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CONSERVATION PROJECT

Annual Report on the 2005 Leatherback Turtle Research and Monitoring Project in Suriname

Prepared by:

M.L. Hilterman and E. Goverse

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

January 2006

This study was commissioned by the World Wildlife Fund – Guianas Forests and Environmental Conservation Project (GFECP). The views expressed herein are those of the author(s) and do not necessarily reflect the views of the World Wildlife Fund.

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NETHERLANDS COMMITTEE FOR
IUCN
THE WORLD CONSERVATION UNION

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EXECUTIVE SUMMARY

- Fieldwork was conducted between April 17th and July 23rd 2005 at Babunsanti by the field coordinator and a small team of volunteers, and with the support of field staff of STINASU.
- A total of 1,068 individual leatherback females were observed. New PIT tags were applied to 433 individuals (40.5%), the remaining 635 (59.5%) carried PIT tags already. Since 1999, a total of 8,461 leatherback females were observed nesting in Suriname.
- The total number of tag records, including 930 within-season recaptures, was 1,998.
- Taking into account the incomplete beach coverage and thus unobserved females, we estimated the preliminary total number of nesting females in 2005 to be at least 3,252. This should be considered a *minimum number.*
- Of the previously tagged turtles, 487 (45.6% of total) were remigrants from Suriname (three originally from 1999, seven from 2000, 158 from 2001, 49 from 2002, 269 from 2003, and one from 2004; 112 of these were observed nesting in more than one previous season); and 148 turtles (13.9% of total) had a PIT code not known for Suriname. A substantial part of the latter had expectedly been tagged in French Guiana.
- Of the PIT tagged females in 1999 (n=69), 40.6% had been seen again by 2005. Of the PIT tagged 2000 cohort (n=456) this was 16.4%, of the 2001 cohort (n=2,927) 18.2%, of the 2002 cohort (n=2,283) 8.1% and of the 2003 cohort (n=2,234) 12.1%. One individual (0.2%) of the 2004 cohort (n=645) returned to nest in 2005.
- Six females with flipper tags were observed: two from Trinidad and two from French Guiana, and two from Nova Scotia, Canada. Of the latter, one was PIT tagged in 2003 at Babunsanti. The other had a non-Surinamese PIT tag and probably originates from French Guiana.
- The mode of the observed internesting period (OIP) was 9 days. Mean OIP was 9.4 ± 1.0 (n=461).
- Mean observed clutch frequency (OCF) was 1.9 ± 1.3 nests (n=1,068 females). OCF ranged between one and eight nests. Of all females, 55.3% (n=591) was seen nesting only once.
- The estimated clutch frequency (ECF) (not corrected for nesting before and after survey period) for turtles seen at least twice was 4.7 ± 2.1 nests (n=296).
- The proportion of one-time observed nesters was highly significantly lower among the remigrant females (40.1%) than among the newly tagged females (63.3%) and non-Surinamese females (77.7%).
- Mean ECF was significantly higher for the remigrants (5.0 ± 2.2 nests) than for the new turtles (4.2 ± 1.8 nests) and non-Surinamese turtles (4.4 ± 1.8 nests).
- Based on PIT tag data (number of observed nestings per night) and rough estimates for beaches/sections that were not or infrequently monitored, we roughly estimated the *minimum number* of nests after correction for incomplete beach coverage and 10% false crawls to be 10,000.
- Mean curved carapace length (CCL) of leatherback females was 155.2 ± 6.8 cm, mean curved carapace width (CCW) was 113.8 ± 4.8 cm. CCL and CCW did not differ from previous years.
- As in 2002-2004, mean CCL of new turtles (153.2 ± 6.8 cm) was highly significantly smaller than that of non-Surinamese turtles (156.0 ± 6.8 cm) and remigrants (156.7 ± 6.5 cm).
- Six dead leatherback females were observed stranded at Babunsanti. No data for Samsambo, Kolukumbo-Marie and Matapica are available.
- Preliminary data indicate that at least 9% of the nesting females had injuries or scars that may have been a result of interactions with fisheries.
- Egg poaching was (almost) 100% on beaches such as Thomas-Eilanti and presumably other beaches that had no permanence presence by STINASU, but was also relatively high at Babunsanti (restricting the PIT tagging surveys on more than one occasion).
- A total of 58 leatherback nests were marked for subsequent monitoring, 44 of which were retrieved and 36 of which the fate could be determined.
- A total of 89.9% of the analysed marked nests did hatch. Of these, average hatch success was 36.3 ± 23.2%. Overall average hatch success, including the zero-hatching of the unsuccessful nests, was 32.3 ± 24.7% - higher than in previous years. Owing to the small sample size, the results are not considered reliable.
- Average hatch success for 61 excavated unmarked leatherback nests of which hatchling tracks were observed was 47.7%, but this is not representative for overall hatch success, because nests with only few hatchling tracks may have been overlooked. 79 green turtle nests were excavated and analysed.
- All marked nests were affected, and on average 47.1 ± 25.3% of the yolked eggs per nest depredated by mole crickets. In 2005, no egg depredation by ghost crabs was recorded at Babunsanti.
- Average clutch size was 89.8 ± 16.0 eggs and 25.9 ± 14.1 yolkless eggs for the marked nests.
- Mean incubation period was 61.0 ± 3.0 days (n=23) with a range of 57 to 69 days.
- Mean nest bottom depth at the time of hatchling emergence was 70.1 ± 12.9 cm (n=36).
- Data on sand temperature profiles and predominant hatchling sex were inconclusive.

1. INTRODUCTION

Some of the globally most important nesting beaches for leatherbacks (*Dermochelys coriacea*) are found in eastern Suriname and western French Guiana, particularly inside and in the vicinity of the mouth of the Marowijne River that separates Suriname from French Guiana. These beaches also provide important nesting sites for the green turtle (*Chelonia mydas*) and the olive ridley (*Lepidochelys olivacea*). It has been estimated that over 40% of the world leatherback population nests in Suriname and French Guiana (Spotila *et al.* 1996), and these leatherbacks are believed to represent a single nesting population (Pritchard 1971, Schulz 1975, Girondot and Fretey 1996, Dutton *et al*. 1999). More recently, other large leatherback nesting populations have been reported for Trinidad (Eckert and Eckert 2005), West Africa (e.g., Gabon) (Billes *et al.* 2003) and along the Caribbean coast of Central America (Troëng *et al.* 2004). Most 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), but this status is disputed (e.g., Girondot 2002, Mrosovsky 2003, Hilterman and Goverse 2004).
The leatherback nesting season in the Guianas typically spans from early April to early August in the rainy season with a peak in May-June. A second, smaller and less significant nesting season occurs around December (Chevalier *et al.* 2000). Observations reported here represent the main nesting period.

Beach locations
Due to the westward-oriented Guyana Current and north-easterly trade winds, the Surinam coastline is highly dynamic and subject to successive phases of beach erosion and accretion. Extensive mudflats dominate the coastline. The sandy beaches are found mainly in the eastern part of the country (Schulz 1975, Augustinus 1978). Total beach length is around 30-40 km, but fluctuates over the years (Hilterman *et al., in press*). The most important nesting beaches for leatherbacks in 2005 were:

- Babunsanti (approx. 6 km length), situated in the Marowijne Estuary, Galibi Nature Reserve (abundant green turtle nesting, moderate to abundant leatherback nesting, minor olive ridley nesting);
- Samsambo and possibly Kolukumbo-Marie (combined total length of approx. 9 km), situated west of the Marowijne Estuary on the Atlantic coast (minor to abundant leatherback nesting, minor olive ridley nesting);
- Matapica (approx. 9 km length), on the Atlantic coast some 10 km eastward of the Suriname Estuary. A highly dynamic beach, that moves to the west with a speed of approximately 1.5 km annually (Augustinus 1978, pers. obs.) (moderate to abundant green turtle and leatherback nesting, minor to moderate olive ridley nesting and some minor hawksbill nesting).

Other nesting beaches are Alusiaka (moderate green turtle and minor leatherback nesting) and Thomas-Eilanti (moderate green turtle and leatherback nesting, minor olive ridley nesting) in the Galibi Nature Reserve, and Diana Beach and Braamspunt just west of Matapica (minor green turtle, leatherback and olive ridley nesting).

In 2005, only Babunsanti and Matapica had permanent presence by STINASU during the entire nesting season. Samsambo was visited a few times during the peak nesting period and when nesting appeared to be high, was covered (by STINASU) since late June. Kolukumbo-Marie were only very occasionally visited and not during the peak season, so the real status of these beaches in 2005 is not known – these beaches did, however, this season not seem highly suitable for nesting.

- ➢ *For a more detailed description of the Surinam coastline and map of the beach locations of eastern Suriname, see Hilterman and Goverse (2003) and Hilterman et al. (in press).*

Project history

In contrast to the nesting leatherbacks in French Guiana, that have been intensively studied and tagged since 1970 (Pritchard 1971, Girondot and Fretey 1996, Rivalan 2003), the Surinam leatherback population had, until recently, received relatively little scientific attention. However, annual nest count data were collected for most years since 1967 by the Foundation for Nature Conservation Suriname (STINASU) (e.g., Schulz 1975, Reichart and Fretey 1993). The annual number of counted nests highly fluctuated but has increased from less than 300 in the late 1960s to peaks of over 10,000 nests in the 1980s (Reichart and Fretey 1993), but since nest counts are often incomplete (De Dijn 2001, pers. obs.) it is likely that these nest numbers are underestimates of the true number of nests laid (Hilterman and Goverse 2002).

In order to obtain better information on the minimum size, and parameters of the leatherback nesting population in Suriname and to assess the extent of nesting exchange with French Guiana, a PIT tagging project was started in 1999, initiated and funded by WWF-Guianas. PIT tagging of leatherbacks has also been done since 1998 at Ya:lima:po beach (Chevalier and Girondot 2000) (and since 1999, also at several other beaches) in French Guiana, and since 2000, on Shell Beach in Guyana.

In addition to the tagging data, biometric data and data on nest survival, hatch success and sand temperatures have been collected annually. All activities of this ongoing project were carried out in close collaboration with STINASU.

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 regional and global status reports;
- Capacity building, and;
- Local and international collaboration.

Specific objectives

Objectives over a period of several years are to:

- 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, beach fidelity) by means of a PIT tagging program;
- 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;
- Qualify and quantify the threats facing adults turtles with a special focus on fisheries related injuries and mortality;
- Train (local) students and field personnel of the counterpart in sea turtle biology and research techniques.

2. METHODS

2.1 PIT tagging of nesting leatherback turtles

In Suriname, French Guiana and Guyana, 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, we always rescanned turtles to check for proper tag placement. Tagging and scanning were done at all stages of the nesting process. In addition to the PIT code, tag status (old/new), time of encounter, 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 and patrolling continued until the last turtle had finished nesting.

We defined three categories of females:

- Newly tagged turtles were untagged turtles that were PIT tagged by us;
- Non-Surinamese turtles were turtles that had previously been PIT tagged in French Guiana or Guyana but were new to Suriname; this category may also include a small proportion of erroneous codes;
- Remigrants were females that returned to nest in a subsequent year to the one in which we originally observed them.

Table 2.1 shows the PIT tagging effort for 2005. As in 2004, we conducted PIT tagging surveys and nest ecological work only at Babunsanti. Additionally, STINASU personnel at Matapica scanned some leatherbacks, whereas few others were scanned by our team at Samsambo during infrequent visits.

Beach	Sections	Distance	Duration of coverage	Permanent presence by
Babunsanti[1]	BS-I,II,N and PB-I,II PB-III	4.5 km 1.5 km	April 17-July 23 May 5-June 6, June 14-24	2-3 IUCN NL team members 1 STINASU field staff
Matapica	-	-	3 nights in May	-
Samsambo	-	-	3 visits in May-June	-

Table 2.1 PIT tagging effort during the 2005 nesting season.

➢ *For a detailed description of beach coverage and PIT tagging efforts during the 1999-2004 seasons, refer to the annual reports of 2000-2004 (Hilterman 2001, Hilterman and Goverse 2002, 2003, 2004, 2005).*

Internesting periods and clutch frequency

Observed internesting period (OIP) was defined as the number of days between two consecutive nesting attempts. In calculating the mean OIP, we excluded OIP values of less than six or greater than eleven days as these values indicated either aborted nesting attempts (false crawls) or unobserved nestings (Miller 1997, Reina *et al*. 2002).

Observed clutch frequency (OCF) was defined as the number of nesting attempts observed during the nesting season for an individual (Steyermark *et al*. 1996). OCF was obtained after correction for false crawls (internesting periods of less than six days).

The estimated clutch frequency (ECF) was calculated for turtles that were observed nesting at least twice by dividing the number of days in between the first and last nesting dates by the mean OIP, adding one for the first oviposition. We used only the individuals with a first nesting date of at least 60 days prior to the end of the survey period, thereby avoiding the possibility that the turtle finished nesting after the end of the fieldwork period (Reina *et al*. 2002).

[1] In 2001, STINASU changed the beach section division at Babunsanti. For continuity reasons, here we use the old beach section division in which PB-I is the present STINASU PB-I&II, and PB-II is part of the present STINASU PB-III.

2.2 Biometric data collection

Minimum (or standard) curved carapace length (CCL) and width (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. The average individual measurement for turtles measured more than once during the season was used for further calculations.

2.3 Nest number estimates

Daily track counts at Babunsanti and Matapica were performed by STINASU field personnel that counted nests and false crawls separately. However, spatio-temporal beach coverage was not 100%, and on narrow and shallow sloping beaches such as Babunsanti, considerable numbers of tracks are washed over and become invisible by the high tide – especially around spring tides when peak nesting occurs. The actual number of tracks counted is thus likely an under-estimate (Hilterman and Goverse 2002, De Dijn 2001, 2003). Less frequent track counts were done on Samsambo, Thomas-Eilanti and Alusiaka.

We used simple interpolation (average of three days before and three days after the gap) to correct for the days with no data of STINASU for Babunsanti, in order to obtain a more complete figure for this beach. For the period April 17 – July 23, in which the PIT tagging surveys took place, we compared the daily number of nesting attempts observed by us with the interpolated ones of STINASU for the beach sections covered both by us and STINASU, and used this information for interpreting track count data on beaches / sections not covered by us.

However, as also the data based on the PIT tagging surveys for Babunsanti are not at all complete during the survey period (e.g., structurally only part of night covered – turtles may have nested outside the nightly survey period, several aborted surveys because poachers were present, heavy rain which made scanning and writing impossible, et cetera) we estimate that on average, we missed another 20% of the females / nesting attempts (Rivalan 2003; Hilterman and Goverse *unpubl. data*). This number does not yet take into account the missed nestings before and after the total survey period. False crawls are believed to make up approximately 10% of all nesting attempts (Hilterman and Goverse, *submitted*).

We made an estimate of the *minimum* total number of nests by: 1) multiplying the number of observed nesting attempts (including false crawls) during PIT tagging survey at Babunsanti by 1.2 (adding 20%) to compensate for missed nestings, after which 10% was subtracted for aborted nesting attempts (false crawls); 2) using the result of the comparison between our observations during PIT tagging and the interpolated STINASU data to estimate nest numbers for beaches / sections covered by STINASU but not (structurally) by us and for nesting outside our survey period; and 3) for beaches or beach sections that were not or only very infrequently monitored (Kolukumbo-Marie, Alusiaka, Thomas-Eilanti), a rough estimate was made based on incidental track counts combined with our experience on nesting patterns at these beaches in previous years.

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. If possible, stranded leatherbacks were scanned for PIT tags.
As part of the PIT tagging 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 (Hilterman and Goverse 2003).

2.5 Determination of nest survivorship and hatch success

Nest marking

A total of 58 *in situ* leatherback nests were randomly marked from April 17th – May 15th at Babunsanti along a 3000 meter transect line with numbered stakes at 20 meter intervals. During the nightly beach patrols, small (temporary) sticks were placed 0.5 meter 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 a narrow channel towards the egg clutch was carefully dug by hand. A tightly folded plastic flag with nest number and date was placed in the sand on top of the 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 shown 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 after egg deposition 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=61) and green turtle (n=79) nests were excavated three days after observation of the first hatchling tracks from the nest.

Nest analyses

For each analysed nest, distance 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). Hatch 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 75 cm depth (average estimated clutch centre depth) at three beach zones (high, mid, low) at section BS-I of Babunsanti at the beginning of the fieldwork period and recovered at the end of the fieldwork period in order to determine sand temperature profiles. One newly laid clutch was split into two sub-clutches that were reburied 0.5 m above the STL straight after. In each sub-clutch, a data logger was placed. Two data loggers were placed at the mid zone of Matapica. Data were recorded every two hours for the whole period. Data were grouped by one week intervals for which the average temperature was calculated.

2.7 Data analysis

Data were tested for normality and homogeneity of variance and subsequently means were compared using ANOVA followed by a post-hoc Bonferroni multiple comparison test, 2-tailed T-test, Kruskal-Wallis or Mann-Whitney test. Means are given with SD. For comparing proportions we used a Chi-square test (Sokal and Rohlf 1987).

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

3. RESULTS

3.1 PIT tagging of nesting females

A total of 1,068 individual leatherback females were observed during the tagging surveys (1,051 at Babunsanti, 14 at Matapica and 3 at Samsambo). New PIT tags were applied to 433 individuals (40.5% of total), the remaining 635 had previously been tagged. Of the previously tagged turtles, 487 (45.6% of total) were remigrants from Suriname (three originally from 1999, seven from 2000, 158 from 2001, 49 from 2002, 269 from 2003, and one from 2004; 112 of these were remigrants that nested in more than one previous season), whereas 148 turtles (13.9% of total) 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 930 within-season recaptures, was 1,998. Table 3.1 shows the annual number of tag records since 1999.

Since 1999, a total of 6,934 leatherbacks have been PIT tagged and 1,527 individuals have been observed that carried TOVAN PIT tags already (non-Surinamese). The total number of observed individuals since 1999 in Suriname is thus 8,461.

From 1999 to 2005, the proportion of newly tagged females decreased from 89.9% to 40.5% per season, whereas that of remigrants increased from 0% to 45.6% per season. The proportion of females of a non-Surinamese origin (but new for Suriname in a particular season) fluctuated between at 10.1% and 17.6% and was 13.9% in 2005 (fig. 3.1).

Nesting season	Newly tagged	Non-Surinamese	Remi-grant	Observed females	Proportion one-time nesters (%)	Intra-seasonal recaptures	Total no. records	Tagging effort / beach coverage
1999	62	7	0	69	—	5	74	- -
2000	385	71	0	456	—	47	503	-
2001	2,455	448	24	2,927	66.7	1,701	4,628	+
2002	1,831	401	51	2,283	46.4	3,110	5,393	++
2003	1,474	362	398	2,234	46.4	2,585	4,819	++
2004	294	90	261	645	63.6	391	1,036	+ / -
2005	433	148	487	1,068	55.3	930	1,998	+ / -

Table 3.1. *The number of newly PIT tagged, non-Surinamese and remigrant turtles and intra-seasonal recaptures observed during the nesting seasons 1999-2005. Beach coverage was incomplete in all of the years and varied considerably between years and beaches, with overall best tagging effort in 2001-2003.*

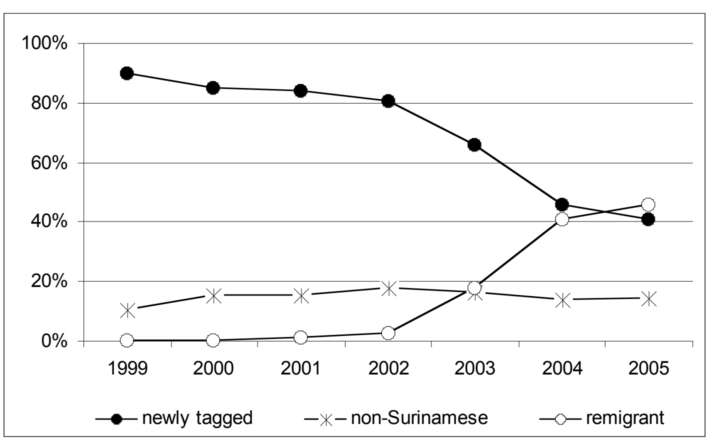

Figure 3.1 *Proportion of newly tagged, non-Surinamese and remigrant turtles nesting during the 1999-2005 seasons.*

Remigration

Of the observed nesting cohort of 1999 (n=69), 40.6% had been seen again by 2005 (table 3.2, only the first subsequent year in which an individual turtle returned is presented). Of the 2000 cohort (n=456) this was 16.4%, of the 2001 cohort (n=2,927) this was 18.2%, of the 2002 cohort (n=2,283) this was 8.1% and of the 2003 cohort (n=2,234) this was 12.1%. One individual (0.2%) of the 2004 cohort (n=645) returned in 2005. 112 individuals were encountered in three different nesting seasons in Suriname: two that were first observed in 1999, five that were first observed in 2000 and 104 in 2001; one female that was first seen in 1999 was encountered in four different nesting seasons.

Year first observed	Observed no. individuals	2000	2001	2002	2003	2004	2005	Remigrants (n)	Remigrants (%)
1999	69	0	22	3	2	1	0	28	40.6
2000	455	—	2	45	19	7	2	75	16.5
2001	2,927	—	—	3	363	114	54	534	18.2
2002	2,283	—	—	—	6	130	49	185	8.1
2003	2,235	—	—	—	—	1	270	271	12.1
2004	645	—	—	—	—	—	1	1	0.2

Table 3.2. *Observed remigration rates (expressed in numbers and as proportion of original cohort) for tagged turtles in Suriname during the 1999-2004 nesting seasons. Beach coverage was incomplete in all of the years and varied between years and beaches, and turtles may have returned on a non-Surinamese beach. Remigration numbers presented here are thus certainly underestimating the true number of remigrants*.

Interseasonal beach fidelity and nesting exchange between beaches

Of the 14 leatherback females that were scanned at Matapica, 10 were new turtles, two were non-Surinamese turtles and two were remigrants. The two remigrants had both originally been tagged at Matapica: one in 2000 and one in 2001. The female tagged in 2000 was also observed nesting at Matapica in 2002. Of the three leatherbacks that were scanned at Samsambo, two were remigrants: one originally tagged in 2001 at Samsambo, the other in 2002 at nearby Kolukumbo. Of the 483 remigrants that nested at Babunsanti in 2005, 391 (81.0%) nested the previous season they were observed at least once at Babunsanti (28 made a shift between Babunsanti and Kolukumbo), 90 (18.6%) at Kolukumbo, one (0.2%) at Samsambo and one (0.2%) at Matapica. Six females with flipper tags were observed: two from Trinidad and two from French Guiana, and two from Nova Scotia, Canada. Of the latter, one was PIT tagged in 2003 at Babunsanti. The other had a non-Surinamese PIT tag and probably originates from French Guiana.

Internesting periods

The mode of the observed internesting period (OIP) was 9 days (fig. 3.2). The smaller peak seen at 16-22 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 2005 was 9.4 ± 1.0 days (n=461).

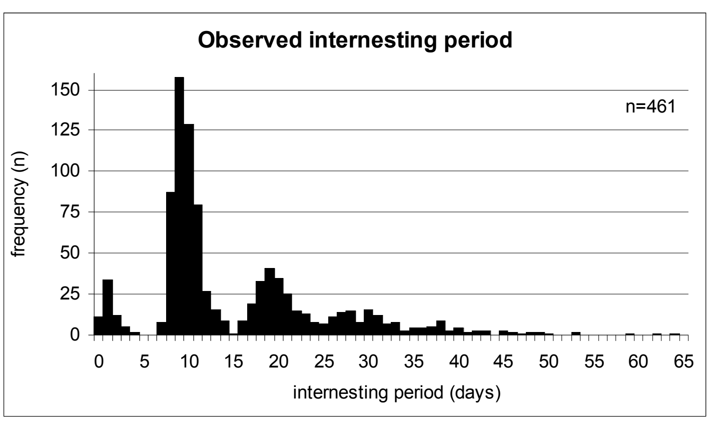

Fig. 3.2 *Observed internesting period (OIP) for leatherbacks nesting at Babunsanti in 2005.*

Clutch frequency

Figure 3.3 shows the observed clutch frequency (OCF) of gravid leatherback females for Babunsanti. Mean OCF was 1.9 ± 1.3 nests (n=1,068). Of all turtles, 55.3% (n=591) was seen only once. OCF ranged between one and eight nests.

Figure 3.4 shows the estimated clutch frequency (ECF) for turtles that were observed nesting twice or more at Babunsanti. Mean ECF was 4.7 ± 2.1 nests (n=296).

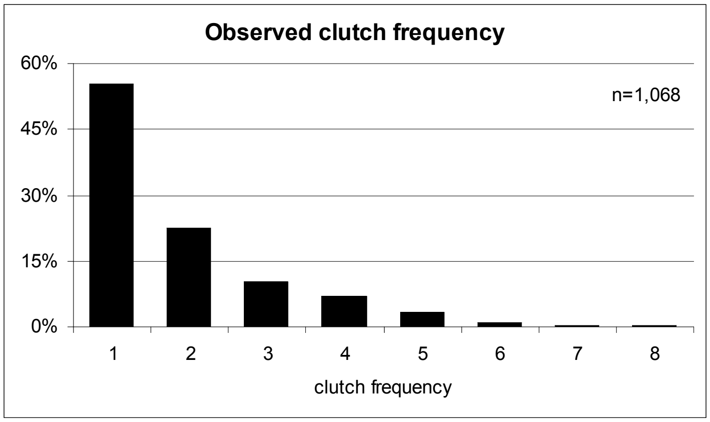

Fig. 3.3 *The observed clutch frequency (OCF) for females nesting at Babunsanti in 2005.*

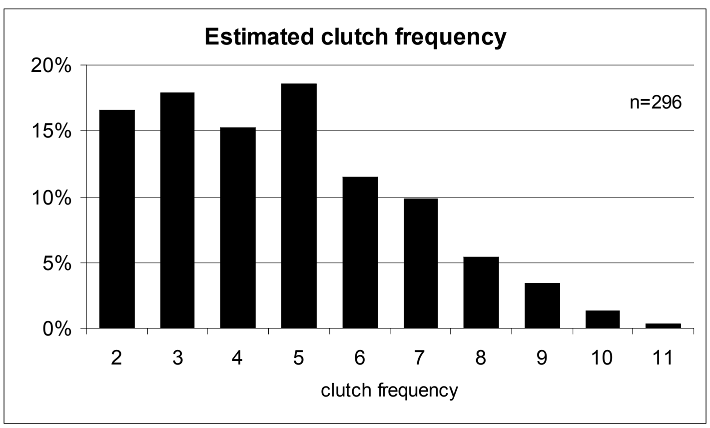

Fig. 3.4 *The estimated clutch frequency (ECF) for females observed at least twice at Babunsanti in 2005 using a mean observed internesting period of 9.4 days.*

The proportion of one-time observed nesters was highly significantly lower among the remigrant females (40.1%) than among the newly tagged females (63.3%) and non-Surinamese females (77.7%) (Chi-square, x^2=85.3, df=2, p<0.001).

Mean ECF was significantly higher for the remigrants (5.0 ± 2.2 nests) than for the new turtles (4.2 ± 1.8 nests) and non-Surinamese turtles (4.4 ± 1.8 nests) (Kruskal-Wallis, p=0.01).

3.2 Nest numbers

For the period April 17 – July 23 in which the PIT tagging surveys took place at Babunsanti, the number of nesting attempts as obtained from PIT tagging were compared to the interpolated STINASU track counts (nests plus false crawls). The first were, on average, a factor 1.4 higher than the latter (40% of tracks were no longer visible or were unobserved during the nest counts). The interpolated STINASU data show that PB-II, III *(is STINASU PB-III)* were the busiest sections, with 31% of all nests – but only some minor tagging was done here.

We estimated the minimum number of nests to be 10,000 (table 3.3), based on:

- PIT tagging data for Babunsanti sections BS-I, II, N and PB-I (number of tagged individuals plus observed missed nesting attempts per night; adding 20% for missed nestings that were a result of incomplete beach coverage, and subtracting 10% false crawls). We calculated the number of nests for PB-II, III based on the above number, assuming that 31% of the nests were laid on PB-II, III (the outcome of which was similar to multiplying the STINASU nest count for this section by 1.4);
- Extrapolated STINASU counts that were first corrected for unobserved nestings (for Samsambo, Matapica and Thomas-Eilanti a factor 1.2 was used instead of 1.4, because these beaches are wider and subject to less regular tidal inundation than Babunsanti), and rough estimates / extrapolations for beaches that were not or only very irregularly monitored.

Figure 3.5 shows the nesting activity pattern for leatherbacks at Babunsanti, combined with the daily high tide heights.

Beach	Estimated total beach length (km)	Distance covered (km)	Observed nesting attempts (during tagging surveys)	Estimated minimum number of nests
Galibi Nature Reserve				
- Babunsanti	6	4.5	2,419	3,650
- Thomas-Eilanti	1.5	0	-	750
- Alusiaka	0.5	0	-	250
Samsambo	8	0	-	3,000
Kolukumbo-Marie	0.8	0	-	350
Matapica, Diana Beach	10	0	-	2,000
Total	26.8	4.5	2,419	10,000

Table 3.3 *Number of nesting attempts observed while PIT tagging (false crawls included), and (roughly) estimated minimum number of nests after correction for incomplete beach coverage in space and time, 10% false crawls excluded.*

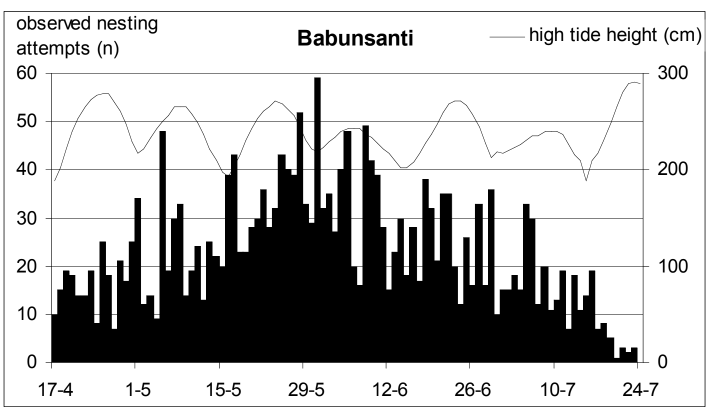

Fig. 3.5 *Observed daily nesting attempts during PIT tagging surveys, and tidal cycles during the 2005 nesting season at Babunsanti, excluding section PB-III. No data are available for period before April 17 and after July 23.*

3.3 Biometric data

The average curved carapace length of gravid leatherback females was 155.2 ± 6.8 cm. Curved carapace width was 113.8 ± 4.8 cm (table 3.4). Figure 3.6 shows the size frequency distribution for nesting leatherbacks at Babunsanti in 2005.

As in 2001-2004, the mean CCL of newly tagged turtles (153.2 ± 6.8 cm, n=411) was highly significantly smaller than that of non-Surinamese turtles (156.0 ± 6.8 cm, n=131) and remigrants (156.7 ± 6.5 cm, n=463) (ANOVA, $p<0.001$).

2005	CCL (cm)	Min.	Max.	n	CCW (cm)	Min.	Max.	n
Babunsanti	155.2 ± 6.8	127.5	175.5	1,005	113.8 ± 4.8	98.0	127.0	528

Table 3.4 *Mean curved carapace lengths (CCL) and widths (CCW) for leatherbacks nesting at Babunsanti, 2005.*

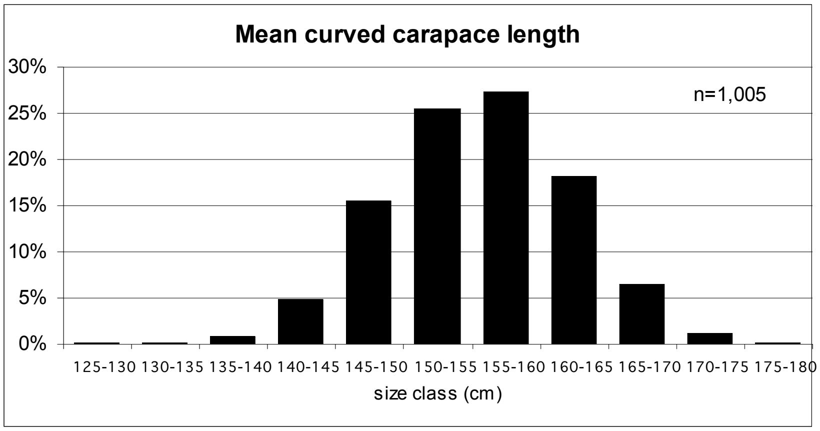

Fig. 3.6 *Frequency distribution of carapace lengths of nesting leatherbacks at Babunsanti in 2005.*

3.4 Threats

Between April 17 and July 23, six dead leatherbacks and two dead juvenile / sub-adult green turtles (CCL 38 cm and 59 cm) were observed stranded at Babunsanti. One green turtle had a rope around one fore flipper, the other had rope marks around both fore flippers.
We have no data on strandings for Samsambo, Kolukumbo-Marie and Matapica.

Data on fisheries related injuries for 2005 indicate that at least 9% of all females that nested at Babunsanti had injuries that were possibly fisheries related.

Egg poaching seemed on the rise again. The few times Thomas-Eilanti was visited by the IUCN NL team, 100% of the nests (leatherback and green turtle) had been poached. We expect this was no different for Samsambo in the period before the camp was built in late June. Also at Babunsanti, poachers were encountered during the nightly tagging surveys (or early morning) more than once and poaching of both green turtle and leatherback nests was no exception. For further data on egg poaching activities refer to STINASU.

3.5 Nest survival and hatch rates

Table 3.5 shows the fate of the randomly marked *in situ* leatherback nests at Babunsanti. Of the unmarked leatherback nests (also referred to as natural nests) of which emerged hatchling tracks were observed, 61 were excavated. Hatch success and emergence success for the marked and unmarked *in situ* leatherback nests is shown in table 3.6.

Marked nests at Babunsanti	
Marked	58 nests
Retrieved	44 nests (75.9%)
Excavated but excluded from further analyses	8 nests (mixed with other nests, poached, depredated, etc.)
Used for determination of *in situ* hatch rates	36 nests
Not hatched of these 36 nests	4 nests (11.1%)

Table 3.5 *Fate of the marked nests of which the exact position was recorded by triangulation during the 2005 nesting season.*

A total of 89.9% of the analysed marked nests hatched. Of these, average hatch success was 36.3%. Overall average hatch success, including the zero-hatching success of the unhatched nests, was 32.3%. A frequency distribution of hatch success for the marked nests is shown in figure 3.7.

Average hatch success for the unmarked, successful nests was 47.7%. This is, however, certainly an overestimate of overall *in situ* hatch success, as there was a bias towards the more successful nests when it came to observing the hatchling tracks.

Babunsanti	**Hatch success (%)**		**Emergence success (%)**	
Marked nests (all nests, including unhatched nests)	32.3 ± 24.7	(n=36)	30.7 ± 24.1	(n=36)
Marked nests (hatched nests only)	36.3 ± 23.2	(n=32)	34.5 ± 22.8	(n=32)
Unmarked nests (only hatched nests, non-random sample)	47.7 ± 20.9	(n=61)	45.8 ± 21.6	(n=61)

Table 3.6 *Average hatching and emergence success and standard deviation per nest for marked and unmarked leatherback nests at Babunsanti (emergence success is hatching success minus the fraction of dead hatchlings and stragglers).*

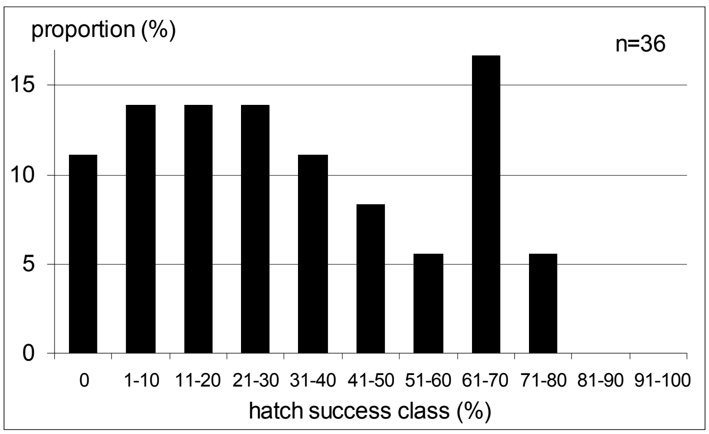

Fig. 3.7 *Frequency distribution of hatching success of the marked leatherback nests at Babunsanti in 2005. Note that due to the small sample size and some beach erosion the results may not be representative for overall hatch success at Babunsanti.*

Figure 3.8 shows the hatching success and egg development for the marked nests. All excavated nests were attacked by mole crickets and egg depredation by this insect was, as in previous years, one of the main causes for egg mortality. The mole cricket depredated an average of 47.1 ± 25.3% yolked eggs per nest. In 2005, no egg depredation by ghost crabs was recorded at Babunsanti.

For 2005, data on nest position along and across the beach and hatching success in relation to the distance to the spring tide line are not considered reliable due to the small sample size.

Clutch size, incubation periods and nest depth

- Average clutch size was 89.8 ± 16.0 yolked eggs and 25.9 ± 14.1 yolkless (‘false’) eggs for the marked nests (n=36).
- Mean incubation period was 61.0 ± 3.0 days (n=23) with a range of 57 to 69 days.
- Average nest bottom depth at the time of excavation was 70.1 ± 12.9 cm (n=36) with a range of 40 to 95 cm.

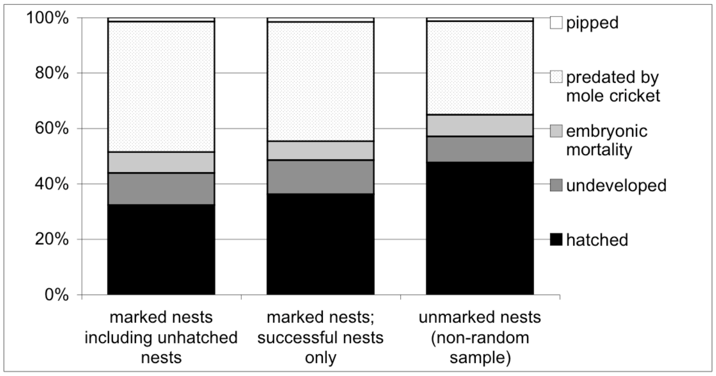

Fig. 3.8 *Average hatch success and egg development per nest for the marked nests and unmarked nests at Babunsanti in 2005.*

3.6 Sand temperature and sex determination

Table 3.7 shows the average sand temperatures for the different beach zones at Babunsanti. Sand temperatures were closely linked to rainfall (fig. 3.10) and the tidal cycle (fig. 3.5).

In the course of the season, the position of the STL shifted downward on the beach by two meters (e.g., the data logger that was buried on the STL, was located at STL +2 when it was retrieved). The loggers lowest on the beach (inundated most frequently) recorded higher sand temperatures than the loggers higher on the beach, which is highly unusual.

As most nests were laid in the mid zone, the data logger at SLT -2/0 seems the most representative for this year (fig. 3.9). The early retrieval rate of the loggers, and considering that large part of the nests were laid in the period between half May-half June whereas hatchling sex is determined during the middle third of the incubation period (day 20-40), make any predictions on the predominant sex difficult. Assuming an average metabolic heating of at least 0.5^{o}C during the middle third of the incubation period (day 20-40) when hatchling sex is determined, however, most nests laid during the peak nesting period at Babunsanti may have produced predominantly females. For Matapica, data are insufficient for any predictions.

	Babunsanti						**Matapica**
	STL 0 / 2	STL -1 / +1	STL -2 / 0	STL -3 / -1	Split clutch STL 0.5 / +1.5	Split clutch STL 0.5 / +1.5	Mid zone
n (days)	92	92	92	82	73	73	66
min	26.73	26.73	27.52	26.34	28.31	28.31	27.91
max	29.50	29.90	31.12	31.52	31.93	31.52	29.90
average	28.22	28.73	29.64	29.29	30.44	30.11	28.74
stdev	0.60	0.63	0.79	0.94	0.90	0.69	0.45

Table 3.7 *Sand temperature overview (^{o}C). Data have been analysed from a day after placing the data loggers to a day before digging up the loggers. Two loggers were placed inside a relocated split clutch and recorded the nest temperature.*

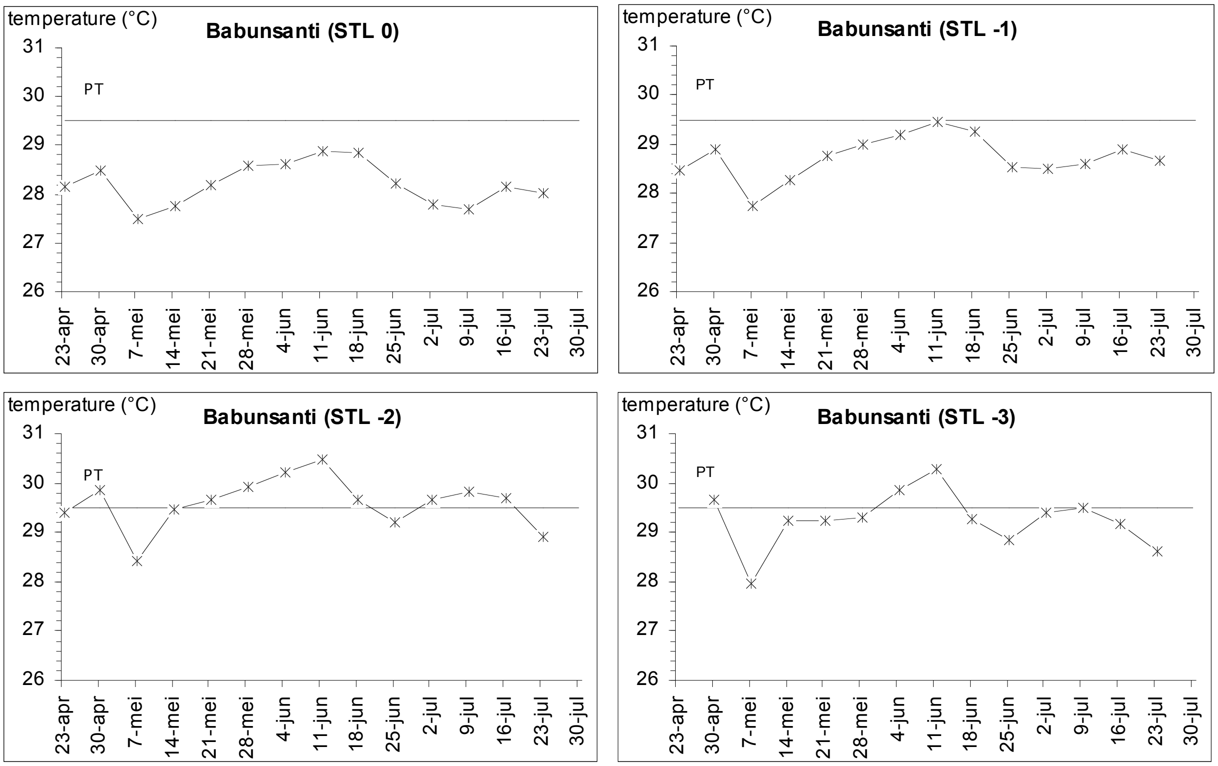

Fig. 3.9 *Sand temperature profiles at Babunsanti. STL in graphs is STL at time of burying loggers (STL shifted down by 2m in course of the season). PT = pivotal temperature for leatherbacks (29.5°C).*

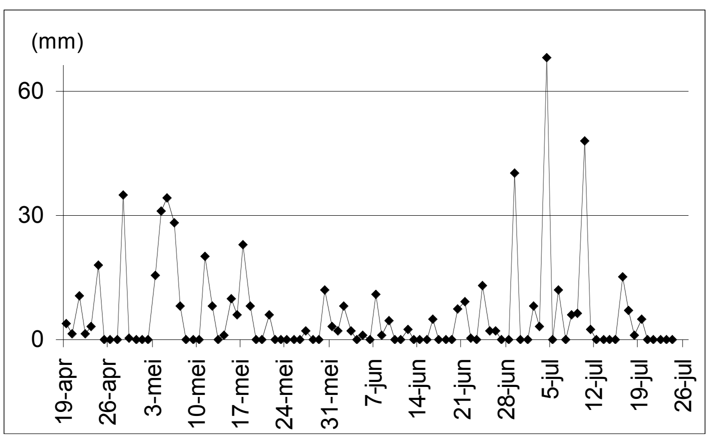

Fig. 3.10 *Precipitation (mm) measured at Babunsanti during the 2005 season.*

4. CONCLUDING REMARKS

- For the three Guianas, with a large nesting colony spread over many highly dynamic and often remote and high density nesting beaches, a 100% beach coverage is not possible and in spite of a maximum tagging effort on some of the beaches, many females are not observed. The PIT tag data demonstrate that *at least* 1,068 leatherback females have nested at Babunsanti during the 2005 season. However, incomplete beach coverage – as is shown also by the much lower observed clutch frequency than in years with good coverage (Hilterman and Goverse, *submitted*) – and the lack of coverage at the other important beaches imply that the actual size of the 2005 nesting cohort was significantly larger. We estimated that no more than, at a maximum, a third of all females were observed and we estimated the total number of nesting females in 2005 to be at least 3,252 – this should be considered a *minimum* number.

- The estimated minimum number of 3,252 females in 2005 is lower than in 2001 (5,500) (Hilterman and Goverse 2002), but similar to that in 2002 and 2003 (*at least* 3,000) (Hilterman and Goverse 2003, 2004) and higher than in 2004 (1,545) (Hilterman and Goverse 2005). The fluctuations in number could be caused by normal – possibly food dependent – reproductive fluctuations, but are more likely a result of the beach dynamics and availability of suitable beaches in the region. Although the previously high-density leatherback nesting beaches Kolukumbo-Marie were in 2004 and 2005 largely blocked by mudflats and thus no longer suitable for nesting, Samsambo had gained importance again and it can be assumed that many former Kolukumbo and Samsambo nesters, nested in 2005 at Samsambo. This is supported by the origin of the two remigrants observed at Samsambo.

- Overall average carapace length and width of nesting females was similar to that in previous years. Their significantly smaller carapace size also in 2005, confirms the hypothesis (Hilterman and Goverse, *submitted*) that the group of newly tagged females were, on average, younger than remigrants and non-Surinamese females (e.g., Zug and Parham 1996), and may indeed represent relatively new or even first-time nesters. Moreover, the nesting behaviour of the group of new females was, as in 2002-2004 (Hilterman and Goverse, *submitted*), also different from that of remigrants. New females had a lower clutch frequency and a higher proportion of one-time nesters.

- The annual proportion of turtles with a non-Surinamese, most likely French Guianese, PIT code (10.1% to 17.6% of females) is relatively stable and much lower than we would have expected when assuming that the leatherbacks nesting on the beaches of Suriname and French Guiana have a high nesting exchange (Pritchard 1971, Girondot *et al., submitted*). Their size in between that of new females and remigrants, further indicates that the group of non-Surinamese turtles, comprises of a combination of (relatively) new nesters and remigrants.

- The strong decrease of the proportion of newly tagged turtles (from 89.9% to 40.5%) and the similar increase of remigrants (from 0% to 45.6%) in only six years time, and the moderate frequency of intra- and interseasonal nesting exchange between beaches (Hilterman and Goverse, *submitted*) suggest that, at least on the time scale of the PIT tagging programme, individual females tend to be relatively faithful to one side of the Marowijne Estuary.

- We estimated that at least 10,000 leatherback nests were laid. However, when looking at the estimated clutch frequency of 4.7 – which was not corrected for nesting before and after the survey period and in itself is already very likely an underestimate – and the estimated number of nesting females of at least 3,252 in 2005, the number of nests should exceed 15,284. This could well be true and the number of 10,000 is considered the lower limit.

- Figure 4.1 shows the nest numbers in Suriname from 1967-2005. The annual method of obtaining and presenting leatherback nest numbers has, however, strongly differed (Hilterman and Goverse 2005), which makes it difficult to compare nest numbers over the years and indicate a trend.
  If we compare the rough nest count data to nest number estimates since 2001 (the first year with a comprehensive PIT tagging program), we can safely assume that the earlier nest numbers, also the peaks of

well over 11,000 nests in the 1980s, are underestimating real nest numbers in most years. For example, the number of nesting attempts observed during PIT tagging surveys in 2005, was 40% higher than that obtained from track counts alone at Babunsanti; and we expect the difference to get bigger the more nests are laid. Therefore, the peak of >30,000 nests in 2001 may not have been unique for the past few decades.

- Overall hatch rates in 2005 at Babunsanti were low but higher than in previous years (32.3% including unhatched nests). However, because of the short time span in which nests were marked and the low retrieval rate – which may partly be due to severe beach erosion on in late June – the sample size is very small (compared to previous years) and does not seem representative for overall hatching success.

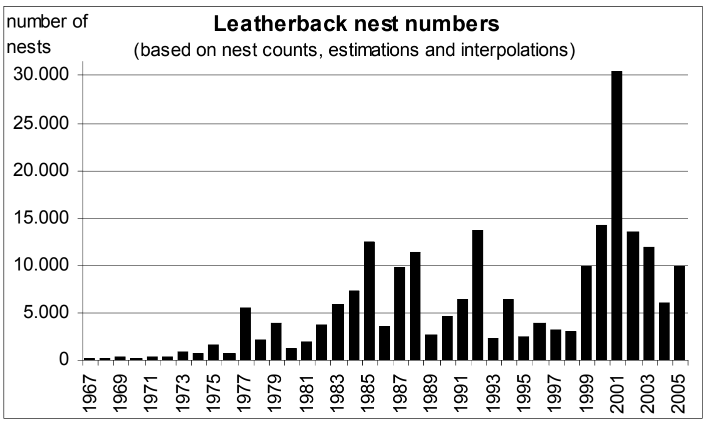

Fig. 4.1 *Leatherback nest numbers for Suriname (a combination of rough counts, corrected counts, estimates and, since 2001, observations during PIT tagging surveys) in the period 1967-2005.*

To conclude

The PIT tagging data collected during the 1999-2005 seasons clearly demonstrate the present status of Suriname as a major leatherback rookery. Since 1999, a total of 8,461 leatherback females have been identified nesting in Suriname and during the 2001-2005 seasons alone, this was 7,936. However, as annual tagging effort and beach coverage varied but were incomplete in all of the years, the real number of nesting females is considerably higher.

By PIT tagging, much larger numbers of females were shown than could have been expected from nest counts alone, and in turn, PIT tagging data (nightly observations) helped to improve nest number estimates. The PIT tagging data since 2001 – the first year with a comprehensive tagging program – have in any case shown that earlier estimates of the annual female population size for Suriname of 600-2000 turtles (e.g., Spotila *et al*. 1996) *are much too low* and, moreover, that nesting exchange between beaches is relatively low (Hilterman and Goverse, *submitted*). We thus support the idea that leatherbacks nesting on the Surinamese side of the Marowijne Estuary and those nesting at the French Guianese side do belong to one meta-population, but should be considered as different management units.

Although the overall trend for the combined Suriname-French Guiana leatherback nesting population seems relatively stable (Girondot *et al., submitted*), the apparent high incidence of (fresh) fisheries-related injuries is, even more than egg poaching, still a serious reason for concern.

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