

REPORT

ON THE 1999 LEATHERBACK PROGRAM

AT TORTUGUERO, COSTA RICA

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and
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by

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1. INTRODUCTION

Caribbean Conservation Corporation (CCC) has organized an annual leatherback (*Dermochelys coriacea*) program in Tortuguero since 1995. In 1998, the monitoring protocol was revised by CCC staff and Scientific Advisory Committee. The 1999 Leatherback Program represents the fifth consecutive nesting season of leatherback monitoring and the second 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 1999 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 Coordinator (RC) and Research Assistants (RAs) arrived in Tortuguero 12-15 March 1999. During the first days the RAs were given lectures in sea turtle biology and the monitoring protocol was explained in detail. The RAs also received training in nest marking, tagging and data collection during the first nights. Most of the training was conducted on the beach between mile 14 and Jalova lagoon in order to maximize the number of encounters with leatherbacks.

The positions of the mile markers along the northern 18 miles of beach (Tortuguero river mouth to Jalova lagoon) 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 Jalova lagoon (mile 18) 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. Between Jalova lagoon and Parismina river mouth the old mile markers were used.

2.2 Track Surveys

Track surveys were conducted approximately weekly by 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 were surveyed the same afternoon (4:00 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 predated by jaguars and the number of green turtles turned by poachers.

Track surveys were also conducted approximately every three days by the RC and the RAs. The beach was divided into 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 and Jalova lagoon-Parismina river mouth. All tracks since the previous track survey were

counted. The tracks were marked with double lines and plastic debris found on the beach in order to avoid counting the same track at more than one survey. Notes were also kept on jaguar predation, turtles turned by poachers and the number of fresh nests poached. From 26 April onwards the section between the CCC station and the Juana López path was only surveyed when park rangers were available to escort the RC due to the permanent presence of poachers along this section of beach.

2.3 Tagging of Nesting Females

Nightly tagging patrols were conducted every night between 16 March and 15 May 1999 with the exception of 13 April. Initially three beach sections were patrolled: Tortuguero river mouth-CCC station, CCC station-mile 5, mile 14-Jalova lagoon. Night patrols were suspended along the last section, from 27 March onwards due to the abundance of jaguar tracks along this section of beach. There are no recorded jaguar attacks on humans in the Tortuguero area but the night patrols were still cancelled to ensure maximum security for the RAs. The tagging teams patrolled between 8 pm-12 am, 12 am-4 am or 10 pm-4 am. Mile 14 - Jalova lagoon was patrolled 8 pm - 5 am.

Turtles were tagged after finishing oviposition or when returning to the sea. Leatherbacks were tagged in the rear flippers. Green turtles (*Chelonia mydas*) and hawksbills (*Eretmochelys imbricata*) were tagged axillary, close to the first scale of the front flippers. Tag numbers, evidence of old tag holes or notches, species, date, time and activity at encounter 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).

Tissue samples were collected from the rear flippers for a sample of 51 leatherbacks. These samples were sent to Dr. Peter Dutton of National Marine Fisheries Service for genetic analysis. Appropriate collection and CITES permits were procured for the collection and export of these samples.

2.4 Biometric Data Collection

If the turtle was encountered before oviposition then 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 contaminating 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 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

If a turtle was encountered previous to covering the eggs, the nest was marked by attaching three pieces of flagging tape to the vegetation behind the nest. The location of the nest could then 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 nests were inspected so that the fate of the nest could be determined. Depredation and poaching was noted and monitoring of those nests was terminated. Nests were only marked between the Tortuguero river mouth and the mile 5 marker.

The marked nests were excavated two days after hatching or 75 days after egg laying 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

The number of visitors to Tortuguero for 1996-1998 were provided by staff at the ACTo office in Guápiles.

The number of visitors to the CCC natural history museum and visitors centre was recorded by Grethel Zamora, Fredy Piedra and Mario Zamora.

The lodges and cabinas in Tortuguero were visited and the name of the lodge/cabinas, number of beds and number of rooms were recorded.

Light surveys were conducted twice during the 1999 Leatherback Program. The beach was surveyed from the Tortuguero rivermouth to the mile 5 marker. Each artificial light visible from the beach was noted and the source was determined. 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

The 10 4/8 mile section was found to be too short and subsequently mile markers 11 to 17 4/8 were shifted 600 feet to the south. No mile marker was posted at mile 18 as it would have been too close to the river opening at Jalova lagoon.

3.2 Track Surveys

The seasonal distribution of leatherback nesting activity from the Tortuguero river mouth to Jalova lagoon is presented in Figure 1. Leatherback nesting begun in late February and continued until early July with peak nesting occurring in May.

A comparison between the results of Eddy Rankin's track surveys (fresh tracks from the night before counted approximately once weekly) and track surveys carried out by the RAs and the RC (all nests since previous survey counted approximately every three days) are shown in Figure 2a-d. Counting only fresh tracks once a week results in an underestimate of leatherback nesting activity, in particular along the sections of beach that are surveyed later in the day (i.e. Juana López path to Jalova lagoon and Tortuguero river mouth to Tortuguero village).

Two leatherbacks and eleven green turtles were killed by jaguars during the 1999 Leatherback Program (Table 14). The leatherbacks were left on the open beach after they had been killed but the majority of the green turtles were dragged into the vegetation by the jaguars. The jaguars only consumed the neck muscles and parts of the internal organs, the remainder was left for vultures and other scavengers.

Poachers killed one leatherback, presumably for its eggs. The RC and two of the RAs encountered the poachers and alerted the park rangers. Thanks to the rapid response of the rangers one of the two poachers was caught and prosecuted.

Poaching of leatherback and green turtle nests are summarized in Figure 2a-d and Table 1. The beach section with the highest percentage of poached leatherback nests was Parismina river mouth to Jalova lagoon that is located outside of Tortuguero National Park. The highest number of leatherback nests were poached between the mile 5 marker and the Juana López path which is also the section with the highest number of leatherback nests deposited. The

section with least poaching of leatherback nests was the section between Tortuguero river mouth and the mile 5 marker. A minimum of 35.9 % of all leatherback and 34.7 % of all green turtle nests laid during the course of the study were poached (Table 1).

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

Date	Leatherback Nests	Minimum Poached Leatherback Nests	Min. % Poached	Green Turtle Nests	Minimum Poached Green Turtle Nests	Min. % Poached
22 March	29	11	37.9	30	13	43.3
25 March	36	17	47.2	17	1	5.9
28 March	33	15	25.5	14	6	42.9
31 March	33	14	42.4	17	4	23.5
3 April	22	3	13.6	20	0	0
6 April	37	9	24.3	22	11	50.0
9 April	53	9	17.0	17	10	58.8
17 April	101	42	41.6	27	10	37.0
20 April	11	7	63.6	0	0	0
23 April	39	20	51.3	17	3	17.6
26 April*	23	11	47.8	2	1	50.0
29 April*	23	12	52.2	0	0	0
2 May*	36	10	27.8	2	1	50.0
5 May*	23	9	39.1	5	4	80.0
8 May	138	47	34.1	38	9	23.7
11 May	63	17	27.0	11	9	81.8
14 May	50	16	32.0	9	4	44.4
Total	750	269	35.9	248	86	34.7

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

*Mile 5 to Juana López path (north of mile 15 marker) not surveyed

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

3.3 Tagging of Nesting Sea Turtles

A total of 647 teamhours were spent on the beach from 16 March to 30 May. During this time a total of 100 leatherbacks, 14 green turtles and one hawksbill encounter were recorded (Appendix 1). This is equal to 0.15 leatherbacks, 0.02 green turtles and 0.0015 hawksbills encountered per team hour on the beach.

The encountered turtles correspond to 80 individual female leatherbacks and 11 female green turtles. A total of 35 % of the leatherbacks were previously tagged. The previously tagged leatherbacks (n=28) were originally tagged on the beaches of Tortuguero and Pacuare/Mondonguillo (S. Rodríguez pers. comm.). A total of 15 % (n=8) of the newly tagged leatherbacks showed evidence of old tag holes or notches when they were encountered the first time during the program.

A total of 76 % of the leatherback females laid eggs in the open beach section (n=76), 6 % nested in the border zone (n=6) and 18 % 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 different in terms of

carapace length or clutch size from leatherbacks with complete caudal projection (t-test $p>0.05$). Hence, data from leatherbacks with incomplete and complete caudal projections have been pooled to determine the overall mean carapace length and clutch size.

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

Caudal projection	Carapace length		Clutch size		
	n	\times CCLmin (cm) \pm S.D.	n	\times eggs \pm S.D.	\times yolkless eggs \pm S.D.
Complete	71	153.5 \pm 7.0	38	75.1 \pm 17.7	30.7 \pm 11.9
Incomplete	6	149.0 \pm 4.5	4	73.8 \pm 15.9	27.5 \pm 14.3
Total	77	153.1 \pm 6.9	42	74.9\pm17.4	30.4\pm12.0

Female leatherbacks that were measured at more than one encounter (n=14) were consistently diagnosed as having complete caudal projections in 86 % (n=12) of cases, and varyingly diagnosed as having complete and incomplete caudal projections in 14 % (n=2) of cases.

The mean carapace length of green turtles and the hawksbill are shown in Table 3.

Table 3. Mean carapace length (cm) of green turtles and a hawksbill.

Species	n	\times CCLmin (cm) \pm S.D.
Green	10	105.0 \pm 4.2
Hawksbill	1	82.7

The precision of the carapace measurement recorded during the same encounter is shown in Table 4a.

Table 4a. Precision of carapace measurements.

Species	n	\times precision for CCLmin (cm) \pm S.D.
Leatherback	77	0.6 \pm 0.4
Green	10	0.5 \pm 0.4

The precision of the carapace measurement for leatherbacks encountered more than once (two or three times) is shown in Table 4b.

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

Encounters	n	\times precision for CCLmin (cm) \pm S.D.	range (cm)
2	10	1.0 \pm 0.5	0.3 - 2.1
3	4	1.8 \pm 0.2	1.5 - 2.0

3.5 Determination of Nest Survivorship and Hatching Success

A total of 44 leatherback nests were marked between 18 March and 28 May 1999. Eight of the nests were poached within one day of oviposition. For one marked nest all flagging tapes were lost. As the fate of that nests cannot be determined with certainty, it has been excluded from further analysis. Two additional nests were located from the hatchlings tracks and subsequently excavated. 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	22	51.2	30.2	26.7
<i>Disturbed</i>				
2. Poached	8	18.6	0	0
3. Dug up by dogs after hatching	7	16.3	30.3	0 - 22.1*
4. Invaded by roots	1	2.3	0	0
5. Flooded	3	7.0	0	0
6. Washed out	2	4.7	0	0
TOTAL	43	100		
(7. Flagging lost	1)			
(8. Nests located from hatchling tracks	2		58.5	41.5)

*If all hatchlings were eaten by dogs the emerging success was 0%, if all hatchlings emerged before the dogs dug up the nests the emerging success for this category was 22.1%.

Undisturbed marked nests had a lower hatching and emerging success than nests that were located from hatchling tracks (Table 5).

Table 6. Results of nest excavations.

Fate	Empty Shells	Pipped eggs	Live hatchlings	Dead hatchlings	Unhatch. no embryo	Unhatch. embryo	Unhatch. full embryo	Depredated	Total eggs	x eggs/nest
Marked nests										
1	506	115	20	38	659	242	95	59	1676	76.2
3	152	45	14	27	171	87	23	24	502	71.7
4	0	4	0	0	8	6	3	31	52	52
5	0	1	0	0	219	41	0	8	269	89.7
ALL	658	165	34	65	1057	376	121	122	2499	75.7
Nests located from hatchling tracks										
8	110	4	8	24	51	15	8	0	188	94

Fate 1=Undisturbed, 3=Dug up by dogs after hatching, 4=Invaded by roots, 5=Flooded, 8=Nests located from hatchling tracks

It is assumed that the washed out and poached nests had the same mean number of eggs as the excavated nests ($x=75.7$ eggs/nest) hence the total number of eggs is 757 eggs for the poached and washed out nests + 2,499 eggs in excavated nests = a total of 3,256 eggs. Therefore the overall hatching success was 20.2% for the 43 monitored leatherback nests (658 empty shells from 3,256 eggs). It is worth noting that if poaching had been completely eliminated the overall hatching success would have been 24.8% i.e. 658 empty shells from 2,640.4 eggs (151.4 eggs for washed out nests + 2,499 eggs in excavated nests).

The emerging success for the monitored leatherback nests, using the same assumption as above, was between 13.8% (assuming that no hatchlings emerged from the nests that were dug up by dogs i.e. 658-210=448 hatchlings emerged from 3,256 eggs) and 17.2 % (assuming that all hatchlings emerged from the nests that were dug up by dogs i.e. 658-99=559 hatchlings emerged from 3,256 eggs).

The distance from the sand surface to the top egg for excavated nests (n=33) varied between 46-87 cm with a mean of 64 cm. The distance from the sand surface to the bottom of the egg chamber for the same nests varied between 70-100 cm with a mean of 85 cm. The incubation period for monitored leatherback nests for which emerging was observed (n=13) varied between 58-73 days with a mean of 62 days.

The three flooded and 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 9 meters from the high tide line. However, five leatherback nests laid within 9 meters of the high tide line hatched undisturbed, including one nest that was located only 2.14 m from the high tide line at the time of oviposition.

3.6 Physical Data Collection

Rainfall is shown in Figure 3 and Table 7. Rainfall was heaviest in December 1998 (Table 7) when large parts of the Tortuguero area were flooded (F. Piedra pers. comm). March and May were the two months with least rain (Table 7).

Table 7. Rainfall, November 1998-July 1999.

Month	Total rainfall (mm/month)	× rainfall (mm/24hrs)
November	418.6	14.0
December	1594.6	51.4
January	493.2	15.9
February	376.8	13.5
March	189.4	6.1
April	706.3	23.5
May	182.1	5.9
June	511.2	17.0
July	607.0	19.6

Minimum and maximum air temperatures are shown in Table 8.

Table 8. Air temperature, November 1998-July 1999.

Month	× minimum temp. (°C) *	× maximum temp. (°C) *
November	24.7	27.5
December	23.7	25.6
January	23.6	26.9
February	23.2	27.6
March	23.8	29.4
April	24.7	29.5
May	25.3	30.3
June	24.7	28.9
July	24.1	30.6

Mean monthly sand temperatures are shown in Table 9. Increased shading caused a decrease in the mean monthly sand temperature. Shallow data loggers (30 cm depth) registered a higher mean temperature for months with few rainy days but a lower mean temperature for months with many rainy days in comparison with data loggers located at 50 cm and 70 cm depth (Table 9).

The sand temperature at 70 cm depth in the open zone (where 76 of 82 marked leatherback nests were deposited) is shown in Figure 4. The sharp decrease in sand temperature in mid-April corresponds to the very heavy rains of 16-17 April (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>		50	70		50	70	30	50	70
Jan, × temp (°C)		27.9	27.7		27.2	27.0	25.0	24.9	24.8
Feb, × temp (°C)		28.8	28.8		28.0	27.8	25.4	25.3	25.4
Mar, × temp (°C)	(31.8) ^a	30.9	30.6	(30.4) ^a	29.9	29.4	26.5	26.3	26.3
<i>Retrieval depth (cm) 13 March</i>		56	70		50	70	30	50	70
<i>Depth (cm) 13 March</i>	30	50	70	30	50	70	30	50	70
April, × temp (°C)	30.7	30.3	30.3	29.5	29.2	29.0	26.7	26.5	26.5
May, × temp (°C)	33.0	32.5	32.0	31.4	31.1	30.6	27.8	27.7	27.5
<i>Retrieval depth (cm) 9 June</i>	37	54	78	29	49	76	32	47	68
<i>Depth (cm) 9 June</i>	30	50	70	30	50	70	30	50	70
June, × temp (°C)	30.3	30.4	30.7	FAIL	29.4	29.4	26.6	26.7	26.9
July, × temp (°C)	30.1	30.2	30.4	FAIL	29.1	29.1	26.4	26.4	26.6
<i>Retrieval depth (cm) 2 Nov.</i>	27	50	66	29	47	66	27	44	67

^aTemperature data from 13 March onwards.

Ground water level is shown in Figure 5. Only after heavy rains did the ground water reach levels that could be detected in the PVC pipes. The heavy rains of 16-17 April caused an increase in the ground water level that may have affected leatherback nests located close to the high tide line.

3.7 Collection of Human Impact Data

The number of paying visitors coming to Tortuguero National Park has increased since 1996 (Table 10).

Table 10. Number of Paying Visitors to Tortuguero National Park, 1996-1998.

Year	CR Visitors	Foreign Visitors	Total
1996	1,287	7,766	9,053
1997	2,274	10,757	13,031
1998	2,685	12,313	14,998

Information from ACTo.

The number of visitors to the CCC Natural History and Visitors Center has remained stable over the last two years. May, June and October are the months with least visitors arriving to Tortuguero (Table 11).

Table 11. Visitors to the CCC Natural History and Visitors Center, January 1997-July 1999.

Month	1997		1998		1999	
	Total	× Per Day	Total	× Per Day	Total	× Per Day
January	2695	87	2086	67	2282	74
February	2805	100	2024	72	1967	70
March	2657	86	1812	58	2068	67
April	1553	52	1953	65	1475	49
May	909	29	852	27	1006	32
June	1194	40	1432	48	1093	36
July	2526	81	2555	82	2567	83
August	2498	81	2809	91	2740	88
September	1259	42	1565	52	1640	55
October	1358	44	1006	32	1574	51
November	1468	49	1437	48		
December*	1401	54	1398	45		
TOTAL	22323	62	20929	57	18412	61

*No record for 11-15 December 1997

Several of the hotels increased their capacity in terms of rooms and beds in 1999 (Table 12). All hotels with the exception of El Manati, Caribe Lodge and Ilan-Ilan have now got swimming pools. The cabinas located in Tortuguero village did not increase their room and bed capacity significantly during 1998-1999. The newly constructed Cabinas Joruki is an exception as is Cabinas Aracari which is expected to soon have added a new building with six rooms.

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

Hotels/Lodges	Rooms	Beds	Cabinas	Rooms	Beds
Mawamba	54	151	Ms Junie	12	30
Pachira	48	94	Sabina	32	80
Tortuga	24	80	Tortuguero	5	15
Caribbean Magic	4	12	Pancana	4	10
Ilan-Ilan	26	64	Aracari	6 (+ 6)	18 (+ 12)
El Manati	8	20	Pisulin/Tropical Lodge	5	20
Laguna	34	98	Joruki	6	12
Jungle	50	110	(CCC	7	30)
Caribe	11	30	<i>Total - Cabinas</i>	77	215
<i>Total - Hotels</i>	259	659	TOTAL	336	874

The sources of artificial lighting did not increase during the 1999 season although clearing for the construction of a swimming pool at Laguna Lodge has made the lights from the lodge more visible from the beach (Table 13).

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

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

3.8 Dead Turtles

The majority of dead turtles encountered during the 1999 leatherback program were nesting green turtles (n=11) that had been killed by jaguars (Table 14). Two leatherbacks were also killed by jaguars. Two juvenile loggerheads and a juvenile green turtle were washed up dead (Table 14).

Table 14. Dead turtles.

Date	Species	Sex	CCLmin	Comments
09-Mar-99	CM	F		Killed by jaguar.
16-Mar-99	DC	F		Killed by jaguar.
20-Mar-99	CM	F		Killed by jaguar.
22-Mar-99	CM	F		Killed by jaguar.
25-Mar-99	DC	F		Killed by jaguar.
28-Mar-99	CM	F		Killed by jaguar.
31-Mar-99	CC	?		Juvenile loggerhead. Only carapace and plastron remaining.
03-Apr-99	CM?	F		Green turtle killed by jaguar? Uptrack without down track, vultures abundant in the vegetation behind the track.
09-Apr-99	CM	F		Killed by jaguar.
15-Apr-99	CM	F		Killed by jaguar after being turned by poachers.
20-Apr-99	CC	?	70.7	Juvenile loggerhead. Only carapace and plastron remaining.
23-Apr-99	CM	?	20.0	Juvenile green turtle entangled in a plastic sack.
23-Apr-99	CM	F		Killed by jaguar after being turned by poachers?
06-May-99	CM	F		Killed by jaguar and dragged 50 meters into the vegetation.
11-May-99	CM	F		Killed by jaguar.

CC=loggerhead, CM=green turtle, DC=leatherback

3.9 Environmental Education Activities

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

The RC and the RAs participated in the Third Regional Workshop on Sea Turtle Conservation in Central America that was held in Shiroles, Talamanca, Costa Rica, 11-16 April 1999. The RC presented a paper on the Biology and Ecology of the Green Turtle.

CCC housed and provided lectures on sea turtle biology at the Tortuguero Conservation Area (ACTo) tour guide training course 24-31 May.

4. DISCUSSION

4.1 Preparations

Renovating mileposts is a time consuming activity. However, it makes the RAs more familiar with the beach and the extensive walking required during work activities. The three markers in front of each mile position makes finding the mile markers considerably easier and it is suggested that this practice be continued in future leatherback and green programs. The positions of mile markers that are still standing at the beginning of the season do not need to be verified. It is suggested that the positions where all markers are missing or fallen be verified at the beginning of each season.

4.2 Track Surveys

Peak nesting for leatherbacks occurred in the second half of May (Figure 1, Appendix 2) when nightly patrols had been terminated. In order to increase the number of encounters with nesting leatherbacks it is suggested that leatherback monitoring be continued until the onset of green turtle monitoring in mid-June. This would also ensure that poaching is discouraged during the time between the turtle programs.

The comparison between Eddy Rankin's and the RAs track surveys shows that weekly track surveys underestimates the total number of leatherback nests deposited on the beach. Leatherback tracks are larger than green turtle tracks and lasts for a longer period of time. It is therefore difficult to determine if a leatherback track is fresh (=from the previous night) or not. In order to get a more accurate estimate of the number of leatherback nests it is suggested that the RAs conduct total nest counts every three days as part of the leatherback program. However, for safety reasons it is required that park rangers maintain a presence on the beach between mile 5 and Jalova lagoon in order to discourage poachers.

The number of turtles killed by jaguars is increasing. It appears that the jaguars prefer green turtles to leatherbacks (Table 14). The two leatherbacks killed represent a significant part of the nesting population and close monitoring of the number of leatherbacks killed should be conducted in coming programs. The jaguar population may be increasing in the area and it is possible that more leatherbacks will be killed in the future.

The killing of a leatherback by poachers caused outrage amongst park rangers and members of the local community. The tour guides participating in the training course expressed a complete lack of understanding for such an unnecessary act. The penalty for killing protected wildlife has increased to a minimum of c100,000 (\approx \$340) (E. Chamorro pers. comm.). The person that was arrested for killing the leatherback will be one of the first turtle poachers to

be tried under the new penal code. At the time of writing this report, the case had not yet come to court.

Poaching of leatherback and green turtle eggs prevailed throughout the leatherback program (Table 1). Park rangers accompanying the RC during track surveys arrested one person, cleared out two camp sites set up by poachers, confiscated leatherback eggs and equipment. The only option for addressing the problem of outsiders poaching is to increase the presence of park rangers on the beach. Due to illegal hunting in other areas of the National Park, the park rangers are virtually absent from the section of beach between mile 5 and Jalova lagoon during March-May. The section of beach between mile 5 and the Juana Lopez path is where the largest number of nests were poached (Figure 2a-d). The opening up of at least one temporary ranger camp along this section of beach for the duration of the leatherback nesting season is likely to considerably limit poaching.

4.3 Tagging of Nesting Sea Turtles

No within season tag loss was observed but 15% of newly tagged turtles showed evidence of prior tagging. Tag loss for flipper tags in leatherbacks has been reported to be very high (Eckert and Eckert 1989). However, since tagging encounter efficiency for the leatherback monitoring is low, the usefulness of tagging data for population modelling purposes is limited. Monel tags appear to have adequate retention within a nesting season and therefore serve to identify individual females. Hence the monel tags are sufficient to fulfill the objectives of the monitoring protocol for the leatherback program. An alternative would be to use PIT (=passive integrated transponder) tags. The added cost of using PIT tags makes such tags less advantageous. PIT tagged turtles would also need to be tagged with flipper tags for the purpose of receiving information on tag returns from fishermen and other non-biologists.

4.4 Biometric Data Collection

No significant difference in carapace length was found for female leatherbacks with incomplete and complete caudal projection (Table 2). It is therefore suggested that the practice of classifying the caudal projection as incomplete or complete be discontinued.

4.5 Determination of Nest Survivorship and Hatching Success

Leatherback nests at Tortuguero have a hatching success that is considerably lower than green turtle nests laid on the same beach (Table 5; Troëng et al. 1998). This can in part be explained by the fact that leatherbacks tend to nest closer to the sea and dig deeper egg chambers than green turtles, hence making leatherback nests more susceptible to flooding or wash out (Table 5, Troëng et al. 1998). Another explanation could be that the large mass of the leatherback clutch results in oxygen depletion in the center of the egg mass as embryonic development progresses and oxygen consumption increases which in turn may increase egg mortality (Ackerman 1980). The many dead embryos (at varying stages of development) encountered in the monitored leatherback nests support this theory (Table 6).

Nest depredation by dogs generally took place after the eggs had hatched. Dogs are not natural predators in Tortuguero and the extent to which they depredated leatherback nests is discouraging (Table 5). It is suggested that an effort be made to control dogs during times of the year when female turtles are arriving to nest and when hatchlings are emerging.

The location of a leatherback nest in relation to the high tide line can not be used to predict the exact fate of the eggs. This has also been shown at other leatherback beaches (Eckert 1987). Hence, relocating leatherback nests may not be appropriate at Tortuguero as “doomed” nests can not be easily identified.

4.6 Physical Data Collection

A total of 93% of the marked leatherback nests were deposited in the open beach zone where there is no shading from vegetation. The pivotal temperature for leatherbacks nesting in French Guiana has been estimated at 29.5 °C and the transitional range of temperature (TRT) that produces hatchlings of both sexes has been estimated to be very narrow at 0.12 °C for TRT_{5%} (Chevalier et al. in press, Girondot 1999). Dutton et al. (1999) studying mitochondrial DNA found few differences between French Guiana and Tortuguero leatherbacks. If the pivotal temperature and TRT are similar for French Guiana and Tortuguero leatherbacks, then the vast majority of hatchlings produced in Tortuguero in 1999 were female (Figure 4). Research aimed at determining the pivotal temperature and TRT for leatherbacks in Tortuguero should be encouraged.

4.7 Collection of Human Impact Data

The number of visitors paying the entrance fee to Tortuguero National Park is continuously increasing (Table 10). This partly reflects that more visitors are coming to the area and partly that a higher percentage of visitors are paying the park fees (pers. obs.). ACTo is improving the collection of fees and it is likely that the number of paying visitors to the park will increase significantly during 1999.

The hotels in the Tortuguero area increased their capacity in 1998-1999 (Table 12). The majority of tourists that visit Tortuguero come on package tours. The tours include transport, food & lodging, village and canal tours. Independent travelers are far less numerous and tend to stay in the cheaper cabins in the village. Package tourists bring less direct economic benefits to the local community than do independent travelers.

4.8 Dead Turtles

The majority of dead turtles encountered during the leatherback program were nesting turtles killed by jaguars (Table 14). Counts of dead turtles are best carried out in association with track surveys. The location of each dead turtle should be noted to avoid double counting carcasses.

4.9 Environmental Education Activities

The cooperation with the Tortuguero school and high school should be continued in future programs as it provides a good channel for exchange between research assistants and members of the Tortuguero community.

The workshop at Talamanca provided a forum for regional discussion about sea turtle conservation. Three Honduran research assistants participated in the 1999 Green Turtle Program as a result of contacts made at the workshop.

The four-day tour guide training course conducted at the CCC station in May was very successful and the 150 participants were uniformly positive in their comments about the

course. The course provided an excellent opportunity for exchange of information and opinions between tour guides, park officials and CCC staff. The interest in sea turtle biology and conservation in the local community has increased as a result. Many of the participants in the course represented a sector of the community that normally is not reached by environmental education activities. Therefore it is suggested that CCC and ACTo expand the annual tour guide training. Local tour guides often do not have access to information that is available to outside guides and subsequently the local guides are outcompeted. A course in English for local guides is urgently needed.

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6. RECOMMENDATIONS

6.1 Preparations

- ⇒ Each mile marker position should be marked with three posts.
- ⇒ Positions where all markers have fallen or gone missing should be verified at the beginning of each season.

6.2 Track Surveys

- ⇒ Leatherback monitoring should be conducted until the onset of the green turtle program.
- ⇒ RAs should conduct track surveys every three days (total counts) as part of the leatherback program.
- ⇒ Continue to monitor the number of leatherbacks killed by jaguars.
- ⇒ A temporary ranger camp should be established along the section of beach between mile 5 and the Juana López path and manned for the duration of the leatherback nesting season.

6.3 Tagging of Nesting Sea Turtles

- ⇒ Leatherbacks should be tagged with monel tags.

6.4 Biometric Data Collection

- ⇒ The practice of classifying the caudal projection of leatherbacks as complete or incomplete should be discontinued.

6.5 Determination of Nest Survivorship and Hatching Success

- ⇒ Dogs should be controlled during nesting and hatching seasons.
- ⇒ Leatherback nests should not be relocated.

6.6 Physical Data Collection

- ⇒ Research aimed at determining the pivotal temperature and the transitional range of temperatures that produce both sexes for leatherbacks in Tortuguero should be encouraged.

6.7 Collection of Human Impact Data

6.8 Dead Turtles

- ⇒ The location of dead turtles should be noted to avoid double counting of carcasses.

6.9 Environmental Education Activities

- ⇒ Continue cooperation with the Tortuguero school and high school.
- ⇒ CCC should increase training activities for local guides.

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

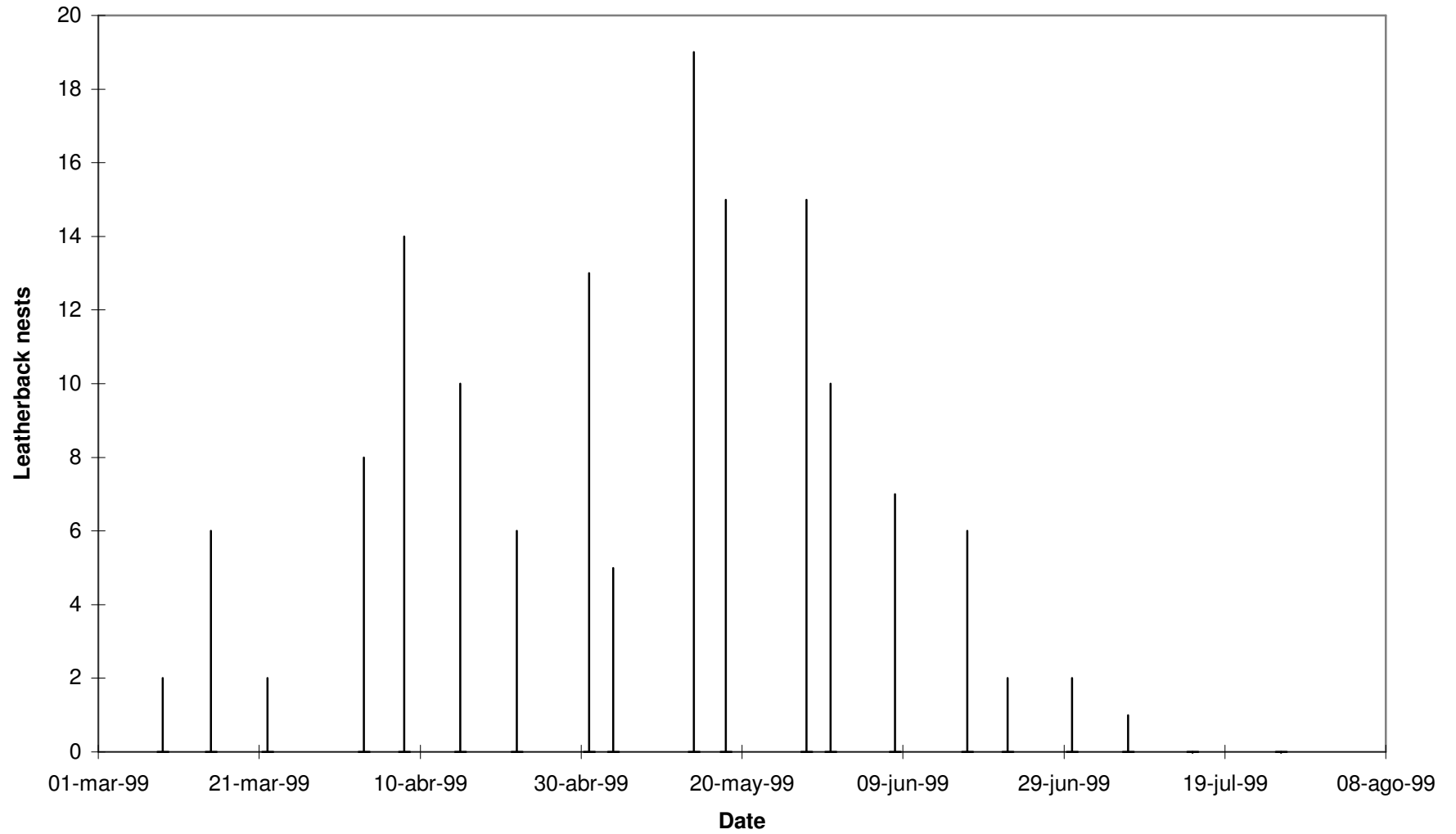


Figure 2a. Leatherback nesting activity from Tortuguero river mouth to the mile 5 marker.

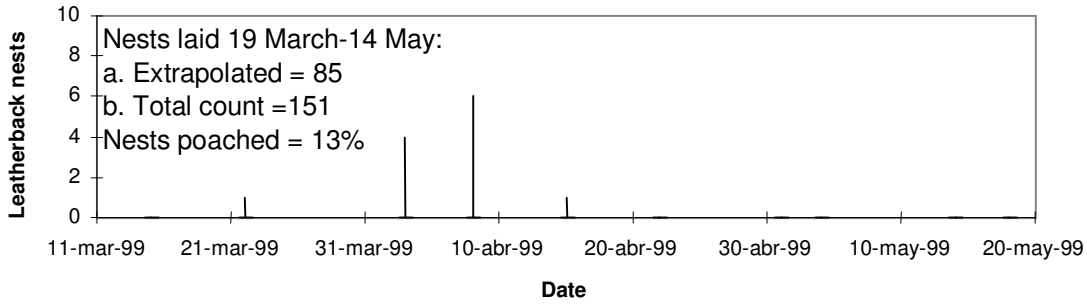


Figure 2b. Leatherback nesting activity from the mile 5 marker to Juana López path.

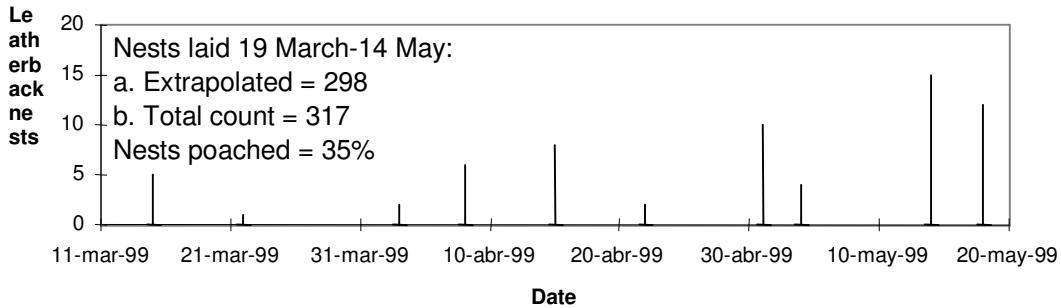


Figure 2c. Leatherback nesting activity from Juana López path to Jalova lagoon.

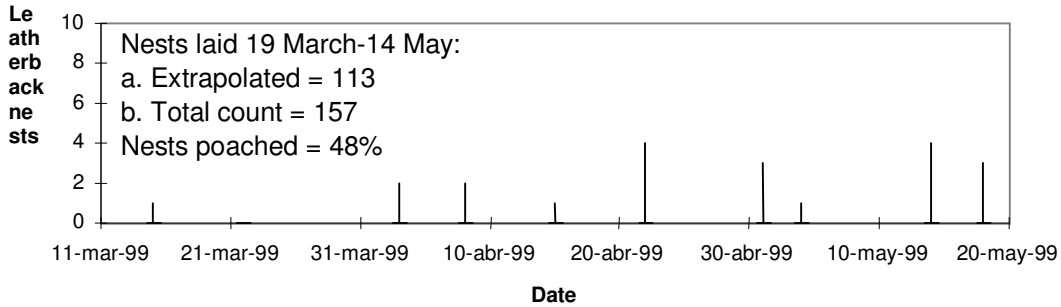


Figure 2d. Leatherback nesting activity from Jalova lagoon to Parismina river mouth.

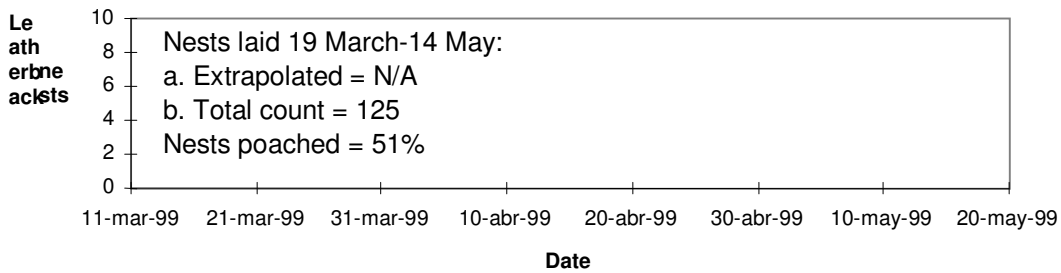


Figure 3. Rainfall.

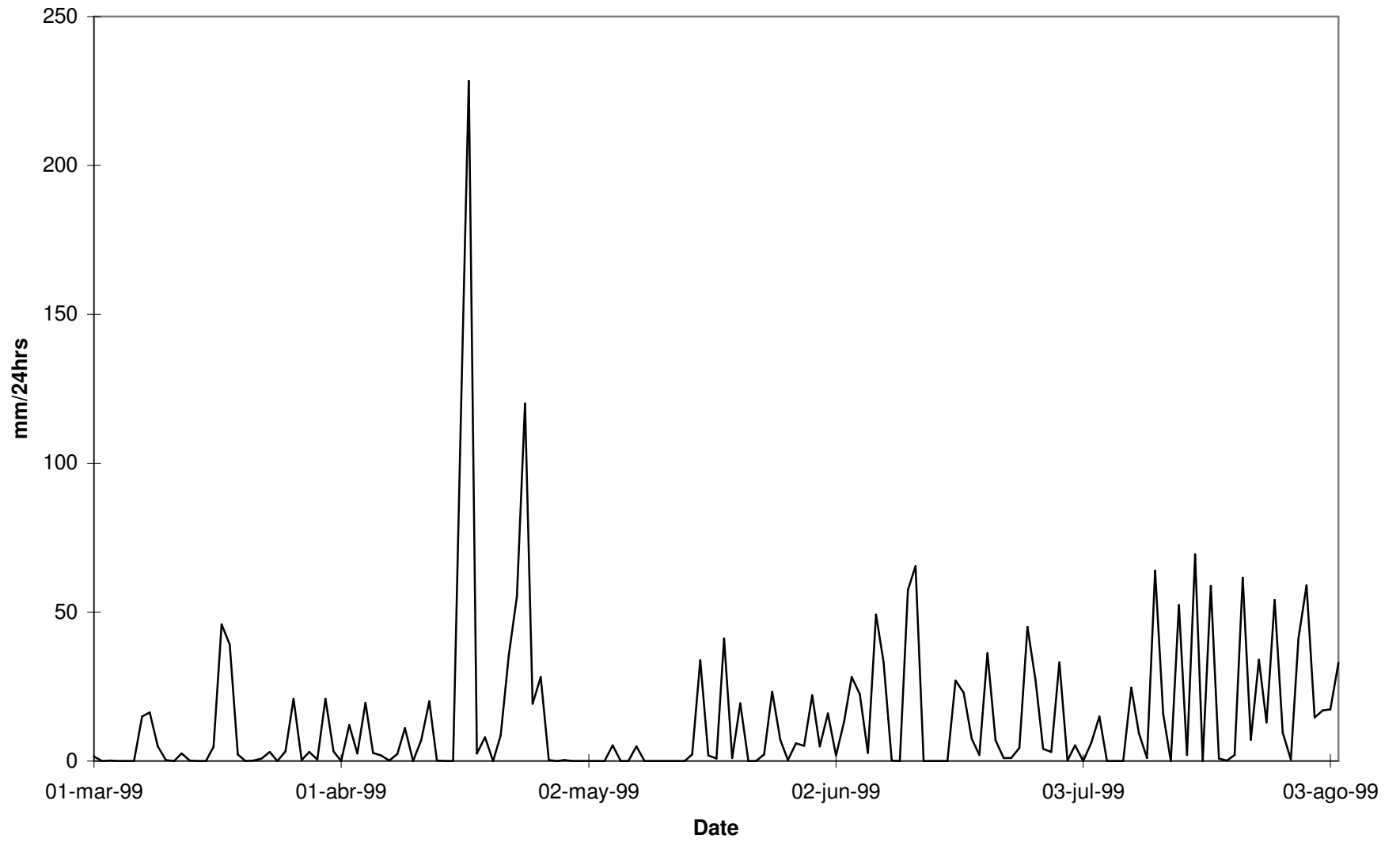


Figure 4. Temperature (°C) at 70 cm depth, open zone.

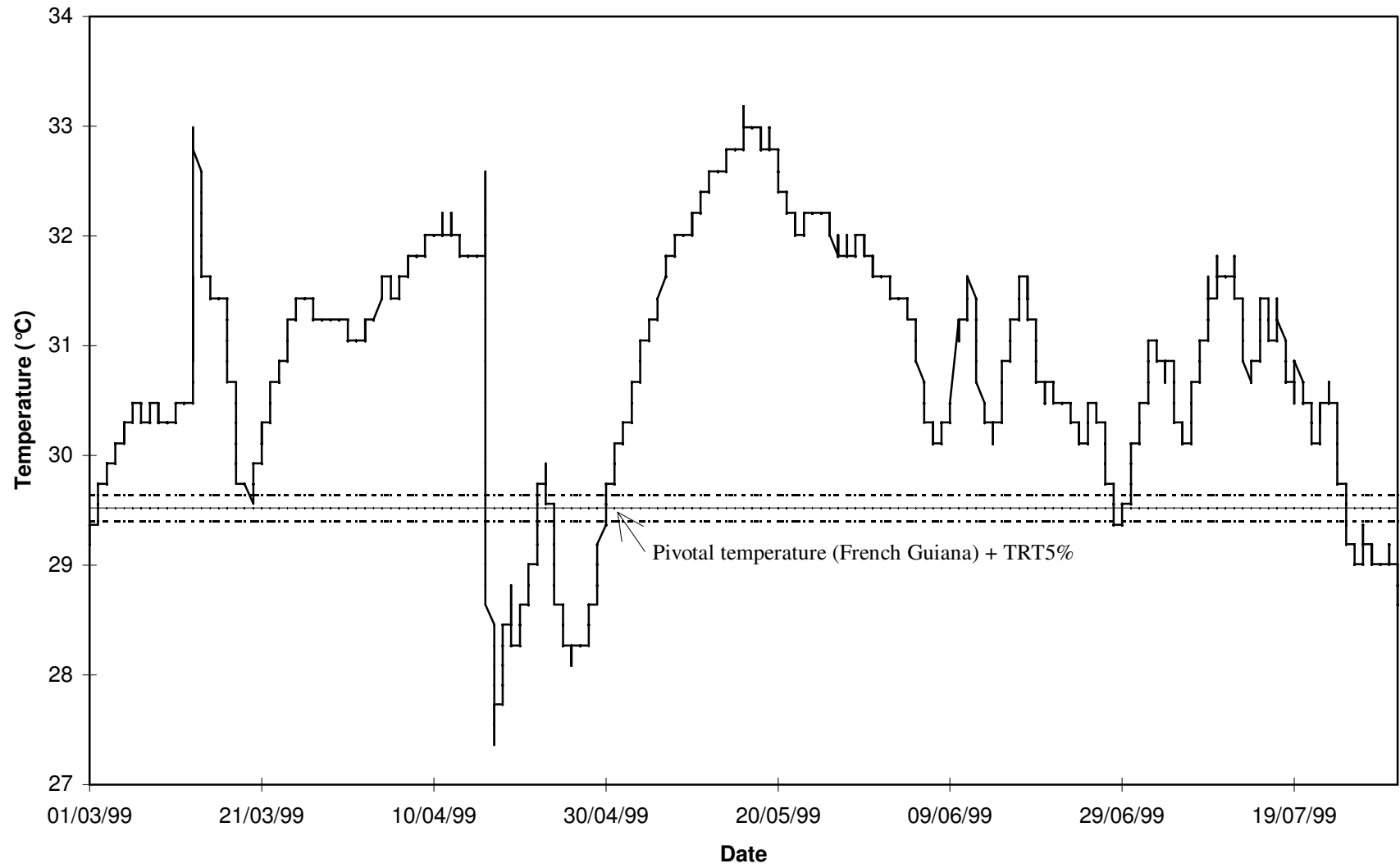
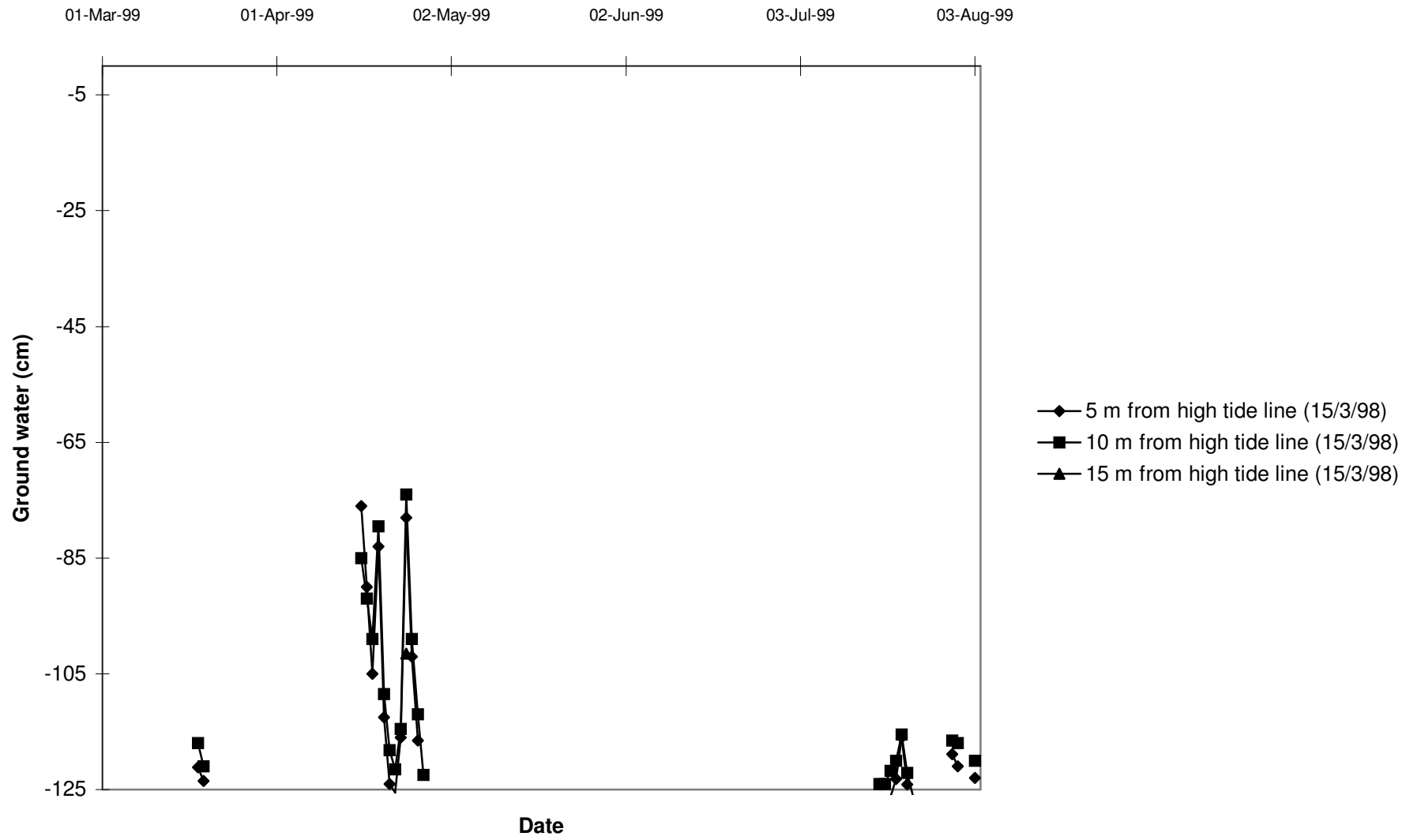


Figure 5. Ground water level



APPENDIX 1. SEA TURTLE ENCOUNTERS.

Date	Leatherbacks				Greens			Hawksbill	
	Newly tagged turtles	Previously tagged turtles	Renesters	Total	Newly tagged turtles	Renesters	Total	Newly tagged turtles	Total
16-mar-99				0			0		0
17-mar-99	1			1	1		1		0
18-mar-99	1			2			1		0
19-mar-99	2			4	1		2		0
20-mar-99	1			5			2		0
21-mar-99				5			2		0
22-mar-99		1		6			2		0
23-mar-99	3			9			2		0
24-mar-99				9	1		3		0
25-mar-99	1			10	1		4		0
26-mar-99	3			13	1		5		0
27-mar-99	1			14			5		0
28-mar-99	1			15			5		0
29-mar-99	1			16			5		0
30-mar-99	1			17			5		0
31-mar-99	3			20			5		0
01-abr-99		1	1	22	1		6		0
02-abr-99	2			24			6		0
03-abr-99	2			26	1		7		0
04-abr-99	4	3		33			7		0
05-abr-99	2		1	36			7		0
06-abr-99	3	2		41			7		0
07-abr-99	1	1	1	44		2	9		0
08-abr-99	1	2	1	48			9		0
09-abr-99	1	1		50			9		0
10-abr-99		2	1	53			9		0
11-abr-99				53			9		0
12-abr-99	1	1	1	56			9		0
13-abr-99				56			9		0
14-abr-99				56			9		0
15-abr-99	2	1	1	60			9		0
16-abr-99	3		1	64			9		0
17-abr-99			2	66			9		0
18-abr-99				66			9		0
19-abr-99				66			9		0
20-abr-99	1			67		1	10		0
21-abr-99	1			68			10		0
22-abr-99				68			10		0
23-abr-99				68			10		0
24-abr-99			1	69			10		0
25-abr-99				69			10		0
26-abr-99			1	70			10		0
27-abr-99				70			10		0
28-abr-99				70			10		0
29-abr-99	1		1	72			10		0
30-abr-99		2	1	75			10		0

01-may-99	1	1		77		10		0	
02-may-99		2		79	1	11		0	
03-may-99				79		11		0	
04-may-99	1			80		11		0	
05-may-99	1	1		82	1	12		0	
06-may-99	1			83		12		0	
07-may-99				83		12		0	
08-may-99	1		1	85		12		0	
09-may-99		2	1	88	1	13		0	
10-may-99		2		90		13		0	
11-may-99			2	92		13		0	
12-may-99				92		13		0	
13-may-99	1			93		13		0	
14-may-99	1	1	1	96		13		0	
15-may-99		1	1	98	1	14		0	
16-may-99				98		14		0	
17-may-99				98		14		0	
18-may-99				98		14		0	
19-may-99				98		14		0	
20-may-99				98		14		0	
21-may-99				98		14		0	
22-may-99				98		14		0	
23-may-99				98		14		0	
24-may-99				98		14		0	
25-may-99				98		14		0	
26-may-99				98		14		0	
27-may-99				98		14		0	
28-may-99		1		99		14		0	
29-may-99				99		14		0	
30-may-99	1			100		14	1	1	
31-may-99				100		14		1	
Total	52	28	20	100	11	3	14	1	1

APPENDIX 2: Observations and Anecdotal Information on Illegal Harvest

The majority of leatherback eggs poached in Tortuguero National Park are poached by outsiders from the Limón area. They arrive every 2-3 days to poach nests laid since their last visit. The approximate cost of travelling from Limón to Tortuguero National Park is c27,000 (approx. \$96) for a 85 hp motorized boat and c35,000 (approx. \$125) for a 150 hp motorized boat. Each boat carries between 4-8 persons. Only the captain remain in the boat and the rest of the crew is dropped off at different section along the beach. They are later picked up when they have collected all the eggs.

Meanwhile, the captain patrols off the beach to keep a lookout for park rangers. If park rangers are spotted, the persons on the beach are quickly picked up. If the persons on the beach are surprised by rangers, they run for the sea and swim to outside of the breaking waves where they are picked up by the boat captain. Often the captain of the boat is heavily armed and exchange of fire between poachers in boats and park rangers on the beach has occurred severla times in the past two years. When no park rangers are present on the beach the poachers set up camp in order to poach leatherback eggs and nesting green turtles.

Limón is the major market for Tortuguero leatherback eggs but eggs are also sold elsewhere in the province. The large scale poachers sell the eggs to an intermediary who prepares the eggs and organize the sale of them. Eggs are mainly sold in the market and by persons walking around the bars offering to sell. The price of a cooked leatherback egg in Limón (yolkless eggs are not consumed) varies between 100-150 colones/egg