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GUIANAS FORESTS & ENVIRONMENTAL CONSERVATION PROJECT

Annual Report on the 2003 Leatherback Turtle Research and Monitoring Project in Suriname

Prepared by:

M.L. Hilterman and E. Goverse

Hosted by the Netherlands Committee for IUCN
In collaboration with the Foundation for Nature Conservation Suriname (STINASU)

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NETHERLANDS COMMITTEE FOR IUCN
THE WORLD CONSERVATION UNION

NC-IUCN, Plantage Middenlaan 2k, 1018 DD, Amsterdam, the Netherlands

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EXECUTIVE SUMMARY

- Fieldwork was conducted between April 28th and August 1st on Babunsanti and between May 9th and July 14th on Kolukumbo by the field coordinator and six (part-time) research assistants.
- A total of 2,235 individual leatherback females were observed, of which 1,358 nested on Babunsanti. New PIT tags were applied to 1,473 individuals (65.9%), the remaining 762 (34.1%) were previously tagged.
- Of the previously tagged turtles, two were remigrants from 1999, 19 were remigrants from 2000, 363 were from 2001 and 6 from 2002, and 365 turtles had a PIT code not known for Suriname. A substantial part of the latter had expectedly been tagged in French Guiana, but wrongly recorded codes may also be included.
- The total number of tag records, including 2,586 within-season recaptures, was 4,821.
- Of the observed nesting cohort of 1999 (n=69), 39.1% had been seen again by 2003. Of the 2000 cohort (n=455), this was 14.5% and of the 2001 cohort (n=2,927) this was 12.5%. Six individuals (0.3%) of the 2002 cohort (n=2,289) returned in 2003. Eight individuals have been encountered in three different nesting seasons in Suriname.
- Two turtles that were PIT tagged in 2001 in Suriname have returned in 2003 in Guyana. The female tagged in 2001 on Kolukumbo that was captured in 2002 in Nova Scotia, Canada, returned to nest in 2003 on Babunsanti.
- 20 individuals with Monel tags form French Guiana were observed.
- Of the 1,197 leatherback females seen twice or more, 101 (8.4%) made one ore more shifts between Babunsanti and Kolukumbo.
- The mode of the observed internesting period (OIP) was 9 days. Mean OIP was 9.48 ± 1.01 (n=1,286).
- Based on the OIP data, 7.6% (n=196) of the nesting attempts resulted in aborted nesting attempts or false crawls.
- Mean observed clutch frequency (OCF) was 3.11 ± 1.32 (n=1.197) nests, calculated without the group of one time nesters. Of all turtles, 46.4% (n=1,038) was seen only once. OCF ranged between one and ten nests.
- The estimated clutch frequency (ECF) for Babunsanti (excluding the group of one-time observed nesters (n=363)) was 4.72 ± 2.05 (n=580) nests.
- Based on PIT tag data (number of new tags + old tags + observed missed nestings per night; false crawls excluded) and rough estimates for beaches/sections that were not monitored, the estimated minimal number of nests after correction for incomplete beach coverage is 12,000.
- The average curved carapace length of gravid leatherback females was 155.2 ± 7.1 cm on Babunsanti and 154.3 ± 6.9 cm on Kolukumbo, curved carapace width was 114.1 ± 5.0 cm on Babunsanti and 113.1 ± 4.5 cm on Kolukumbo.
- Seventeen dead leatherback females were observed stranded on the beaches, 5 on Babunsanti, 5 on Samsambo, 3 on Kolukumbo and 4 on Kolukumbo-West (a new beach 1.5 km west of Kolukumbo), 41.2% of the strandings occurred in June.
- A first data analyses indicates that of the 2,235 individuals observed during the 2003-nesting season, at least 21.1% (472 individuals) had injuries that may have been fisheries related.
- A total of 200 leatherback nests were marked on Babunsanti for monitoring, of which the fate of these nests was determined. Twelve nests were excluded from further analyses because they were mixed with other nests, poached, depredated.
- A total of 79.3% of the marked nests hatched. Of these, average hatching success was 28.0%. Overall average hatching success, including the zero-hatching success of the unsuccessful nests, was 22.2%.
- A (non-random) selection of non-marked *in situ* leatherback (n=294), green turtle (n=215) and olive ridley turtle (n=10) nests were excavated and analysed.
- Average hatching success for the non-marked leatherback nests was 41.9%. This can, however, not be considered representative as the nests were not randomly chosen and bias existed towards recognising nests with many hatchling tracks.
- Of all marked nests 90.4% were attacked by mole crickets and 1.6% by ghost crabs, for the successful marked nests this was 97.9% and 2.0% respectively, and for the unmarked nests this was 99.6% and 2.4%.
- On Babunsanti, 17.0% of the marked nests were situated in the high beach zone, 25.0% in the mid zone and 57.9% in the low zone, 18.6% of the marked nests were laid more than 2 meter below the spring tide line (STL). The lower hatching success for the low zone can mainly be attributed to nests situated at more than 2 m below the STL.
- Average clutch size was 86.6 ± 18.4 yolked eggs and 31.6 ± 20.9 yolkless ('false') eggs for the marked nests on Babunsanti.
- The mean incubation period of Babunsanti was 62.6 ± 3.0 days (n=104) with a range of 56 to 70 days.
- Nest bottom depth was 78.6 ± 10.7 cm (n=181) on Babunsanti with a range of 47 to 114 cm.
- Sand temperatures were below the pivotal temperature for leatherbacks (29.5°C) on both beaches for most of the season. Temperatures of Kolukumbo were higher than those of Babunsanti.

1. INTRODUCTION

More than half the present world leatherback (*Dermochelys coriacea*) population is estimated to be nesting in the Guianas, on the beaches in and close to the Marowijne River Estuary in Suriname and French Guiana (Chevalier and Girondot 2000; Spotila *et al*. 1996, 2000). Large leatherback nesting colonies have also been reported in Trinidad (pers. comm. of A. Rambaran and M. Ramjattan, Nature Seekers) and West Africa (Gabon, Congo) (Billes *et al.* 2003). All former mass leatherback nesting colonies in the Pacific and Indian Oceans have collapsed (Spotila *et al*. 1996, 2000). The species is enlisted as critically endangered in the IUCN Red List of Threatened Species (IUCN 2000, 2003). Conservation of the leatherback nesting aggregations in the Guianas is essential for survival of the species is the Atlantic.
Leatherback nest numbers in French Guiana showed a decrease in the 1990's (Chevalier *et al*. 1999) Nest numbers in Suriname have, however, shown a strong increase since monitoring started in the late 1960's (more than 10,000 nests per year since 1999, with a peak of over 30,000 nests in 2001) and the long-term trend for the Suriname and French Guiana population seems to show an increase (Hilterman and Goverse 2002, 2003; Girondot 2002; Mrosovsky 2003). The leatherback nesting season in the Guianas typically runs from April to August (rainy season).

Project history
In 1999, the *'Leatherback Turtle Research and Monitoring Project Suriname'* (since 2003 hosted by the Netherlands Committee for IUCN (NC-IUCN) and before that by the Biotopic Foundation) started by means of a PIT (Passive Integrated Transponder) tagging program, as part of the *regional 'Guianas Forests and Environmental Conservation Project'* (GFECP) - initiated and funded by WWF-Guianas - following the WWF-France and University of Paris-XI teams in the Amana Natural Reserve in French Guiana.
In 2000, the Guyana Marine Turtle Conservation Society (GMTCS) also started a PIT tag program on Shell Beach, Guyana and so did the Kwata Foundation on Montjoli Beach, French Guiana, as part of the WWF-Guianas program. The project is carried out in close collaboration with STINASU (Foundation for Nature Conservation in Suriname).

Overall goal
To add to the protection of the leatherback turtle nesting population in Suriname and the surrounding countries, by means of:
- assessment of population size and trends in order to improve conservation strategies and update world status reports;
- capacity building, and;
- local and international collaboration.

Specific objectives
Objectives over a period of several years are:
- determine the number of leatherback females nesting in Suriname and the number of nests they produce, and trends of this population (*e.g.* clutch frequency, internesting intervals, remigration rates, beach fidelity) by means of a large scale PIT tag program on the Index beaches;
- determine nest survival and hatch success for *in situ* leatherback nests;
- determine the prevalent sex-ratio of hatchlings, based on sand temperature profiles;
- obtain biometric data on nesting leatherbacks and leatherback hatchlings;
- qualify and quantify the threats facing adults turtles with a special focus on fisheries related injuries and mortality;
- educate and train local students and counterparts in sea turtle biology, research techniques, data analyses and interpretation.

Beach locations
Sea turtle nesting beaches are found only in the eastern part of Suriname. The main present nesting beaches for leatherbacks are:
- Babunsanti, 6 km length, situated in the Marowijne River Estuary, Galibi Nature Reserve;
- Kolukumbo, 1 km length, situated approximately 15 km west of the Marowijne River Estuary on the Atlantic coast;
- Matapica, 9 km length, situated on the Atlantic coast approximately 10 km eastward of the Suriname River Estuary. A highly dynamic beach, that moves to the west with a speed of approximately 1.5 km annually (Augustinus 1978, pers. obs.). Unfortunately, during the 2003-nesting season there was no opportunity to continue PIT tagging and nest monitoring activities on Matapica.

Other nesting beaches are Alusiaka (mainly green turtle nesting), Thomas-Eilanti (green turtle, olive ridley and some leatherback nesting), Samsambo (leatherback and olive ridley nesting), Diana Beach (some green turtle, leatherback and olive ridley nesting).
- ➢ *For a more detailed description of the Surinam coastline and map of the beach locations of eastern Suriname, see Hilterman and Goverse (2003).*

2. METHODS

2.1 PIT tagging of nesting leatherback turtles

In the three Guianas, TROVAN ID100 PIT tags and LID500 scanners are used. Tags are injected in the muscle of the right shoulder as described by Dutton and McDonnald (1994). After tagging, turtles are always rescanned to check for proper tag placement. Tagging and scanning are done at all stages of the nesting process and in addition to the PIT code, the turtle's activity, distance of the nesting position to the spring tide line, distance travelled from the water line, location on the transect line and the turtle's size were recorded.
Nightly beach patrols stretched from at least three hours before high tide to at least two hours after high tide. Patrolling continued until the last turtle had finished nesting. Table 2.1 shows the PIT tagging effort for 2003.

In 2003, PIT tagging was done on Babunsanti and Kolukumbo. The total length of Babunsanti is approximately 6 km but for logistical reasons, nightly beach patrolling and PIT tagging was done on 4.5 km. On Kolukumbo, only the most western 0.3 km of the beach was suitable for nesting because of an extensive mudflat in front of the beach.

Beach	Sections	Distance	Duration of coverage	Permanent presence by
Babunsanti	BS-I/II/N and PB-I/II	4.5 km	April 23rd - August 1st	3 - 4 researchers
Kolukumbo	western side	0.3 km	May 9th - July 14th	1 researcher

Table 2.1 *PIT tagging efforts during the 2003-nesting season.*

2.2 Biometric data collection

Curved carapace length and width (CCL and CCW) of tagged leatherback females were measured with a flexible aluminium tape measure. Minimum (or standard) CCL was measured alongside the vertebral ridge. CCW was measured at the widest point, spanning from ridge crest to ridge crest (Wyneken 2001). Depending on the activity of the turtle in the nesting process, CCW could not always be measured.

2.3 Nest number estimates

Daily track counts were done by STINASU field personnel. In addition, based on the observed (missed) nesting attempts on Babunsanti and Kolukumbo as obtained from the PIT tag program, an estimate was made of the number of leatherback nests on these beaches. The number of observed turtles was multiplied by 1.1 (adding 10%) to compensate for missed nestings, after which 10% was distracted for aborted nesting attempts (false crawls).
For beaches or beach sections that were not monitored, an estimate was made based on incidental nest counts and experiences of former years.
Alternatively, by multiplying the number of (observed) leatherback females by the estimated clutch frequency, nest number estimates can be obtained.

- *Nest number overview of the other nesting sea turtle species is presented in appendix 1.*

2.4 Identification and quantification of threats

The commercial drift-net fishing fleet poses a serious threat to nesting leatherback females in the Guianas. It is believed that large numbers of adult females drown in the nets or die as a result of being cut out of the nets in order for the fishermen to save their nets (Chevalier 2000; pers. obs.).
On the monitored beaches the number of strandings for each sea turtle species was recorded. Notes were made on the state of the carcass and possible causes of death. Stranded leatherbacks were scanned for PIT tags.

As part of the PIT tag program, all scanned leatherback females were briefly examined for fisheries-related injuries. Short notes were made of the kind of damage and degree of freshness of the wounds or scars. The categories encountered most are (partially) chopped off flippers or hind limbs, net wounds or net scars around the neck and shoulders, machete marks in shoulders, neck, limbs or carapace, parts of nets still wrapped around the turtle, holes in carapace and flippers, and fishing hooks in flesh.

2.5 Determination of nest survivorship and hatching success

Nest marking

A total of 200 *in situ* leatherback nests were randomly marked from April 28th to June 2nd on Babunsanti along a 3000 meter transect line with numbered stakes at 10 meter intervals in the beach-vegetation. During the nightly beach patrols, small (temporary) sticks were placed 0.5 m behind the egg chamber of leatherbacks in a far stage of digging their nest, depositing eggs or closing the nest, and the turtle's position (direction of the head) was schematically recorded.

The next morning the clutches were carefully opened by hand. A tightly folded plastic flag with nest number and date was placed on top of each clutch as a nest-marker, after which the nest was firmly closed again. Exact location of each nest was triangulated from the nearest two stakes. This procedure has proved not to disturb the nests (Hilterman and Goverse 2003).

Triangulation records were used to retrieve the nests and determine their fate after two months of incubation. Three days after first hatchling emergence at the surface, or 73 days in case of non-emergence or unnoticed emergence, the nests were excavated and nest contents analysed. Also a (non-random) selection of non-marked *in situ* leatherback (n=294), green turtle (n=215) and olive ridley turtle (n=10) nests were excavated three days after observed emergence.

- *Results of green turtle and olive ridley nests can be requested at the authors*.

Nest analyses

For each analysed nest, distance of the nest to the spring tide line, nest bottom depth, incubation time, number of yolkless eggs, hatched eggs (empty shells), undeveloped eggs, ruptured (predated) eggs and type of predation, number of eggs with embryonic mortality and embryonic stage, number of pipped hatchlings, life hatchlings (stragglers), dead hatchlings, and deformed hatchlings were recorded at a standard data-sheet.

The categories for non-hatched egg contents are described in Hilterman and Goverse (2003). In Suriname, main predators of eggs are a mole cricket species (*Scapteriscus didactylus*) (Maros *et al.* 2003) and the ghost crab (*Ocypode quadrata).* Hatching success (%) is determined by dividing the empty shells by the total number of eggs (empty shells + pipped eggs + all non-hatched eggs), yolkless eggs not included.
The spring tide line (STL) is determined by the highest deposition of driftwood. Nests located landward perpendicular to the STL are referred to as 'plus STL', nests located seaward of the STL are referred to as 'minus STL'.

2.6 Determination of sand temperatures

The pivotal temperature for leatherbacks is 29.5ºC. Above that temperature, more females are produced, and below, more males (Mrosovsky and Yntema 1980, Desvages *et al.* 1993, Godfrey *et al.* 1996).
Electronic HOBO temperature data loggers were deployed at 70 cm depth (average estimated clutch centre depth) on three beach zones (high, mid, low) of Babunsanti and Kolukumbo at the beginning of the fieldwork period and recovered at the end of the leatherback nesting season in order to determine sand temperature profiles. The beach zones were chosen for their popularity as a nest site for leatherback turtles. Data were recorded every two hours for the whole period. Data were grouped by 10-days intervals for which the average temperature was calculated.

- *A more detailed description of used methods can be found in Hilterman and Goverse (2003).*

3 RESULTS

3.1 PIT tagging of nesting leatherback turtles

A total of 2,235 individual leatherback females were observed, of which 1,358 nested on Babunsanti (table 3.1). New tags were applied to 1,473 individuals (65.9%), the remaining 762 (34.1%) were previously tagged. Two were remigrants from 1999, 19 were remigrants from 2000, 363 were from 2001 and 6 from 2002, and 365 turtles had a PIT code not known for Suriname. A substantial part of the latter group had expectedly been tagged in French Guiana, but wrongly recorded codes may also be included. The total number of tag records, including 2,586 within-season recaptures, was 4,821.

Beach	Total length of beach	Monitoring area		New tags	Old tags	Within-season recaptures	Total records
Babunsanti	6 km	BSI/II/N, PBI/II	4.5 km	793	565	1,765	3,123
Kolukumbo	1 km	western part	0.3 km	680	197	821	1,698
Total	**16 km**		**4.8 km**	**1,473**	**762**	**2,586**	**4,821**

Table 3.1 *Tag effort and number of tag records per monitored beach for the 2003-nesting season.*

Table 3.2 and figure 3.1 show the yearly number of tag records since 1999, a distinction is made between new tags, individuals that had a tag already (including remigrants of former years and tag codes unknown for Suriname) and within-season recaptures.

Tag category	1999	2000	2001	2002	2003	Total
Newly tagged individuals	62	385	2,455	1,832	1,473	6,207
Old tag, but new individual for Suriname	7	70	448	401	365	1,291
Old tag, remigrant from Suriname	0	0	24	51	397	472
Total number of observed individuals	69	455	2,927	2,284	2,235	7,970
Within-season recaptures	5	47	1,701	3,110	2,586	7,449
Total number of records	**74**	**502**	**4,628**	**5,394**	**4,821**	**15,419**

Table 3.2 *Overview of PIT tag records in Suriname 1999-2003. Note: PIT tag efforts in 1999-2000 were significantly less intensive than in 2001-2003, and in 2001-2002 PIT tagging was done on Matapica as well.*

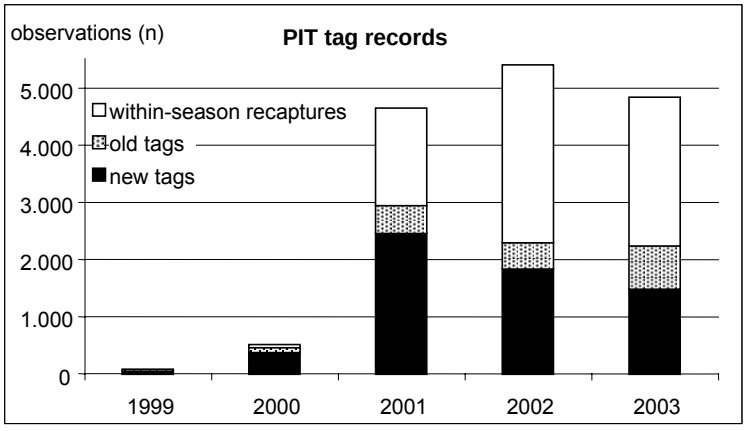


Fig. 3.1 *Number of PIT tag records in Suriname.*

Remigration

Of the observed nesting cohort of 1999 (n=69), 39.1% had been seen again by 2003 (see table 3.3). Of the 2000 cohort (n=455), this was 14.5% and of the 2001 cohort (n=2,927) this was 12.5%. Six individuals (0.3%) of the 2002 cohort (n=2,289) returned in 2003. Eight individuals have been encountered in three different nesting seasons in Suriname.

Two turtles PIT tagged in 2001 in Suriname have returned in 2003 in Guyana (pers. comm. of A. Arjoon, Guyana Marine Turtle Conservation Society). The female tagged in 2001 that was captured in 2002 in Nova Scotia, Canada, (pers. comm. of M. James, Nova Scotia Leatherback Turtle Working Group) returned to nest in 2003 on Babunsanti.

	Number of remigrants					Percentage of remigrants				
year	**2000**	**2001**	**2002**	**2003**	**n**	**2000**	**2001**	**2002**	**2003**	**%**
1999	0	22	3	2	27	0,0	31,9	4,3	13,0	39,1
2000	-	2	45	19	66	-	0,4	9,9	4,4	14,5
2001	-	-	3	363	366	-	-	0,1	12,4	12,5
2002	-	-	-	6	6	-	-	-	0,3	0,3

Table 3.3 *Overview of remigrants from Suriname. Eight turtles were seen in three different nesting seasons but recorded here as remigrants in the first year they were seen again.*

Other observations:

- 20 individuals with Monel tags form French Guiana were observed, seven of which had not previously been PIT tagged.
- Of the 1,197 leatherback females seen twice or more, 101 (8.4%) made one ore more shifts between Babunsanti and Kolukumbo.

Internesting periods

The mode of the observed internesting period (OIP) was 9 days (fig. 3.2). The smaller peaks seen at 17-21 days and subsequent peaks, are presumably the result of turtles that were missed on their previous return(s), or which had nested outside the study area. Mean OIP in 2003 was 9.48 ± 1.01 (n=1,286), we excluded OIP values of less than six or greater than eleven days as either aborted nesting attempts or as including an unobserved nesting (Miller 1997, Reina *et al.* 2002).
Based on these OIP data, 7.6% (n=196) of the nesting attempts resulted in aborted nesting attempts or false crawls.

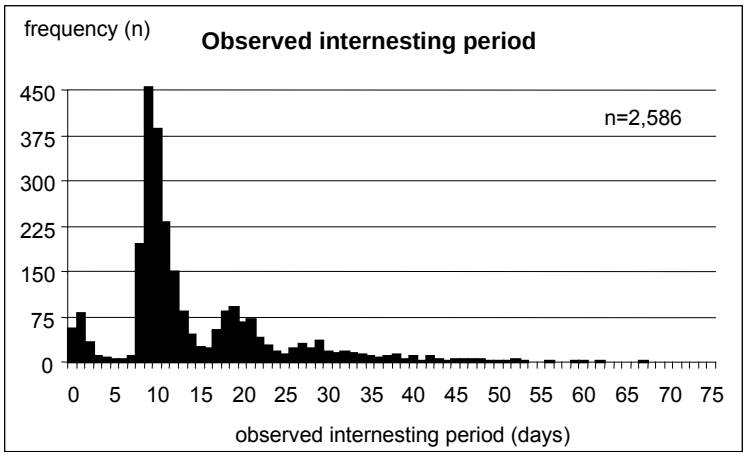


Fig. 3.2 *Observed internesting period (OIP) for Babunsanti and Kolukumbo data grouped.*

Clutch frequency

Figure 3.3 shows the observed clutch frequency (OCF) of gravid leatherback females for Babunsanti and Kolukumbo. OCF was obtained after correction for false crawls (internesting periods of less than six days). Mean OCF was 3.11 ± 1.32 (n=1,197) nests, calculated without the group of one time nesters. Of all turtles, 46.4% (n=1,038) was seen only once. OCF ranged between one and ten nests.

Figure 3.4 shows the estimated clutch frequency (ECF) for turtles that were observed nesting twice or more on Babunsanti. Babunsanti is considered more representative here than a combination of the two beaches because of the higher degree of beach coverage in time.

The ECF-Babunsanti was calculated by dividing the number of days in between the first and last nesting dates for an individual by the mean OIP-Suriname of 9.48, adding one for the first oviposition. We used only the individuals with a first oviposition date before June 2nd, thereby avoiding the possibility that the turtle finished nesting after the end of the fieldwork period, following Reina *et al.* (2002). Mean ECF on Babunsanti (excluding the group of one-time observed nesters (n=363)) was 4.72 ± 2.05 (n=580) nests.

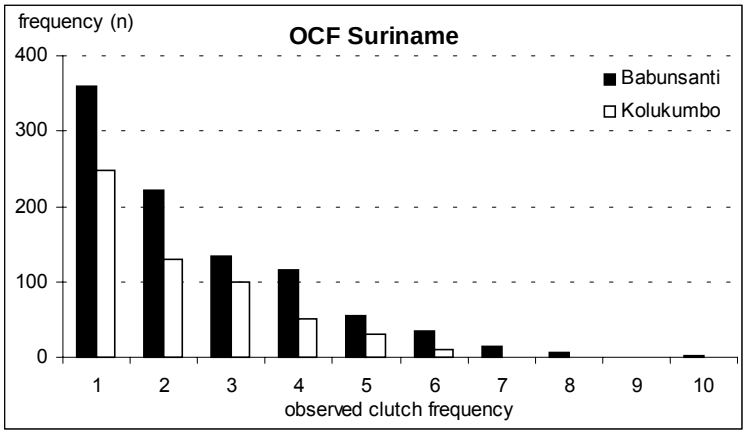


Fig. 3.3 *The observed clutch frequency (OCF) for Babunsanti and Kolukumbo.*

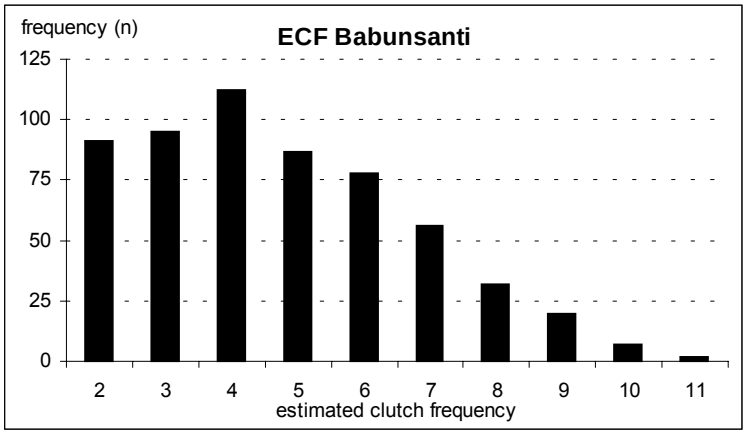


Fig. 3.4 *The estimated clutch frequency (ECF) for Babunsanti using a mean observed internesting period of 9.48 days.*

3.2 Nest numbers

At the time of submission of this report STINASU nest count data for the 2003-season were not yet available. Based on PIT tag data (number of new tags + old tags + observed missed nestings per night; false crawls excluded) and rough estimates for beaches/sections that were not monitored, the estimated minimal number of nests after correction for incomplete beach coverage is 12,000 (table 3.4).

Figure 3.5 shows the nesting activity pattern for leatherbacks on Babunsanti and Kolukumbo combined with the daily high tide heights (monitoring period differs between the beaches).

Beach		length (km)	STINASU nest count	Observed nesting attempts (PIT tagging)	Estimated No. of nests (minimum)
Babunsanti	-exc. pb3	4.5	-	3,882	4,000
	-pb3	1.5	-	-	1,000
Thomas-Eilanti		1.2	-	-	400
Samsambo		8.0	-	-	1,500
Kolukumbo		1.0	-	1,692	2,300
Kolukumbo-West		0.2	-	-	400
Matapica		9.0	-	-	2,200
Other beaches					200
Total		**25.7**	**-**	**5,574**	**12,000**

Table 3.4 *Number of nesting attempts observed while PIT tagging (false crawls included) and (roughly) estimated number of nests after correction for incomplete beach coverage in space and time, false crawls excluded. Other beaches include Braamspunt, Alusiaka, Diana Beach, etc.*

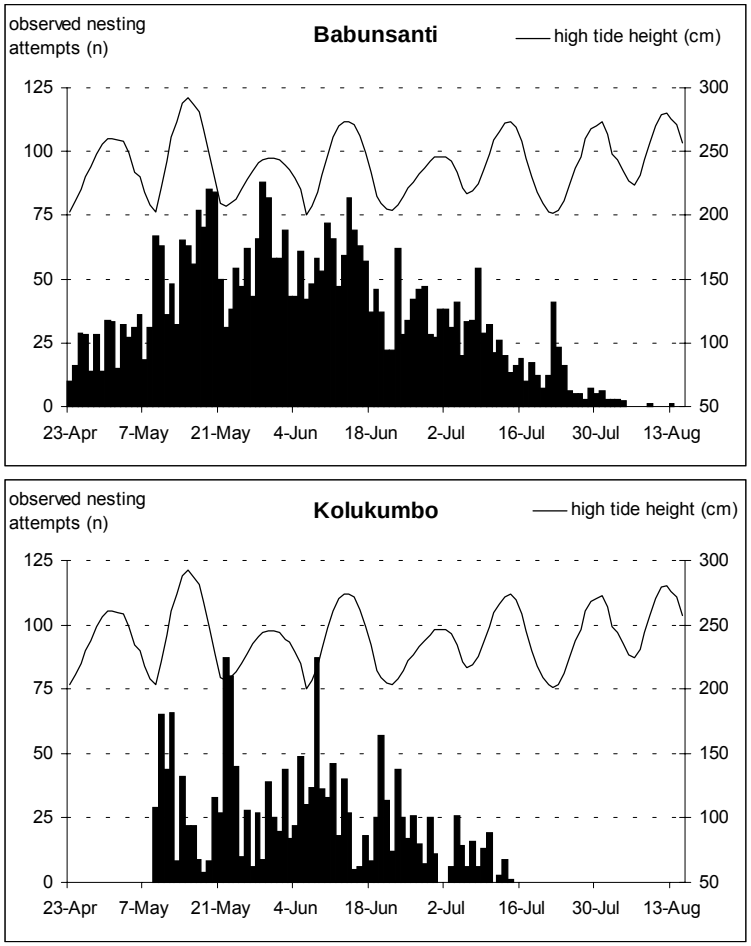


Fig. 3.5 *Observed daily nesting attempts during PIT tagging and tidal cycles during the 2003-nesting season on Babunsanti and Kolukumbo*.

3.3 Biometric data

The average curved carapace length of gravid leatherback females was 155.2 ± 7.1 cm on Babunsanti and 154.3 ± 6.9 cm on Kolukumbo. Curved carapace width was 114.1 ± 5.0 cm on Babunsanti and 113.1 ± 4.5 cm on Kolukumbo (table 3.5). This is similar to average carapace sizes found in 2000-2002. Figure 3.6 shows the size frequency distribution for nesting leatherbacks on Babunsanti and Kolukumbo.

2003	CCL (cm)	Min.	Max.	n	CCW (cm)	Min.	Max.	n
Babunsanti	155.2 ± 7.1	129.0	184.0	2,152	114.1 ± 5.0	100.0	130.0	912
Kolukumbo	154.3 ± 6.9	129.0	175.0	622	113.1 ± 4.5	103.5	128.0	101
total	**155.0 ± 7.1**	**129.0**	**184.0**	**2,774**	**114.0 ± 4.9**	**100.0**	**130.0**	**1,013**

Table 3.5 *Mean curved carapace lengths (CCL) and widths (CCW) on Babunsanti and Kolukumbo (n= number of records, individuals can be measured more than once).*

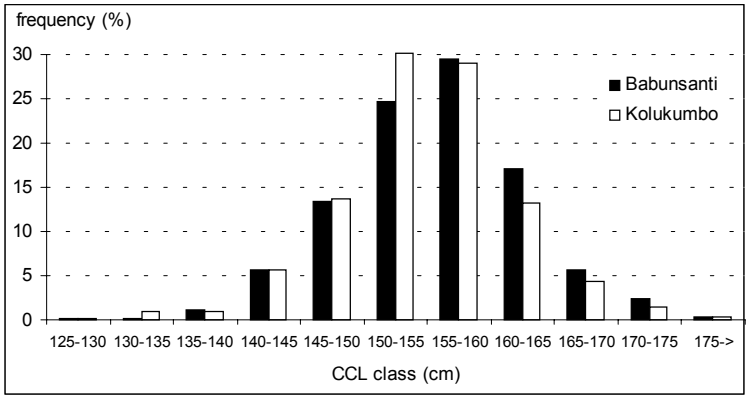


Fig. 3.6 *Size frequency distribution for nesting leatherbacks on Babunsanti (n=2,152) and Kolukumbo (n=622).*

3.4 Threats

Seventeen dead leatherback females were observed stranded on the beaches, 5 on Babunsanti, 5 on Samsambo, 3 on Kolukumbo and 4 on Kolukumbo-West (a new beach 1.5 km west of Kolukumbo), 41.2% of the strandings occurred in June (table 3.6). No data for Matapica are available.

A first data analyses indicates that of the 2,235 individuals observed during the 2003-nesting season, at least 21.1% (472 individuals) had injuries that may have been fisheries related. Injuries were categorised as machete or net scars and wounds (72.1%), hooks in flesh or propeller damage (0.8%), (partly) missing flippers or hind limps (13.9%) and tip of carapace missing (13.2%). Some turtles showed multiple injuries.

For data on egg poaching activities refer to STINASU.

Date	Species	Beach	State of carcass	Fishery related injuries	PIT tagged	Remarks
24-Apr	Dc	Samsambo	fresh, 2 days	-	-	-
29-Apr	Dc	Babunsanti	> 1 week	-	-	only rear part
3-May	Dc	Babunsanti	fresh, 1 day	machete cuts	-	flipper cut off
30-May	Dc	Kolukumbo-West	> 1 week	none	-	stuck between trees
2-Jun	Dc	Samsambo	-	-	-	seen from boat
12-Jun	Dc	Kolukumbo	few days old	-	00061108F9	-
16-Jun	Dc	Kolukumbo	ca. half a week	none	-	-
26-Jun	Dc	Babunsanti	-	none	00060DAB90	-
29-Jun	Dc	Kolukumbo	few days old	shoulder wound/cut	-	-
30-Jun	Dc	Samsambo	ca.3 days	-	-	observed from boat
30-Jun	Dc	Samsambo	ca.3 days	-	-	observed from boat
2-Jul	Dc	Babunsanti	> 1 week	-	-	-
2-Jul	Dc	Kolukumbo-West	> 1 week	-	-	-
2-Jul	Dc	Kolukumbo-West	> 1 week	-	-	-
2-Jul	Dc	Kolukumbo-West	-	wrapped in net	-	-
14-Jul	Dc	Samsambo	fresh, 2 days	hole in carapace	000127B939	-
19-Aug	Dc	Babunsanti	fresh	-	-	-

Table 3.6 *Overview of stranded turtles that were observed during the 2003-nesting season (Dc = leatherback turtle).*

3.5 Nest survival and hatch rates

Table 3.8 shows the fate of the randomly marked *in situ* leatherback nests on Babunsanti. All observed unmarked leatherback nests (also referred to as natural nests) of which emerged hatchling tracks were observed were also excavated (294 nests on Babunsanti, of which 4 were excluded from further analyses).

Marked nests on Babunsanti	
Marked	200 nests
Retrieved	200 nests (100%)
Excavated but excluded from further analyses	12 nests (mixed with other nests, poached, depredated, etc.)
Used for determination of *in situ* hatch rates	188 nests
Not hatched of these 188 nests	39 nests (20.7%)

Table 3.7 *Fate of the marked leatherback nests of which the exact position was recorded by triangulation.*

Hatching success and emergence success for the marked and unmarked *in situ* leatherback nests is shown in table 3.7. Successful nests are defined as nests of which one or more eggs had hatched.

A total of 79.3% of the marked nests hatched. Of these, average hatching success was 28.0%. Overall average hatching success, including the zero-hatching success of the unsuccessful nests, was 22.2%. A frequency distribution of hatching success for the marked nests is shown in figure 3.7.

Average hatching success for the unmarked, successful nests was 41.9%. This can, however, not be considered representative for overall *in situ* hatching success, as the nests were not randomly chosen and a bias towards the more successful nests was likely when it came to recognising the hatchling tracks.

Babunsanti	Hatching success (%)		Emergence success (%)	
Marked nests (all nests, including un-hatched nests)	22.2 ± 22.4	(n=188)	21.0 ± 22.1	(n=188)
Marked nests (successful nests only)	28.0 ± 21.6	(n=149)	26.4 ± 21.8	(n=149)
Unmarked nests (only successful nests, non-random selection)	41.9 ± 22.1	(n=290)	39.5 ± 22.3	(n=290)

Table 3.8 *Average hatching and emergence success and standard deviation per nest for marked and unmarked leatherback nests on Babunsanti (emergence success is hatching success minus the fraction of dead hatchlings and stragglers).*

Figure 3.8 shows the hatching success and egg development for the marked nests. Of all marked nests 90.4% were attacked by mole crickets and 1.6% by ghost crabs, for the successful marked nests this was 97.9% and 2.0% respectively, and for the unmarked nests this was 99.6% and 2.4%. Egg depredation, divided over mole cricket and ghost crab, was one of the main causes for egg mortality.

For the successful marked nests, an average of 35.9% of the yolked eggs per nest were predated by the mole cricket and 0.1% by the ghost crab.

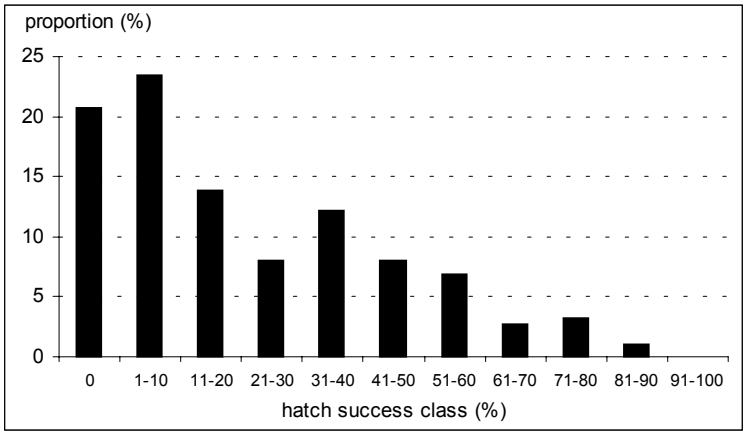


Fig. 3.7 *Frequency distribution of hatching success of the marked nests.*

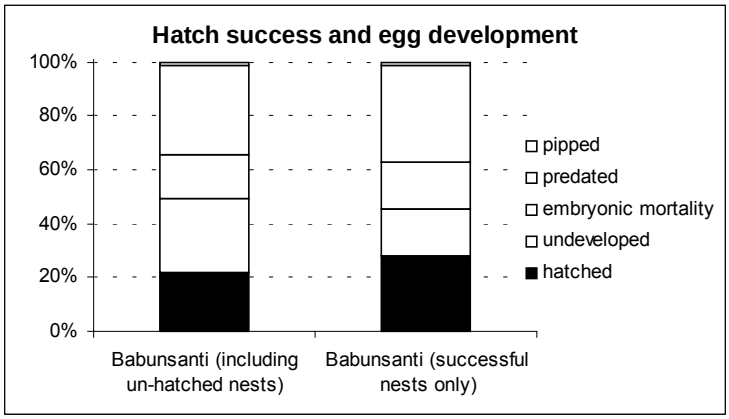


Fig. 3.8 *Average hatching success and egg development per nest for the marked nests on Babunsanti.*

Nest location and hatching success

Figure 3.9 shows the distribution of the marked nests along and across the study beaches. Babunsanti is a narrow beach (maximum 4 m width during high tide to 0.5 m with spring tide) with dense beach vegetation like *Ipomoea pes-caprae* (Convolvulaceae) and *Canavalia rosea* (Fabaceae) reaching up to the spring tide line. Based on beach morphology, the beach was divided into three zones: high, mid and low (see table 3.9).

Beach	High zone	Mid zone	Low zone
Babunsanti	STL > 0.5 m	-0.5 m ≤ STL ≤ 0.5 m	STL < -0.5 m

Table 3.9 *Criteria for beach zone demarcation (distance to STL in meters) based on beach morphology. Minus STL corresponds to seaward of the spring tide line.*

On Babunsanti, 17.0% of the marked nests were situated in the high zone, 25.0% in the mid zone and 57.9% in the low zone (fig. 3.10), 18.6% of the marked nests were laid more than 2 meter below the STL.
Hatch rates for the three beach zones are shown in table 3.9. Hatching success as a function of the distance of the nest to the STL is shown in figure 3.11. The lower hatching success for the low zone can mainly be attributed to nests situated at more than 2 m below the STL.

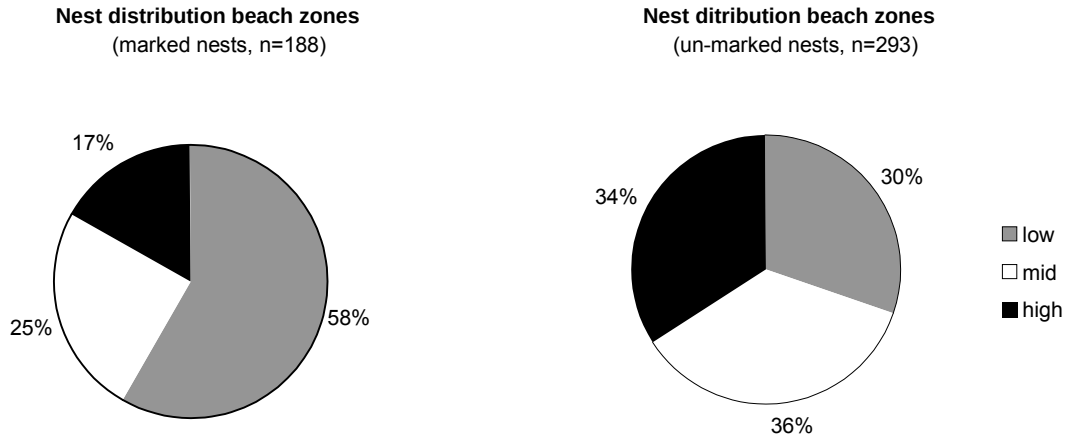


Fig. 3.10 *Nest distribution across the beach, divided over the three beach zones high (STL > 0.5 m), mid (-0.5 m ≤ STL ≤ 0.5 m) and low (STL < -0.5 m) for randomly marked and unmarked (non-randomly chosen) nests.*

Nest type	H% high zone		H% mid zone		H% low zone	
Marked (incl. un-hatched nests)	32.5 ± 21.4	(n=32)	28.3 ± 24.7	(n=47)	16.5 ± 19.8	(n=109)
Marked (successful nests only)	34.7 ± 20.3	(n=30)	31.7 ± 24.0	(n=42)	23.3 ± 19.9	(n=77)
Unmarked (successful nests)	44.3 ± 21.2	(n=101)	41.8 ± 23.5	(n=103)	38.5 ± 21.3	(n=89)

Table 3.10 *Average hatching success (H%) and standard deviation per nest for the beach zones on Babunsanti.*

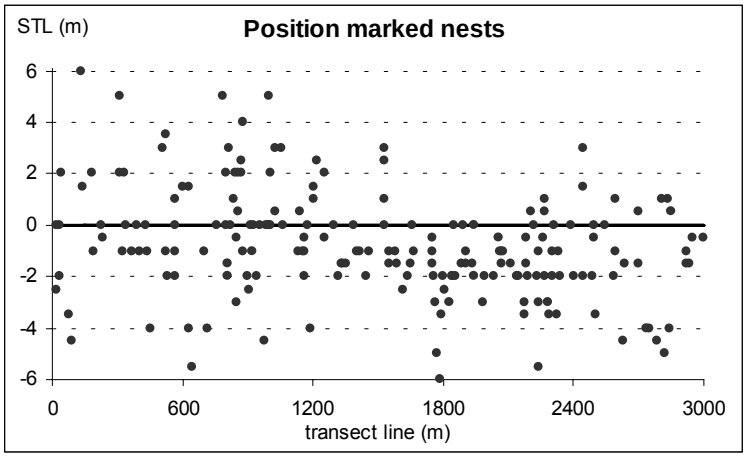


Fig. 3.9 *Nest distribution along and across the beach (distance of the nest to the STL) of the randomly marked* in situ *leatherback nests at Babunsanti.*

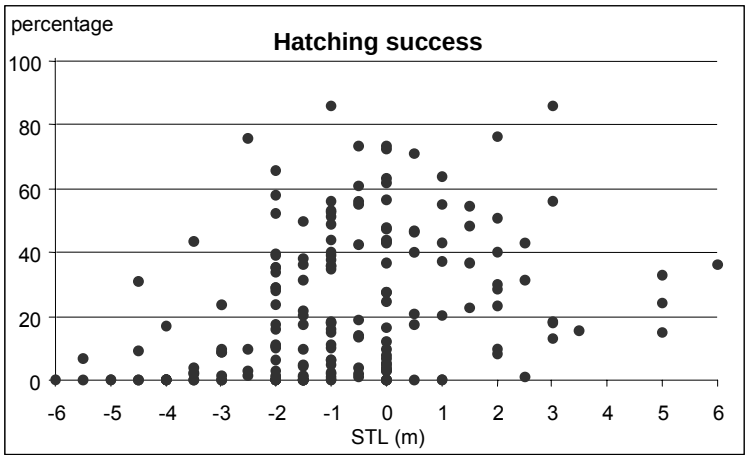


Fig. 3.11 *Hatching success of the marked nests on Babunsanti as a function of the distance of the nest (n=188) to the spring tide line (nest position across the beach).*

Nest failure is highest at distances of two or more meters below the STL. The fraction of undeveloped eggs is higher for the lower beach zone. Nests laid more than 2 meters above the STL (between the beach vegetation) show a lowered hatching success as well.

Clutch size, incubation periods and nest depth

- Average clutch size was 86.6 ± 18.4 yolked eggs and 31.6 ± 20.9 yolkless ('false') eggs for the marked nests on Babunsanti.
- The mean incubation period of Babunsanti was 62.6 ± 3.0 days (n=104) with a range of 56 to 70 days (fig. 3.12).
- Nest bottom depth was 78.6 ± 10.7 cm (n=181) on Babunsanti with a range of 47 to 114 cm.

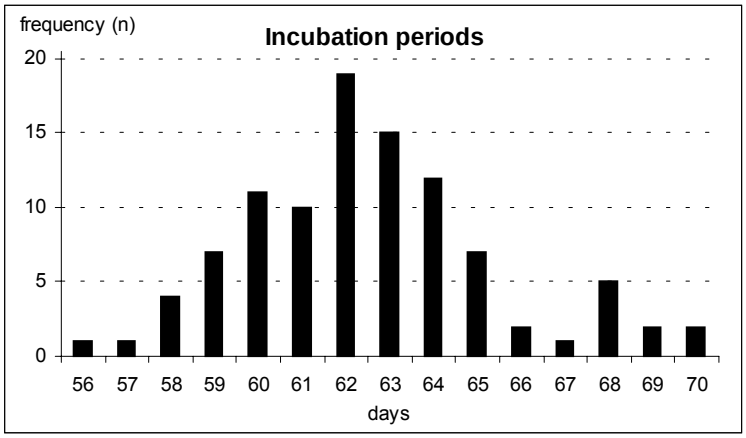


Fig. 3.12 *Frequency distribution of incubation periods on Babunsanti 2003.*

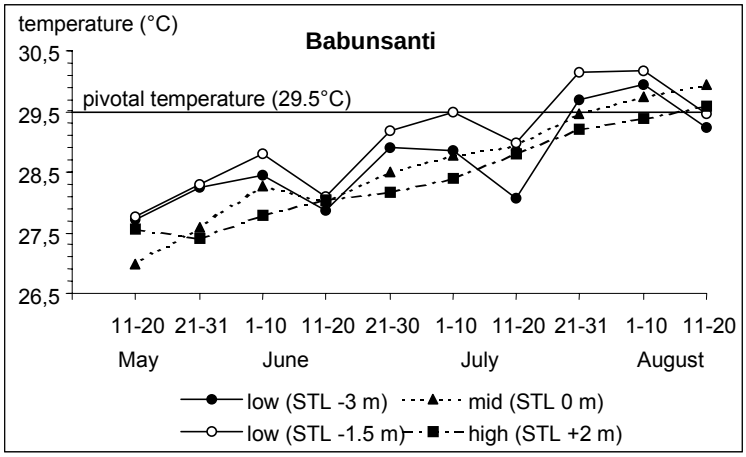
3.6 Sand temperature and sex determination

Sand temperatures were below the pivotal temperature for leatherbacks (29.5°C) on both beaches for most of the season (fig. 3.13). Temperatures of Kolukumbo were higher than those of Babunsanti. The higher temperatures of the low zones on Babunsanti compared to those of the mid and high zones are unusual. The temperature measured inside the nest was significantly higher than that of the sand a few meters from the nest (at the same distance from the STL).

The nest in which a data logger was placed had a hatch rate of 6.3%. The two major drops in temperature on Babunsanti during June 11-20 and July 11-20 is due to extreme spring tide.

	Babunsanti					Kolukumbo		
zone	low	low	mid	high	mid (nest)	low	mid	high
STL	-3.0 m	-1.5 m	0.0 m	+2.0 m	0.0 m	0.5 m	3.0 m	6.5 m
data logger buried	May 10	May 10	May 10	May 10	May 30	May 13	May 13	May 13
data logger retrieved	August 14	August 14	August 14	August 14	July 29	August 14	August 14	August 14
starting depth	70 cm	70 cm	70 cm	70 cm	± 60 cm	70 cm	70 cm	70 cm
end depth	73 cm	66 cm	81 cm	70 cm	-	80 cm	70 cm	70 cm
n	575	575	575	575	360	552	552	552
minimum T	25.95	25.95	25.17	26.34	27.91	26.73	27.91	27.91
maximum T	31.93	31.12	30.31	29.90	33.59	31.52	31.52	31.12
average T	28.67	29.02	28.53	28.36	30.42	29.88	29.82	29.38
standard deviation	0.95	1.03	1.02	0.80	1.61	0.93	1.01	0.77

Table 3.11 *Sand temperature (T) overview. Data have been analysed from a day after placing the data loggers to a day before digging up the loggers.*



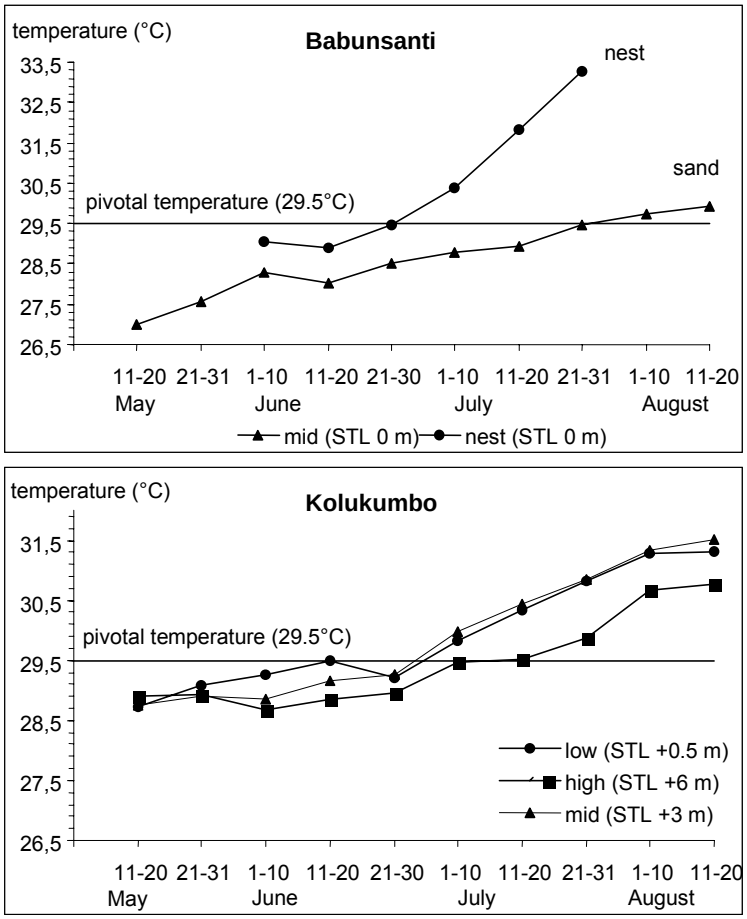


Fig. 3.13 *Sand temperature profiles on different beach zones on two beaches. The second graph presents the two data loggers from the mid zone of which one was placed in the sand the other inside a transferred nest.*

3.7 Miscellaneous

Leatherbacks stuck in the mud

379 leatherback females were observed stuck on the mud flat in front of Kolukumbo. None of these females died on the mudflat, they were all released by the next high tide. On June 8th, 42 leatherbacks were stuck together. All peaks of turtles stuck in the mud were during the moon phases first or last quarter (see also Goverse and Hilterman 2003).

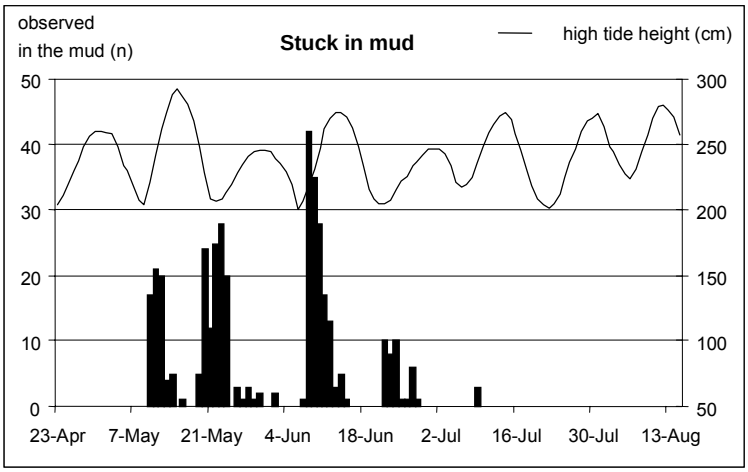


Fig. 3.14 *Number of observed leatherbacks stuck in the mud at Kolukumbo.*

Leatherbacks flipped over

In the course of the nesting season, 5 leatherback females were observed up-side down. This strange phenomena has been observed on Babunsanti and Samsambo. Most likely, they had flipped over in the surf (pers. obs.). All were turned around to the normal position with help of the research and STINASU personnel. Flipped-over leatherbacks were observed in 2001 on Babunsanti (pers. obs.) and some Amerindian STINASU personnel had seen it before a couple of times as well (pictures are presented on the image library of the http://www.seaturtle.org/).

Twin and albino hatchlings

In the analysed marked nests (n=188) 7 twin leatherback hatchlings were observed.

In the analysed un-marked nests (n=290) 5 twins and 2 'albinos' were observed (a picture is presented on the image library of the http://www.seaturtle.org/)

4. Discussion and conclusions

4.1 Tagging of nesting turtles

The PIT tag data demonstrate that *at least* 2,235 leatherback females have nested in Suriname during the 2003-nesting season. However, incomplete beach coverage (and the data on observation frequency) indicate that that the actual size of the 2003-nesting cohort is significantly larger, namely > 3,000. This is less than in 2001 – 2,927 individuals observed and > 5,500 estimated (Hilterman and Goverse 2002) - but comparable to the situation of 2002 – 2,284 identified and > 3,000 estimated (Hilterman and Goverse 2003) - and undoubtedly confirms the present status of Suriname as a major leatherback rookery.

Since 1999, 7,790 individual leatherback females were observed nesting in Suriname. A large nesting colony spread over several beaches and with relatively low beach fidelity like in Suriname and French Guiana can never be covered completely. The estimated number of individuals is higher, we estimated that in the past three years alone, at least 11,500 individuals came to nest. Combined with data from French Guiana and Trinidad, and data from Gabon, it is clear that estimates of the world population of adult females as made by Spotila *et al*. (2000) and in de IUCN Red List 2003 are much too low and that for the Atlantic, populations may not be critically endangered.

Of the 1999 cohort, 39.1% had returned to nest in Suriname by 2003. Of the turtles tagged in 2000, 14.5% were observed to have returned to nest by 2003. Of the 2001 cohort, this was 12.5%. However, these may be under-estimates given the high fraction of turtles not observed and turtles nesting outside the study area (e.g. in French Guiana). Clearly, the situation in the Guianas is very complicated with many highly dynamic beaches spread over a relatively large area.

Data need to be looked at on a regional scale. Given the intensive PIT tag program as carried out since 1998 in French Guiana, it is remarkable that of all observed individuals in 2003 in Suriname, 65.9% did not have a PIT tag yet (in former years this group was even larger). A high recruitment may be one of the reasons for this. It is recommended to have a closer look at the group of untagged turtles regarding carapace size, clutch frequency, etc.

4.2 Nest numbers

We estimated that at least 12,000 leatherback nest were laid (fig. 4.1). When looking at the estimated clutch frequency (ECF) of 4.72 and the estimated minimum number of nesting females of 3,000 in 2003, the number of nests should exceed 14,160. This may well be true and the number of 12,000 is considered the lower limit.

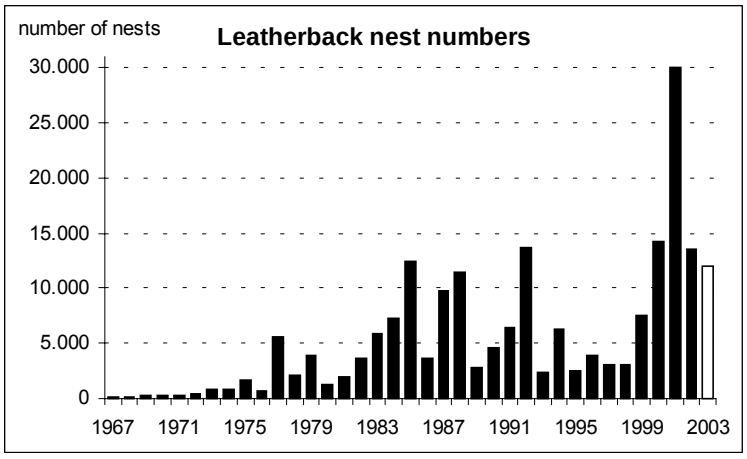


Fig. 4.1 Annual nest number estimates since 1967 for leatherback turtles in Suriname. The 2003-number presents a minimum estimate and is likely to be a vast under-estimate.

4.3 Biometric data collection

Carapace length and width did not differ from former years.

4.4 Threats

The high rate of fisheries related injuries on nesting turtles is alarming and reflects the high incidence of incidental captures. Fisheries regulations in the region must be stricter and a better enforcement is needed if the leatherback population is to remain stable. Egg poaching by villagers is still occurring but seems to be mitigated by the presence of STINASU personnel and researchers on the beaches. However, not all beaches are covered and here, poaching seems to be more of a problem.

4.5 Nest survival and hatch rates

In the 2003-nesting season, approximately 96,000 leatherback hatchlings were produced on Babunsanti. Overall hatch rates on Babunsanti were low (22.1% including nests that did not hatch) but comparable to those of 2002 (25.8%) and higher than in 2001 (10.6%, but probably too low because of the way of marking, see Hilterman & Goverse 2003). From 2000-2002 hatch rates on Matapica were monitored as well, these almost doubled the hatch rates on Babunsanti, which seems to be structurally low.

Although nest numbers on Matapica are generally lower than those on Babunsanti, the number of hatchlings produced may be higher because of the better environmental conditions of this beach, leading to remarkably better hatch rates. Matapica, and probably other oceanic beaches in the Guianas, are very important in terms of leatherback hatchling recruitment and should receive more attention from a conservation point of view.

It was shown in both the present study and that of 2001 and 2002 that leatherback nests can tolerate relatively high amounts of wash-over and being situated below the spring tide line does not per definition mean that hatching success will be close to zero.

4.6 Sand temperatures

Assuming that the mean temperature at nest depth between day 20-40 of the incubation period represents the incubation temperature for the nest (Desvages *et al*. 1993), only nests laid after the beginning of July on Babunsanti and after the beginning of June on Kolukumbo will have produced mainly female hatchlings. This implies that in 2003, on Babunsanti predominantly males were produced and on Kolukumbo, approximately equal numbers of females and males.

4.7 Concluding remarks

With an estimated 11,500 individuals nesting in 2001-2003 in Suriname alone, the leatherback nesting population of Suriname and French Guiana is one of the largest world-wide. Nest numbers in Suriname have been above 10,000 since 2000, with a peak of over 30,000 nests in 2001. In 2001, the number of nests for Suriname and French Guiana combined was 60,000, one of the highest numbers observed for this region in 35 years. For this population the long-term trend seems to show an increase. Combined with the promising messages about high nest numbers in Trinidad (> 10,000 per year) and West Africa (> 30,000 per year), the Atlantic leatherback populations appear stable or even growing.

However, given the dramatic decline of the Pacific leatherback populations, protection and conservation of the nesting populations of the Guayana Shield may be essential to the survival of the species. Continuation of the PIT tag program and assessment of hatchling recruitment is needed for understanding status and trends of this important nesting population as well as direct protection of it.

Regionally, the leatherback populations of the Guianas are threatened by, especially, drift net fisheries. At least 21% of all recorded individuals in the 2003-nesting and 17% in the 2002 season showed some degree of fisheries related injuries. More research and monitoring is needed to quantify and qualify incidental captures by the Surinam fisheries fleet.
Although fisheries regulations and enforcement in Suriname had been a lot improved in the Marowijne River Estuary, it is strongly recommended to extend the direct conservation efforts to the Matapica area. Because of the high hatch rates due to the good environmental quality of this beach, Matapica is very important to the reproductive output (hatchling production) of not only the leatherback population but also of the green turtle, olive ridley and hawksbill nesting populations.

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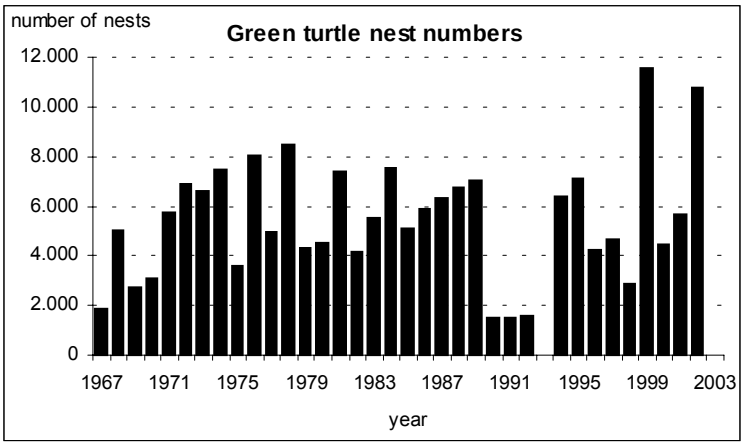
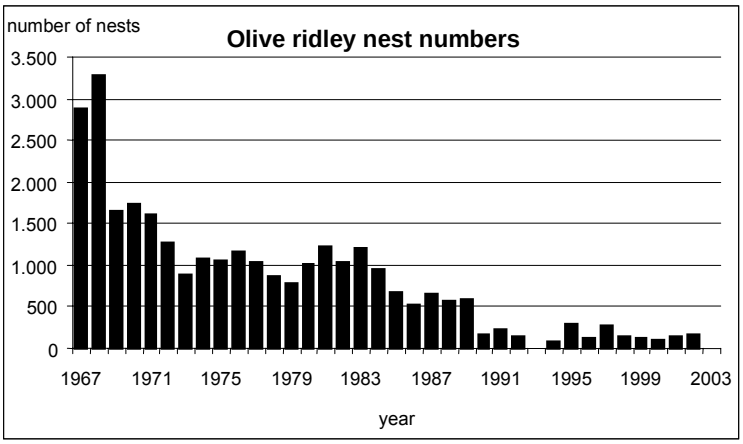
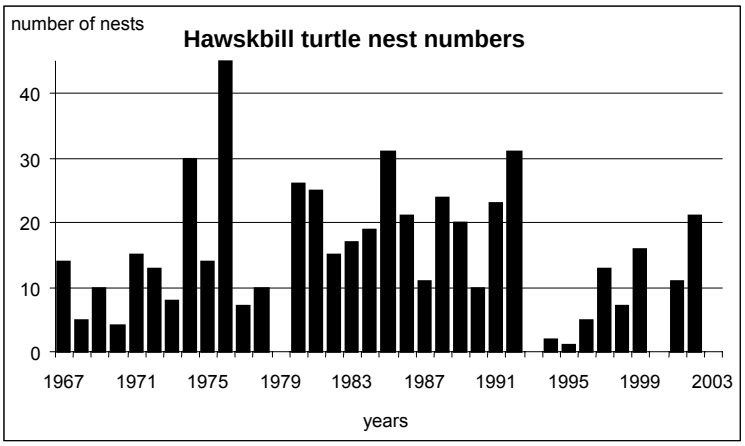
Appendix 1 Green turtle, olive ridley, and hawksbill turtle nest number graphs







Overview of green turtle, olive ridley, and hawksbill turtle nest numbers in Suriname. Data collected by STINASU for the 2003-season were not yet available. Data of some years are incomplete, like the period 1989 – 1994 due to the occupation of the Galibi Nature Reserve by Amerindians from Galibi village. (Source see below.)

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