beach sections (Figure 2a-c). However, it is encouraging to see that the total estimates for the entire beach between the Tortuguero river mouth and Jalova lagoon, 782 nests for surveys conducted by the track surveyor and 779 nests for surveys conducted by RAs are very similar.

Poaching of leatherback nests was lower during the 2002 Leatherback Program than during previous leatherback turtle nesting seasons. One of the major reasons for the decline in poaching were the increased patrols by park rangers on ATV and boats that were made possible by a Care for the Wild International donation of funds for purchase of additional gasoline. As a result of the early start to the green turtle nesting season, many green turtle nests also benefitted from the increased park ranger patrols and poaching of green turtle nests was remarkably low (Table 1). Similar park ranger patrols must be maintained during future programs to control poaching of leatherback and other sea turtle nests within Tortuguero National Park. Track survey results indicate that the beach section between Jalova lagoon and the Parismina river mouth is most affected by poaching (Figure 2a-d). Although this beach section is located outside of the National Park, it would be highly beneficial if Tortuguero National Park rangers or personnel from the Costa Rican Coast Guard based in Parismina would increase patrols along this beach section in future leatherback nesting seasons. This would not only result in a decrease in poaching along that particular stretch of beach but is also likely to decrease poaching in adjacent beach sections, both within and outside of Tortuguero National Park.

4.3 Tagging of Nesting Sea Turtles

Tagging of nesting sea turtles was carried out from mid-March to mid-June, which coincides with the period of heaviest leatherback nesting (Figure 1). The dedicated efforts of the FC and RAs resulted in more team hours of beach patrols than during any previous leatherback program. The 1,181 hours of beach patrols paid off and more leatherback encounters were registered during the 2002 Leatherback Program than during any previous year (Appendix 1). The record number of leatherback encounters logged during the 2002 Leatherback Program was due to the increase in nightly tagging patrols between Jalova lagoon and mile 14 rather than large numbers of nesting leatherback turtles. Also, the early start to the green turtle nesting meant that more green turtle encounters were logged than during previous leatherback programs (Appendix 1).

The many encountered leatherback turtles originally tagged on other nesting beaches in Caribbean Costa Rica and Panama emphasize the high mobility of nesting leatherback turtles in the region. It also highlights the importance of cooperation between conservation projects and the need to expand activities to the entire coastline. Beach sections with little institutional presence and probably high levels of poaching include Jalova lagoon-Parismina and Lagunas de Urpiano-Moín in Costa Rica.

The low level (4 %) of newly tagged turtles that showed evidence of old tag holes or notches is encouraging and may indicate that flipper tag loss is less of a problem for the Caribbean Costa Rica and Panama leatherback population than for leatherback populations elsewhere (Eckert & Eckert 1989). However, the only way of testing this hypothesis is to compile information from all leatherback tagging projects along the coast and determine the probability of tag loss according to the methodology described by Wetherall (1982).

4.4 Biometric Data Collection

The mean carapace length (CCLmin) for leatherback turtles measured during the 2002 Leatherback Program is slightly larger than during previous programs (Table 2). Future monitoring of CCLmin should be a priority so it may be determined if the increase in mean CCLmin is a result of observer variation or if it represents a change in age or size specific survivorship rates (decreased recruitment of smaller females into nesting population or increased survivorship of larger mature individuals).

4.5 Determination of Nest Survivorship and Hatching Success

A lower number of leatherback nests than normal was marked and monitored. The reason is that fewer nests than normal were laid in the northern 5 2/8 miles where nests are marked. A positive sign is that no poaching of marked leatherback nests was observed (Table 5). However, it is possible that poaching did occur but that rough seas and high tides washed out the beach section where the marked leatherback nests were located so that poaching evidence could not be found. Overall, hatching success was similar to previous years.

It remains clear that the distance between the nest and the high tide line as well as the distance between the nest and the vegetation line can not be used as exact clues for the fate of leatherback nests. The dynamic nature of the Tortuguero beach means that some leatherback nests will be washed out as a result of rapid changes in the beach morphology and that this is not related to nest location at the time of laying. Therefore, relocation of selected leatherback nests does not appear to be a suitable conservation technique for leatherback nests at Tortuguero.

Although only one deformed leatherback embryo was encountered during excavations (Table 6b), it represents 0.18 % of all eggs in undisturbed and washed over nests. Research into the presence of pesticides and other agricultural chemicals in the Tortuguero beach are needed to determine if use of chemicals inland from Tortuguero National Park represents a threat to sea turtle egg and hatchling survival.

4.6 Physical Data Collection

Unusually heavy rains fell in early May 2002 (Table 7). This is a period that is usually amongst the driest months of the year. The heavy rains caused extensive flooding along the Caribbean coast of Costa Rica and Panama.

As a result of the heavy rains, sand temperatures at 70 cm depth in the open beach zone dropped as much as 4°C between 23 April and 20 May (Figure 3). If the pivotal temperature for leatherback turtles nesting at Tortuguero is the same as the estimated pivotal temperature for leatherback turtles in French Guiana (Figure 3; Girondot 1999) then it is probable that both male and female hatchlings were produced during the 2002 leatherback nesting season. Due to the lower temperatures from late June to mid-September, it is likely that many of the late leatherback nests (laid in late June-early July) resulted in predominantly male hatchlings.

The new TidBit datalogger (Onset Computer Corporation) that was placed in a protective casing appears to have recorded temperatures successfully. The protective casing reduces the likelihood of dataloggers failing due to high temperature coupled with high humidity. It is suggested that when dataloggers fail, they are replaced with TidBit dataloggers.

The early May rainfall also raised ground water levels to a point where lowlying leatherback nests may have been inundated (Figure 4).

4.7 Collection of Human Impact Data

According to the results of the Tortuguero Conservation Area (ACTo) monitoring of paying visitors to Tortuguero National Park, tourism is continuing to increase (Table 10). The capacity of hotels and cabins in the Tortuguero area is also increasing (Table 12) which may contribute to more people benefitting economically from ecotourism activities in Tortuguero.

The data from the CCC Natural History and Visitors Center suggest that visitation to Tortuguero declined after 11 September 2001 (Table 11). However, by June 2002 visitation was back to pre-11 September levels and since then it appears that visitation has increased further (Table 11).

The increase in infrastructure and housing in Tortuguero also increases the number of artificial lights, mainly along the beach sections that are already developed (Table 13). It is encouraging to see the efforts made by the Tortuguero workers of the Costa Rican Electricity Institute (ICE) to shade street lights in order to minimize the disorientation of hatchlings.

4.8 Dead Turtles

The relatively low levels of poaching (Table 1) also meant that few slaughtered turtles were encountered (Table 14). However, the jaguars kept killing and eating sea turtles during the 2002 Leatherback Program. The jaguars were selectively killing green turtles even if a greater number of nesting leatherback turtles were present on the beach. Tortuguero Conservation Area biologist Magaly Castro began a more detailed study of jaguars and sea turtle depredation towards the end of the 2002 Leatherback Program.

4.9 Environmental Education Activities

It is suggested that efforts be made to continue the practise of having at least one research assistant position for each sea turtle program filled by a person from Tortuguero. Also, a more formalized sea turtle education program for the Tortuguero School and High School would be highly beneficial and it is anticipated that such a program be implemented during the 2003 Leatherback Program.

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6. RECOMMENDATIONS

6.1 Preparations

- ⇒ Three mile markers should be placed at each beach section. At least two markers should be marked with the mile number, one of them should be placed by the vegetation line and the other on the open beach.
- ⇒ Special rubber radio bags should be bought to protect the handheld walkie-talkies.

6.2 Track Surveys

- ⇒ Beach sections with little institutional presence and high levels of poaching include Jalova lagoon-Parismina and Lagunas de Urpiano-Moín. Increased park ranger or coast guard patrols along these beach sections are desirable during the leatherback nesting season.

6.3 Tagging of Nesting Sea Turtles

- ⇒ A joint database for all leatherback tagging projects along the Caribbean coast of Costa Rica and Panama should be pursued. For example; probability of tag loss could be determined for the Monel #49 tags currently used by all projects.

6.4 Biometric Data Collection

- ⇒ Monitoring of carapace length of female leatherback turtles should be a priority as it may indicate changes in size or age specific survivorship rates.

6.5 Determination of Nest Survivorship and Hatching Success

- ⇒ Leatherback nests should not be relocated as the distance between the high tide line and the nest at the time of laying can not be used as an exclusive cue for hatching or emerging success.
- ⇒ Research is needed to determine if there is any correlation between deformed embryos and presence of agricultural chemicals in the beach.

6.6 Physical Data Collection

- ⇒ TidBit dataloggers with protective casings should be bought when dataloggers need replacement.

6.7 Collection of Human Impact Data

- ⇒ The Costa Rican Electricity Institute should be encouraged to continue shading street lights in Tortuguero.

6.8 Dead Turtles

- ⇒ Any advice or datasharing that can be provided to jaguar researchers should be encouraged.

6.9 Environmental Education Activities

- ⇒ An attempt should be made to have at least one Tortuguero youth participating as a research assistant in each future leatherback program.

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

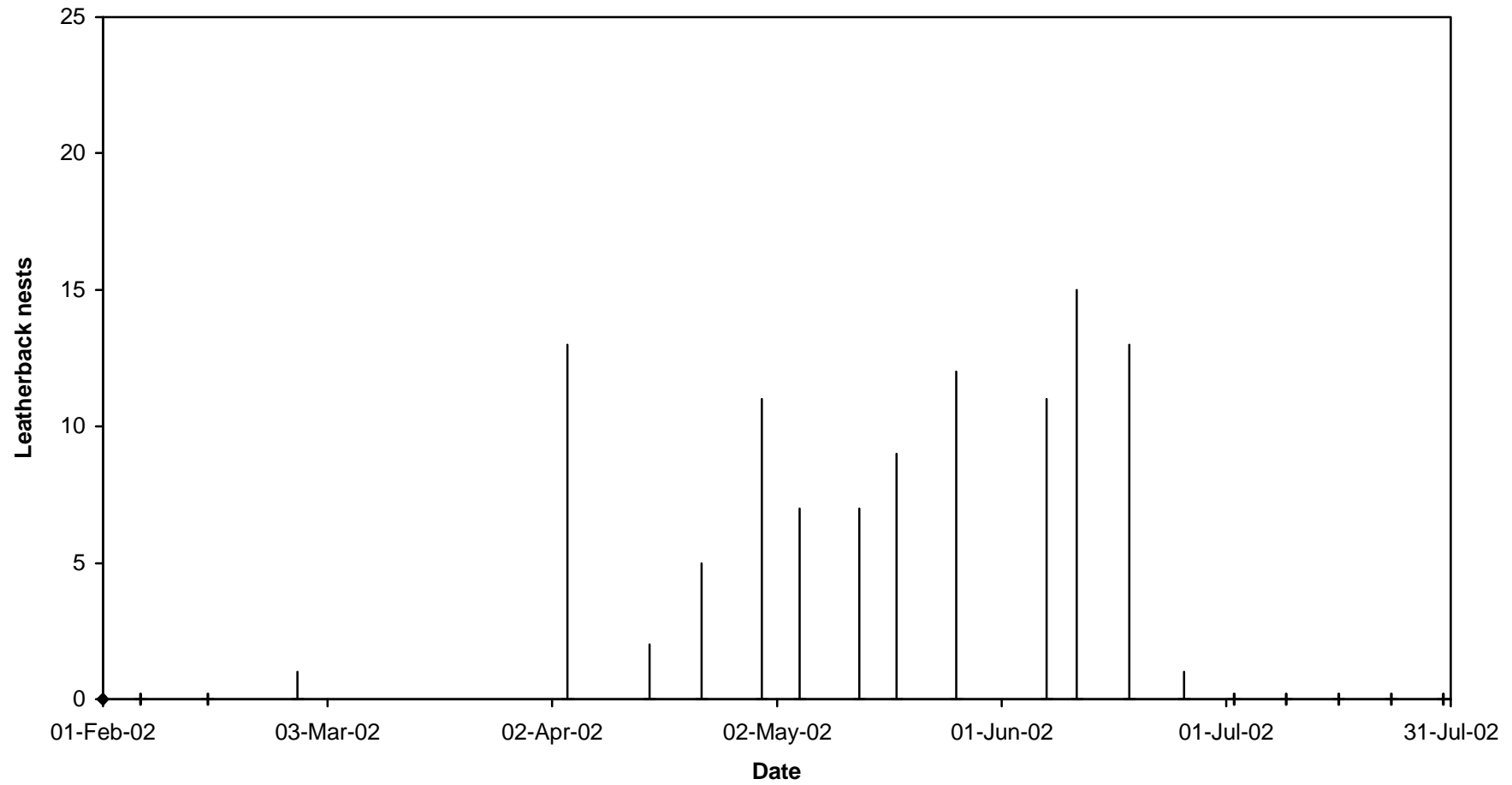


Figure 2a. Leatherback nesting activity from Tortuguero river mouth to the mile 5 marker.

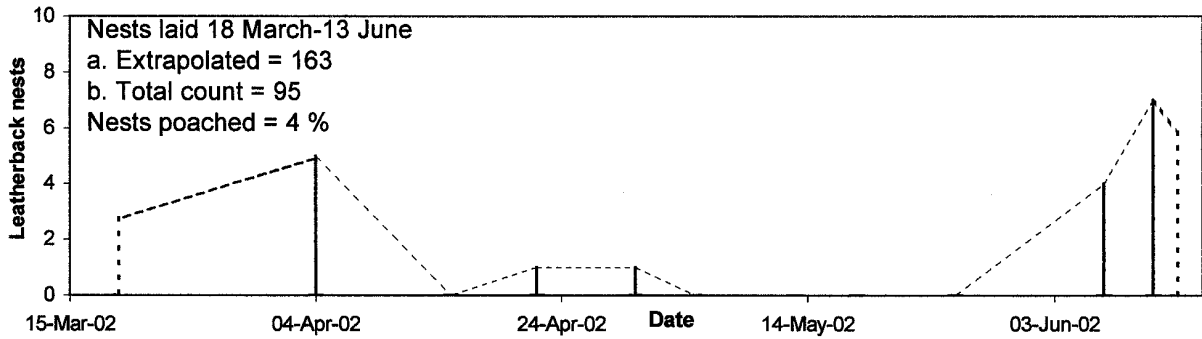


Figure 2b. Leatherback nesting activity from the mile 5 marker to Juana López path.

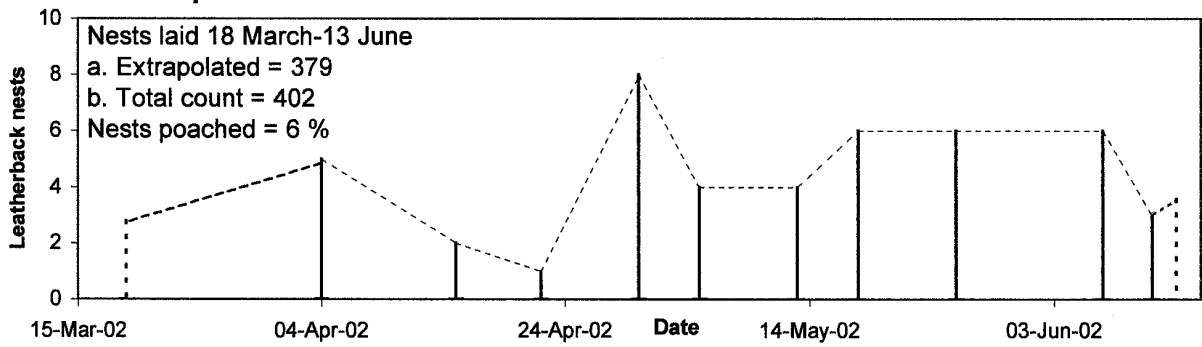


Figure 2c. Leatherback nesting activity from Juana López path to Jalova lagoon.

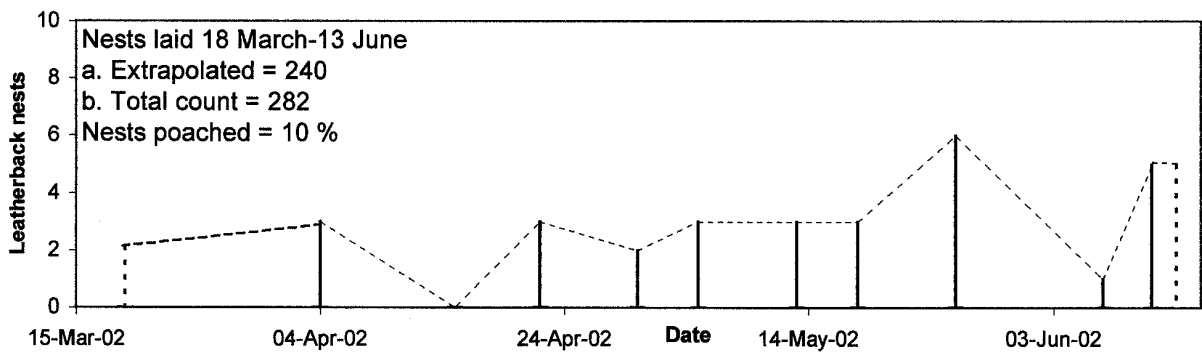


Figure 2d. Leatherback nesting activity from Jalova lagoon to Parismina river mouth.

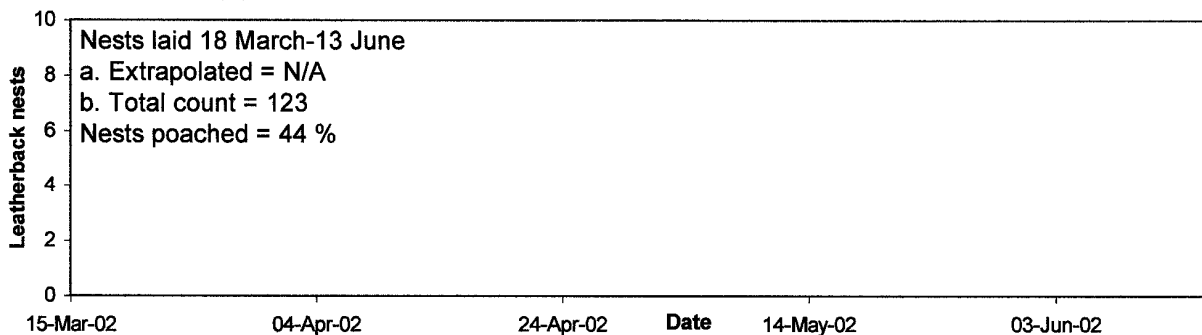


Figure 3. Temperature (°C) at 70 cm depth, open zone.

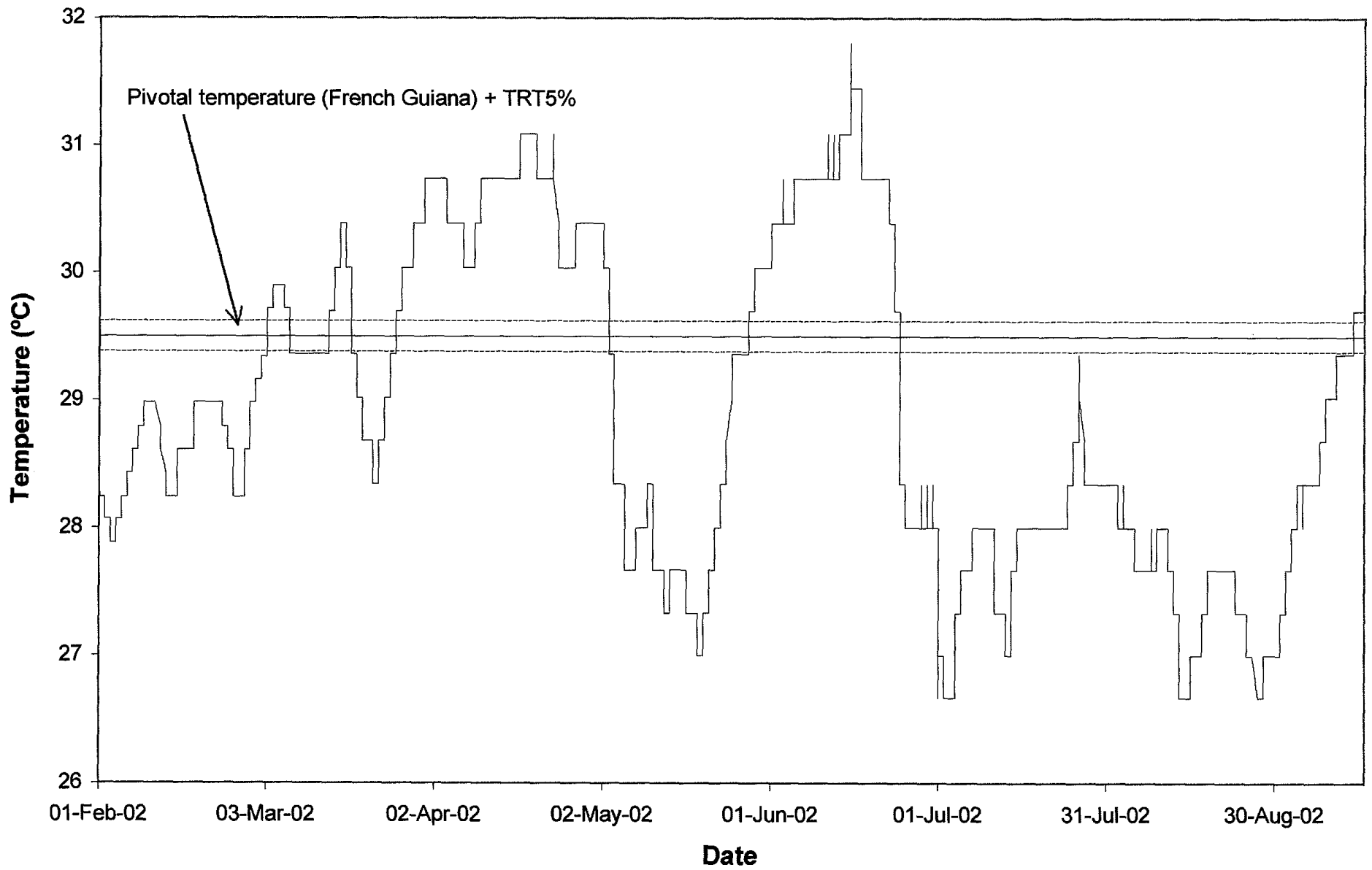
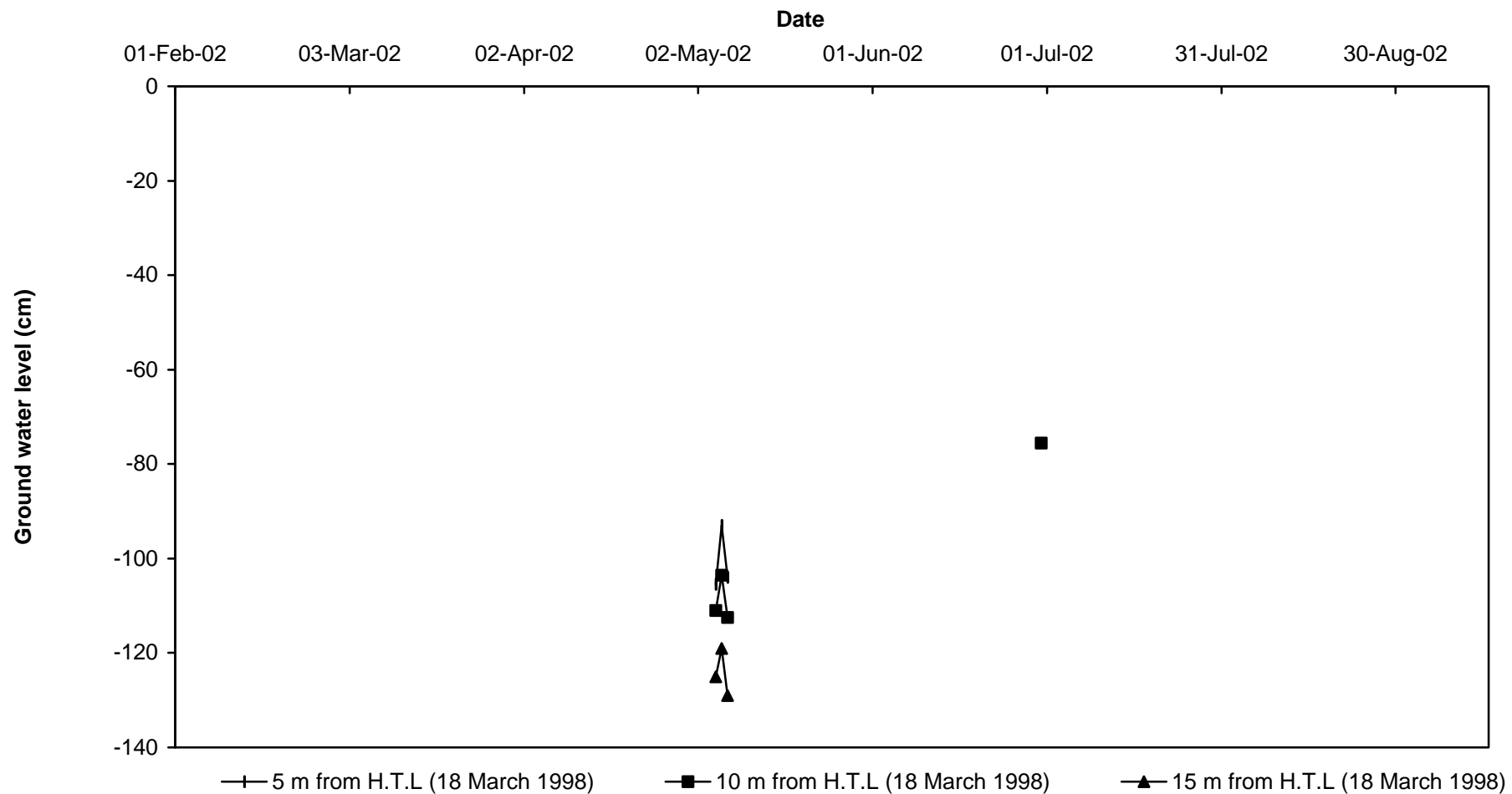


Figure 4. Ground water level.



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

APPENDIX 1. SEA TURTLE ENCOUNTERS.

Date	Leatherbacks				Greens				Hawksbills	
	Newly tagged turtles	Previously tagged turtles	Renesters	Total	Newly tagged turtles	Previously tagged turtles	Renesters	Total	Newly tagged turtles	Total
11-Mar-02				0				0		0
12-Mar-02				0				0		0
13-Mar-02				0				0		0
14-Mar-02				0				0		0
15-Mar-02	2	1		3				0		0
16-Mar-02	2			5				0		0
17-Mar-02				5				0		0
18-Mar-02				5	1			1		0
19-Mar-02		1		6	1			2		0
20-Mar-02				6				2		0
21-Mar-02	2			8				2		0
22-Mar-02	1	3		12				2		0
23-Mar-02				12				2		0
24-Mar-02	1	2		15				2		0
25-Mar-02		2	1	18	1			3		0
26-Mar-02				18				3		0
27-Mar-02	1			19	2			5		0
28-Mar-02				19	1			6		0
29-Mar-02		1		20				6		0
30-Mar-02	1	2		23	1			7		0
31-Mar-02	1	1	3	28	1			8		0
01-Apr-02				28				8		0
02-Apr-02	1	1	2	32				8		0
03-Apr-02	2	1		35				8		0
04-Apr-02		1		36				8		0
05-Apr-02				36	2			10		0
06-Apr-02	1	1		38				10		0
07-Apr-02				38				10		0
08-Apr-02	1	1	1	41				10		0
09-Apr-02	2	1	1	45	1			11		0
10-Apr-02		1		46				11		0
11-Apr-02		2	2	50				11		0
12-Apr-02		1		51	1			12		0
13-Apr-02				51				12		0
14-Apr-02	1	1		53				12		0
15-Apr-02	3	4		60				12		0
16-Apr-02				60				12		0
17-Apr-02	2	2	1	65				12		0
18-Apr-02	3	1	1	70	3			15		0
19-Apr-02				70				15		0
20-Apr-02		1		71			1	16		0
21-Apr-02	1	2		74				16		0
22-Apr-02		1		75				16		0
23-Apr-02			1	76	1			17		0
24-Apr-02		1	1	78				17		0
25-Apr-02				78				17		0
26-Apr-02	2		5	85				17		0

27-Apr-02	1	2	2	90				17		0
28-Apr-02				90				17		0
29-Apr-02	2	1	1	94				17		0
30-Apr-02	2	2	1	99				17		0
01-May-02			1	100				17		0
02-May-02	1	1		102	1			18		0
03-May-02			3	105				18		0
04-May-02				105				18		0
05-May-02			1	106				18		0
06-May-02			1	107				18		0
07-May-02				107				18		0
08-May-02		1	1	109				18		0
09-May-02				109				18		0
10-May-02	1		1	111				18		0
11-May-02		1		112				18	1	1
12-May-02				112				18		1
13-May-02				112				18		1
14-May-02		3	1	116				18		1
15-May-02		3	1	120				18		1
16-May-02				120				18		1
17-May-02	2	1	1	124	1			19		1
18-May-02		1	1	126	2			21		1
19-May-02			1	127				21		1
20-May-02		1	1	129				21		1
21-May-02		1	2	132				21		1
22-May-02			1	133				21		1
23-May-02	1		2	136				21		1
24-May-02		1	1	138				21		1
25-May-02				138				21		1
26-May-02		1	2	141	3			24		1
27-May-02			1	142	3			27	1	2
28-May-02		1		143				27		2
29-May-02		1	3	147	2			29		2
30-May-02		3		150	1			30		2
31-May-02				150	1			31	1	3
01-Jun-02	1		1	152	6			37		3
02-Jun-02	1	2	3	158	5	2		44		3
03-Jun-02		1		159	1			45		3
04-Jun-02		2		161	4			49		3
05-Jun-02		1		162	3	2		54		3
06-Jun-02	1			163	1	1		56		3
07-Jun-02	1			164	11			67		3
08-Jun-02		1		165	7		2	76		3
09-Jun-02	2			167	1	1		78		3
10-Jun-02		2	1	170	4			82		3
11-Jun-02				170	4	1		87		3
12-Jun-02		1		171	3			90		3
13-Jun-02		1		172	8	1		99		3
14-Jun-02				172	11			110	1	4
Total	46	72	54	172	99	8	3	110	4	4

APPENDIX 2: Observations and Anecdotal Information on Illegal Harvest

Poaching levels were lower during the 2002 Leatherback Program than during previous leatherback nesting seasons at Tortuguero. However, there still appears to remain an active group outside Tortuguero whose members are dedicated to poaching of sea turtles and their eggs. Since the Costa Rican Coast Guard initiated conservation activities and beach patrols along the beach section south of the Parismina river mouth, it seems like the major focus for poachers is the beach section between Jalova lagoon and the Parismina river mouth. This stretch is outside of Tortuguero National Park and track surveys indicate that poaching is higher along this beach section than elsewhere (Figure 2a-d).

According to local sources, the organized group involved in turtle and egg poaching has access to fast boats and attempt to visit the beach within Tortuguero National Park every couple of days during the leatherback nesting season. The eggs and green turtles that are poached are then transported out of the area, mainly to the city of Limón. Eggs are sold for approximately ₡150/egg (~US\$0.40) by persons that walk from bar to bar in Limón offering eggs for sale to customers frequenting the bars. Green turtle meat is sold by persons that walk around residential neighbourhoods in Limón offering meat for sale or through personal contacts.