

Modeling Approaches to Quantify Leatherback Nesting Trends in French Guiana and Suriname

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ABSTRACT. – Nesting of leatherbacks in French Guiana and Suriname has been monitored for more than 30 years. Given the documented exchange of tagged females across the nesting beaches, leatherbacks found on the 6 principal nesting areas in French Guiana and Suriname are considered to be a single large nesting population. Despite more than 3 decades of work on this population, this population's status remains unclear. Here we describe the most recently available estimates of various life history parameters and describe the trend of the number of nests laid in the region over the past 36 years. Our analyses suggest that the trend of the whole population in French Guiana and Suriname is stable or slightly increasing over this time period. We strongly urge the continued monitoring of the population by the different research groups in the region so that future data sets will enable an accurate description of the status of this leatherback population.

KEY WORDS. – Reptilia; Testudines; Dermochelyidae; *Dermochelys coriacea*; sea turtle; nesting; status; population; survivorship; migration; French Guiana; Suriname

The leatherback turtle, *Dermochelys coriacea*, is the most abundant of the 4 species of marine turtles that nest in French Guiana and Suriname. The other 3 species, in descending order of numbers of nests laid in the region, are the green turtle (*Chelonia mydas*), the olive ridley turtle (*Lepidochelys olivacea*), and the hawksbill turtle (*Eretmochelys imbricata*). Tagging data for leatherbacks have been collected since the early 1980s in the Guianas and have shown that exchanges occur between and among beaches in French Guiana and Suriname (Chevalier et al. 1998). This suggests that females nesting in these 2 countries belong to the same population. French Guiana and Suriname beaches are the largest remaining nesting grounds for leatherbacks in the world and host ca. 40% of the global population of breeding leatherback females (Spotila et al. 1996).

Despite observations and reports of large numbers of leatherbacks in French Guiana and Suriname over the past 30 years, leatherbacks are mentioned infrequently in literature published before 1950. Many historical authors have described the marine fauna of French Guiana but leatherbacks appeared for the first time in discussions of the region only in 1664 (Biet 1664). The next description of this turtle species was by Goupy des Marets in 1675 (Goupy des Marets 1675–1676, 1687–1690), who probably copied Biet's descriptions. Another 50 years passed before they were reported again, by Barrère (1741). In 1774, leatherbacks were described as being seen near the Kourou River estuary in French Guiana in a document that codified the regulation of marine turtles fishing activity (Anonymous 1774). The next historical document avail-

able with information about leatherbacks in the Maroni/Marowijne River region was published by Kappler (1881), nearly 100 years later. The 1941 and 1945 fisheries reports of Diemont and Geijskes (Schulz 1971) contained a number of observations on leatherbacks nesting in Suriname. Finally, the main nesting beaches were “discovered” in the late 1960s, and population surveys have been conducted on these beaches since then (Pritchard 1969; Schulz 1971). Daily nest counts on most beaches in Suriname have been conducted by Stinasu from 1969 to now. It is interesting to mention that Stedman (1796) wrote that in Suriname “the turtles are . . . generally distinguished by the names of *calipee* or green turtle, and *caret*” (this latter name refers to olive ridley turtle, Schulz 1971); he did not mention specifically the presence of leatherbacks.

Since 1967, work in this region has concentrated on counting nests (since 2001 combined with counting females on the beach) in Suriname and counting nests and female leatherbacks on the beaches in French Guiana; numerous reports and publications deal with these data (Pritchard 1969; Pritchard 1971; Schulz 1971; Schulz 1975, 1982; Reichart and Fretey 1993; Chevalier et al. 1998; Chevalier and Girondot 1998a; Chevalier and Girondot 1998b; Chevalier et al. 1999a; Hilterman 2001; Schouten et al. 2001; Hilterman and Goverse 2002, 2003; Girondot et al. 2006). However, some older reports lack a clear description of the methodology used to collect the data, the exact temporal window used (both in terms of hours and dates the beaches were patrolled), and the extent of the sampled area. Therefore, the quality of data varies

greatly among sites and years. An initial attempt to analyze trends revealed a strong correlation between the number of nests observed on beaches in French Guiana and Suriname, near the Maroni estuary (Chevalier and Girondot 1998b), and demonstrated a temporal tendency for a higher proportion of nests laid in eastern Suriname compared with central Suriname (Chevalier and Girondot 1998b).

There are at least 2 methods available to describe the status of a marine turtle population. The first is to use a population dynamics model (Spotila et al. 1996), and the second is to do trend analysis, incorporating current and historical records of the number of nests or females (Spotila et al. 2000). We will discuss both strategies as applied to leatherbacks in French Guiana and Suriname to estimate the trend of the nesting population in this region over the last 36 years.

Model Parameters

Nesting Area. — Nesting by leatherbacks regularly occurs from the eastern end of the coast of French Guiana around Cayenne and extends westward to Braamspunt at the head of the confluence of the Commewijne and Suriname Rivers in Suriname. It encompasses approximately 600 km of coastline, with highly dynamic beaches that appear or disappear according to the displacement of large mud bank from Amazonian origin (Marchand 2003). The principal nesting areas are generally separated into 5 zones: the Matapica area in the central section of coastal Suriname, the Galibi Natural Reserve area in eastern Suriname near the border with French Guiana (Babunsanti and remote nesting beaches), the French beaches in and near the estuary of the Maroni and Mana Rivers (Yalimapo-Awala and Pointe Kawana), the western oceanic beaches of French Guiana (from Pointe-Isère nesting beach), and the Kourou and Cayenne area in eastern French Guiana (Fig. 1). Further east, nesting of leatherbacks in the extreme north of Brazil was reported in Cabo Orange National Park (Roberto 2004), although a recent survey by one of us (LP) found no sandy beaches in this region. Further west, the closest known nesting beach for leatherbacks is Shell Beach in Guyana. The relation between the nesting populations in Guyana, Trinidad, and Suriname/French Guiana is unclear. To date, there have been 2 exchanges of nesting females from Guyana to nesting beaches in Suriname and 3 exchanges of nesting females between the nesting beaches of French Guiana/Suriname and Trinidad, located northwest of Guyana (Hilterman and Govere 2003).

Nesting Seasons. — In French Guiana, nesting leatherbacks have been shown to exhibit a bimodal nesting season, with a brief nesting season in December and January (“small nesting season”) and a long one from March to August (“normal nesting season”) (Chevalier et al. 1999c). Limited data suggest that nesting females are

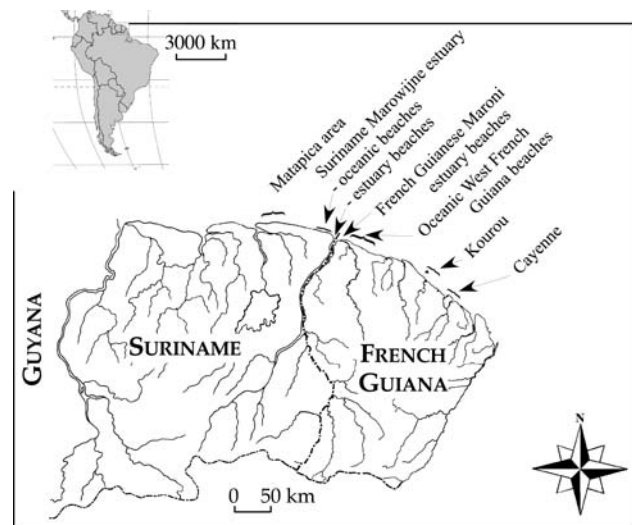


Figure 1. Map of French Guiana and Suriname with the principal nesting areas highlighted (see text).

not segregated by season (Table 1). The scarcity of these observations reflects that field workers are generally not present on the beaches in December and January; to date, only 20 tagged females have been observed during the “small nesting season” compared with a total of 28,986 identified females for the normal nesting season in French Guiana (Chevalier et al. 1999c) (note that a same female can appear several times in the database because of tag loss).

Number of Nests per Female per Nesting Season. — During the normal nesting season in French Guiana, females have been observed 1–11 times (note that not all females nesting in the region are observed each time they lay eggs on the beach). Females nest every 9 or 10 days. This repeatability can be used to estimate by interpolation the total number of nests laid between 2 extreme observation dates and generates a maximum estimate of 14 nests laid in 1 year. However, this methodology underestimates the true number of nesting events by females, because it implicitly assumes that the first observation of a female during the season is its first nest of the season. However, it is possible that earlier nesting events may not have been observed, and a similar situation exists for the last observed nest. To account for this, stopover methodology can be used, because it uses the total duration an animal remains in a given place to estimate the missing observations outside the first and last records (Schaub et al. 2001). By using stopover methodology, the mean total number of nests per female during the nesting season is calculated to be 8.3 ± 0.9 standard error (SE), with significant interannual variation (Rivalan 2003). Note that females seen only one time during the nesting season are not taken into account for this analysis. The significance of these “one time nesters” appears to be more complex than simply reflecting a low probability of observation (see below and also Hilterman and Govere 2007).

Table 1. Examples of tagged female leatherbacks nesting during both the small nesting season (December-January) and the normal nesting season (March-August).

Turtle ID (PIT) ^a	Nest date and location during small season	Nest date during normal season
00012695B2	28/12/1998 – Yalimapo, French Guiana	10/5/2001 31/5/2001 20/6/2001
0001CF087E 0001E02E8C	03/01/2000 – Yalimapo, French Guiana 01/02/2000 – Yalimapo, French Guiana	21/6/2002 30/5/1998

^a PIT = passive integrated transponder.

Loyalty of Females to a Nesting Beach. — When tag data from several beaches are analyzed together, it appears that females may switch nesting beaches from season to season. However, females are generally faithful to one nesting beach during a nesting season and only rarely move to another nesting beach for a single laying event (Table 2). Therefore, the females observed nesting only once during the nesting season in Yalimapo Beach could be “unfaithful visitors” rather than true “one time nesters”. However, this hypothesis remains untested. An alternative hypothesis is that the females observed only once may be new recruits in the population (Hilterman and Govere 2007).

The loyalty of female leatherbacks can also be investigated on the scale of different sections along a beach during consecutive nesting events. During the 1997 nesting season, we separated Yalimapo Beach into 2 sections of similar length (2 km): Awala in the east and Vigie in the west. We recorded the section in which a single female nested during 2 successive observations with less than 18 days between them, to ensure that only true successive nesting events were used. Each female was included only once in the analysis to ensure independence between observations. Of 473 pairs of successive observations, 89 females nested twice in a row in the Awala section, 180 females nested twice in a row in the Vigie section and 204 females nested once in Awala and once in Vigie. Based on these values, the probability of nesting in Awala was $p_A = 0.40$ and in Vigie was $p_V = 0.60$. If the choice of section was independent of the previous nesting section, the expected number of successive nesting events in Awala would be $N \cdot p_A \cdot p_A = 77.12$, in Vigie, it would be $N \cdot p_V \cdot p_V = 168.12$, and for switching between sections would be $2 \cdot N \cdot p_V \cdot p_A = 227.74$. The difference between observed and expected is significant ($\chi^2 = 5.14$, $df = 1$, $p = 0.02$), reflecting a greater likelihood of consecutive nesting in the same section. Note that this effect disappeared if nest locations of the first and third nest of individual females were analyzed without information on

the location of the second nest ($n = 280$, $\chi^2 = 0.003$, $df = 1$, $p > 0.05$). Therefore, although there appears to be some preference for beach section for successive nests, nest site selection across the nesting season is more complex.

Number of Years Between Nesting Seasons and Female Annual Survivorship. — It is commonly reported that individual females of most sea turtle species, including leatherbacks, do not nest every year. This character of reproductive behavior of sea turtles complicates analyses of demographic variables, e.g., population size (Hays 2000). Moreover, female mortality outside the nesting season can bias estimates of the time females spend away from the nesting beach. A new capture-mark-recapture (CMR) methodology has been recently designed to more accurately describe this behavior. Indeed, in classical Cormack-Jolly-Seber CMR analyses, one of the implicit assumptions is that the probability of observing an individual will be independent of the individual’s history. For leatherbacks and, more generally, for most marine turtles, this assumption is violated, because the probability that an individual will nest 2 years in a row is low but not zero (Girondot and Fretey 1996). The new CMR methodology is free of this assumption and was applied to leatherbacks. The majority of females return to nest in French Guiana 2 years after their prior nesting season, and the annual survivorship of adult females is at least 0.96 (Rivalan 2003).

Hatching Success and Sex Ratio. — Hatching success (the number of eggs in a clutch that produce viable hatchlings that reach the water) for leatherbacks in French Guiana and Suriname is difficult to assess when nesting density is high, making it logistically challenging to follow the fate of all nests laid (Caut et al. 2006b). It is known that some leatherback nests on beaches in Suriname and French Guiana were lost to erosion (Mrosovsky 1983, 1997). At Yalimapo Beach, hatching success in 2001 was estimated for 48 nests to lie between 33.27% (3.37 SE) and 38.95% (3.51 SE) (Torres 2002), 35.9% (7.1 SE) for 10

Table 2. Example of inter- and intra-annual observations of tagged leatherback females.^a

Date	8/6/1994	9/6/1994	25/6/1994	19/5/1997	28/5/1997	16/6/1997	3/7/1997	2/6/1999	20/6/2001
Nesting location	Yal	Azt	Yal	Yal	Yal	Yal	Yal	Yal	Yal

^a Yal = Yalimapo Beach; Azt = Aztec Beach.

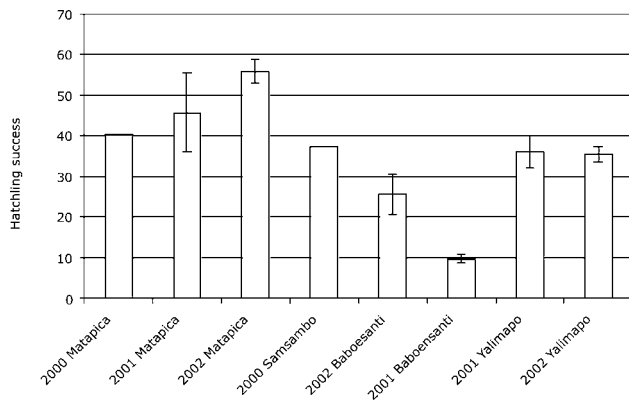


Figure 2. Hatching success in French Guiana and Suriname according to the year of experiment. Matapica and Samsambo are Atlantic Surinamese nesting beaches, Babunsanti and Yalimapo are nesting beaches within Maroni estuary. Error bars are SE, but it cannot be calculated for 2000 season.

nests laid in 2001 and 2002 (Maros et al. 2003) and 35.5% (1.9 SE) for 99 nests in 2002 (Caut et al. 2006a). Data from Suriname sometimes include the proportion of nests that were not found at the end of the incubation. These nests could be completely lost or position could have been lost. Then, we have estimated the range of possible values according to these 2 hypotheses, but the standard error cannot be calculated, because the raw data are not available. In 2000, hatching success of randomly marked nests, including that of nonemergent nests was 37.48% and 40.35%, respectively, at Samsambo and Matapica Beaches (Hilterman 2001). However, these data should be used with caution, because standardized methodology subsequently used was not still implemented in 2000 (M. Hilterman, *pers. comm.*). In 2001, hatching success was between 9.15% and 10.6% at Galibi Beach within the Maroni estuary, and between 38.9% and 52.7% in Matapica Beach (Hilterman and Goverse 2002). For this year, erosion was very low on the worked beach section and the missing nests were probably lost by the way of marking (M. Hilterman, *pers. comm.*). In 2002, the hatching success was 56% (2.96 SE) at Matapica and 25.8% (4.93 SE) at Babunsanti (Hilterman and Goverse 2003). Data are summarized in Fig. 2 and older studies on beaches in Suriname give a similar range of values for leatherback clutches, despite the differences in methodologies (Whitmore and Dutton 1985; Schouten et al. 1997).

Leatherbacks, as all other species of marine turtles, exhibit temperature-dependent sexual differentiation, with warmer incubation temperatures producing more females and cooler temperatures producing more males (Rimblot et al. 1985; Wibbels 2003). The pivotal temperature (the constant incubation temperature that produces equal number of both sexes) for leatherbacks in French Guiana is close to 29.5° C (Chevalier et al. 1999b).

Quantification of Nesting. — We used a mathematical model to render the global shape of nesting season, which, in turn, allowed us to estimate the missing nest count data and also to calculate the total number of nests laid during

the nesting season, together with its standard error (Girondot et al. 2006).

Nesting seasons of marine turtles typically show a peak of nesting at the approximate middle of the nesting season. The number of nests at the extreme ends of the nesting season is usually low, generally less than 1 nest per week or even month in some cases. This type of pattern can be modeled by using the product of 2 sigmoid equations, the first one ranges from 0 to 1 and the second one ranges from 1 to 0. Therefore, the product of the equations describes a 0-1-0 pattern, if the transition of the first equation is observed at lower abscissa than the second. For the sigmoid equations, we used a modified form of the classical Verhulst equation (Verhulst 1846) that allows asymmetry to be set. The first-order derivative of this equation is similar to the Richards equation (Richards 1959):

$$M(d) = \left(1 + (2^{e^k} - 1)e^{\left(\frac{1}{3}(P-d)\right)}\right)^{-1/e^k} \quad (1)$$

The value of $M(d)$ ranges from 0 to 1 with $M(d) = 0.5$ for $P = d$, d being the number of days since the starting date of the nesting season. The steepness of $M(d)$ at $P = d$ depends on S and K values. The value of $M(d)$ increases when S is negative (i.e., beginning of the nesting season) and decreases when S is positive (i.e., end of the nesting season). Asymmetry around P is determined by a positive or negative K value.

The mathematical description of nesting season is therefore described as:

$$N(d) = \min + (\max - \min)(M_1(d) \cdot M_2(d)) \quad (2)$$

With $M_1(d)$ and $M_2(d)$ being different according to the sign of the S parameter (by convention, 1 is used for beginning of nesting season and 2 for the end). Thus, S_1 is negative and S_2 is positive and $P_1 < P_2$.

The parameter \min is the basal level of nesting outside the nesting season and $\max - \min$ is a scaling factor. Note that \max is not the maximum of the function because $(M_1(d) \cdot M_2(d))$ can be lower than 1 at the peak of nesting season. The maximum can only be calculated numerically.

The curve was fitted to experimental data by the maximum likelihood method. For this purpose, we assumed that the error associated with day d was normally distributed with a standard deviation, $\sigma = \text{Exp}(a \cdot N'(d)^c + b)$, where a , b and c are parameters that were also fitted. This function has the advantage of being strictly positive and monotonically increasing according to $N'(d)$ for positive values of a and c . It also takes into account the observed heteroskedasticity (i.e., counts that are more dispersed at the peak of nesting season). Goodness of fit of the model was evaluated by using the determination coefficient (r^2) between observed and estimated nest number.

Measuring the Nesting Trend in French Guiana and Suriname. — The nesting peaks for different seasons varied slightly (Fig. 3). Nest counts corrected by using this

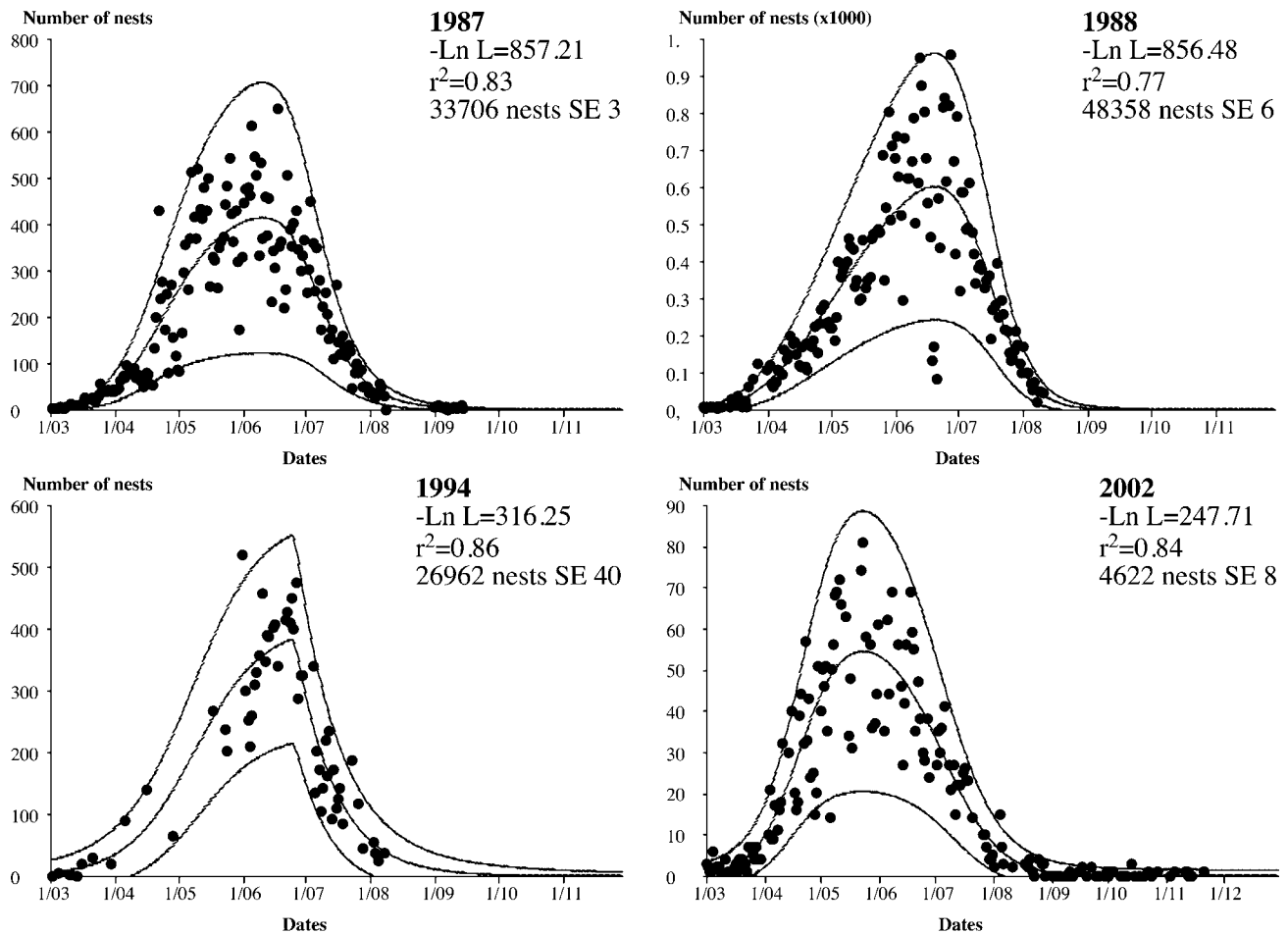


Figure 3. Example of fitted daily nest counts during leatherback nesting season from Yalimapo Beach. Envelopes are ± 2 SD.

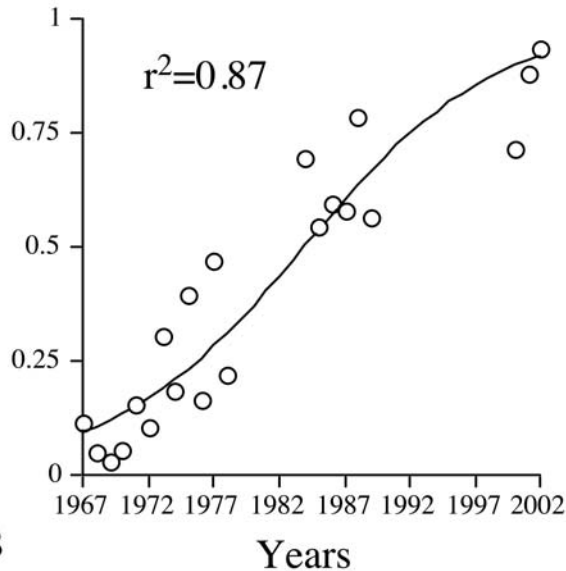
methodology were coded with a quality index of 1, whereas nests counts taken from the literature that had no reported precision concerning the method of data collection were coded with a quality index of 0.6. It is important to note that this quality index is a relative value that measures the quality of data and, therefore, a value of 1 does not indicate that the number of nests is known without error. A temporal trend in the relative proportions of nests in eastern and central Suriname has been already demonstrated (Chevalier and Girondot 1998b). We expanded on this finding with more recent data and modeled this proportion by using a logistic model with the year as a cofactor. We used least-square criteria between the angular transformations ($2 \cdot \text{Asin}(p^{0.5})$) of the logistic model and the proportion of nests at eastern Suriname relative to the total nest number in Suriname (Fig. 4a). Similarly, we expanded upon the relation between nest counts in Yalimapo and eastern Suriname (Babunsanti in Fig. 1), as previously described in Chevalier and Girondot (1998b) (Fig. 4b). However, whereas this relation was still observed when using general linear modeling, the 3 most recent points were clearly outliers based on Tukey's biweight (Press et al. 1992). Therefore, the strong relation between Yalimapo and eastern Suriname was not observed

for the data from the most recent years and the fitted equation (nests at Yalimapo = 5.69 nests at Babunsanti) could not be used after 1999. This recent change in the relation is probably related to the development of new large areas of nesting habitat at the western edge of this region (Kolukumbo and Samsambo Beaches, see the Suriname Marowijne estuary–oceanic beaches column in Appendix 1). The determination coefficient, r^2 , multiplied by the quality of the reference count was then used as an index of quality for the estimates generated from this relation. For example, if we used the second relation ($r^2 = 0.67$) with nest counts at Babunsanti with a quality index of 0.75, the result would be coded with $0.67 \times 0.75 = 0.5025$ quality index.

For the beaches in and around Irakumpapy, there is a lack of strong historical information. Partial information is available in various unpublished reports and one of us (MG) has visited these beaches each year since 1985. However, the available information is not extensive enough to precisely establish the nest numbers for each entire nesting season. Instead, by using available information, we constructed the most plausible temporal series on these beaches but assigned a quality index of 0. A similar situation exists for beaches in the Cayenne region.

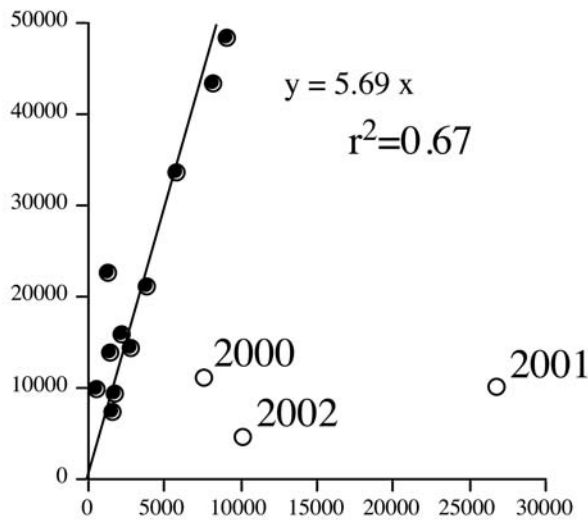
A

Proportion of Surinamese nests deposited at East



B

Number of nests at Yalimapo beach



Number of nests at East Suriname

Figure 4. Relations between the number of nests deposited on different beaches in French Guiana and Suriname. A: The temporal change in the proportion of nests deposited in Babunsanti region (eastern Suriname) relative to the total number deposited in Suriname. B: Correlation between number of nests deposited on Babunsanti region (eastern Suriname) and those laid on French Guiana beaches within the Maroni estuary. Data from 2000 to 2002 were excluded as outliers (see text).

Whereas, nesting occurred in this region before 1984, all the sandy beaches there disappeared from 1985 until 1988 when new beach reappeared in the eastern French Guiana. At that time, nests were regularly reported to one of us (MG) in this region, as well as in Kourou. Nesting activity has been actively recorded from 1999 in eastern French Guiana. However, only partial information is available and

the quality indices from these estimates were coded as 0.5. In 2002, nightly nest counts were available for all principal nesting beaches of Suriname (De Dijn, *pers. comm.*), except for Galibi area where data were partly based on nightly observations of PIT (passive integrated transponder)-tagged females on the beaches (Hilterman and Goverse 2003). By using these data, it was possible to correct for partial information on all the beaches. Therefore, the quality indices for the 6 main regions were coded as 1 for 2002. The synthesis of the available nest data is summarized in Appendix 1. The quality index for total nests laid per year is the sum of confidence indices for each of the 6 main nesting areas (Fig. 5a).

Model Application

Population Dynamics Model. — The life history parameters discussed above can be used to create a population dynamics model (Spotila et al. 1996). However, the lack of detail for specific variables only serves to reduce the confidence of the results of this exercise. For example, the life histories of juveniles and subadults are completely unknown. Also, the variation of many of the estimates of the parameters discussed the previous sections is unknown but could have a major impact on the outcome of a population dynamic model, at least enough to warrant their consideration. For example, previous studies have suggested that for sea turtles, large juveniles and subadults survivorship are the main factors driving population dynamics (Heppell 1998), whereas, the adults possess the highest reproductive value per individual (Laurent 1993). However, if adult survivorship is nearly constant over time while hatchling success is highly variable, as might be expected, then population dynamics will also be influenced by the latter factor (Gaillard et al. 1998). Finally, the covariation or compensation among the different life-history parameters is largely unknown. For example, the relation among nest density, hatching success, and primary sex ratio production as described above may be only one of many complex relations among life-history characters (Girondot et al. 2002). In particular, there appears to be a positive relation between number of nests laid in a season and the number of years that females remained away from the nesting beach before this (Rivalan 2003). This effect is probably mediated by the amount of energy a female can allocate to future reproduction. We also expect non-independence between leatherback survivorship and the number of years between 2 nesting seasons, if the risks are different while turtles are in front of or near the nesting beach, where there are concentrated driftnet fisheries (Ferraroli 2003), and while they are in other areas of the ocean (Ferraroli et al. 2004). However, data are lacking to adequately test these relations.

In general, we have little information on factors that are essential to the construction of an efficient population dynamics model for leatherbacks. In the meantime, only

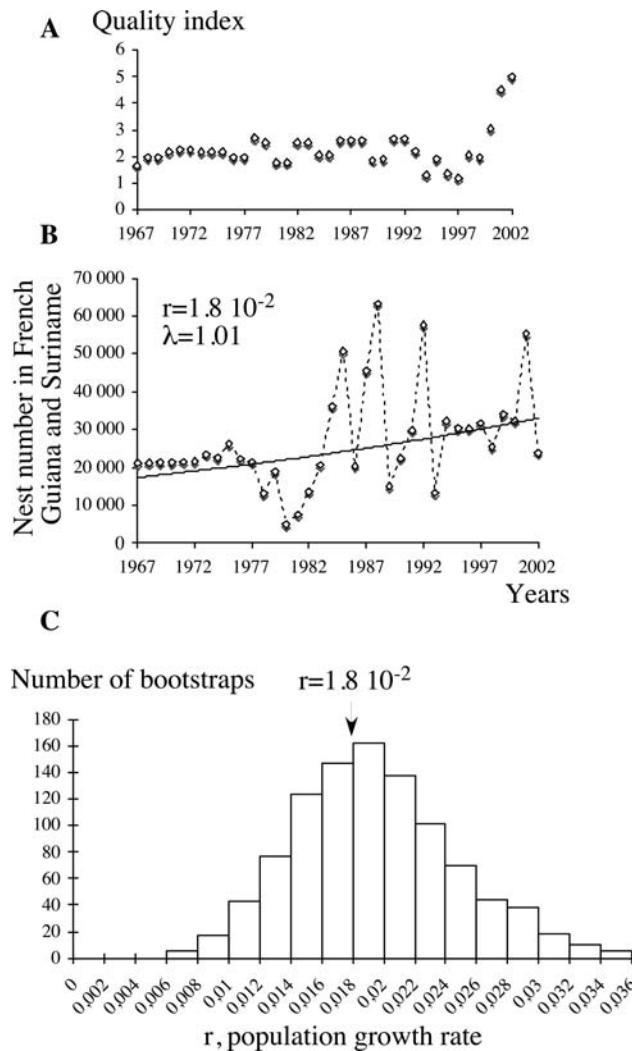


Figure 5. Leatherback nest counts in French Guiana and Suriname per year (B) with the quality index (range 0–6) associated with each estimate (A). Rate of population growth is given as r and the finite rate of increase is given as λ . In panel C, the growth rates (r) were derived from bootstrapping (1000 repetitions), while taking into account the quality index for each year.

one option remains to describe the status of the nesting population in French Guiana and Suriname: the description of trends of either females or their nests over time. Although the number of females is a preferred measure of population size, it is not directly measurable in Suriname or French Guiana. To estimate the number of females nesting per year on a scale greater than 10 years, we would require the use of a CMR model that can take into account transient nonrandom emigration, multisite modeling and tag-loss correction (Rivalan et al. 2005). Given that such a model is not currently available, we must focus our effort on analyzing the trend of a variable that is measurable and for which data exist: the number of nests laid per year.

Trend of Leatherback Nesting Activity in French Guiana and Suriname. — The growth rate calculated from these 36 years is positive ($r = 1.8 \times 10^{-2}$, Fig. 5b). One

thousand series have been generated by parametric bootstrapping, where the probability of the occurrence of a year was set as proportional to the quality index of that year. For each series, the growth rate was calculated (Fig. 5c) and was always positive. Therefore, by using these trend analyses, nesting seems to be increasing at a low rate in French Guiana and Suriname. However, given the uncertainty of many of the data used to construct this temporal series, a more conservative conclusion is that leatherback nesting has been stable in French Guiana and Suriname over the past 36 years.

Conclusions

By using the largest amount of data available to date to understand the nesting trends of leatherbacks in French Guiana and Suriname, we found that nesting activity for this species is stable or slightly increasing. This conclusion is in contrast with previous studies on this species in this region (Chevalier et al. 1999a). We suggest that the recent discrepancies in describing the status of this population of leatherbacks is related to various forces, including the following: a) most sea turtle populations are automatically assumed to be “endangered” even in the face of contrary evidence (Mrosovsky 2003; Hays 2004); b) too much attention has been given to the exceptional nesting years of 1988 and 1992, which have then been inappropriately used as baselines for the population; c) the general focus of research in French Guiana and Suriname has been to uncover the cause of an assumed population decline (Chevalier et al. 1999a; Girondot et al. 2002; Ferraroli et al. 2004). Given the dramatic decline of leatherback populations in Pacific Ocean (Spotila et al. 2000), we agree that caution should be used when assessing the status of leatherback populations in the Atlantic Ocean. However, in the case of the leatherback nesting population in French Guiana and Suriname, much information remains to be collected and reported before we can fully understand the trend of this species. Therefore, we urge all local associations and organizations working on sea turtles in the region to share data for comprehensive analyses, because, as seen in this review, it is a necessary and essential step toward generating a realistic and representative view of the trend for leatherbacks in Suriname and French Guiana.

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Appendix 1. Summary of nest number estimates in French Guiana and Suriname from 1967 until 2002. The number to the right of each estimate of the nest count is the quality index (QI) that is a relative measure from 0 to 1 that indicates the quality of data used to calculate the number of nests (see text).

Year	Suriname Matapica area	Suriname Marowijne estuary - Galibi Nature Reserve (GNR)	Suriname Marowijne estuary - oceanic beaches	French Guianese Maroni estuary beaches	Oceanic West French Guiana beaches	Cayenne + Kourou	Total
	QI	QI	QI	QI	QI	QI	QI
1967	80	10	0	57	20,000	1000	21,147
1968	190	10	0.3	57	20,000	1000	21,257
1969	296	9	0.3	51	20,000	1000	21,356
1970	242	13	0.3	74	20,000	1000	21,329
1971	242	43	0.3	245	20,000	1000	21,530
1972	341	39	0.3	222	20,000	1000	21,602
1973	626	274	0.3	1559	20,000	1000	23,459
1974	643	142	0.3	808	20,000	1000	22,593
1975	989	636	0.3	3619	20,000	1000	26,244
1976	560	110	0.3	626	20,000	1000	22,296
1977	2958	2607	0.3	14,835	0	1000	21,400
1978	1691	469	0.4	10,000	0	1000	13,160
1979	2581	1319	0.261	13,986	0	1000	18,886
1980	820	480	0.261	2729	0	1000	5029
1981	1192	798	0.261	4539	0	1000	7529
1982	2085	1595	0.261	9500	0	500	13,680
1983	3152	2760	0.261	14,381	0	400	20,693
1984	2252	5039	0.4	28,675	0	200	36,166
1985	5666	6735	0.4	38,326	0	0	50,727
1986	1469	2130	0.2	15,825	1000	0	20,424
1987	4148	5668	0.2	33,706	2000	0	45,522
1988	2506	8930	0.2	48,358	3000	500	63,294
1989	1192	1540	0.2	8764	3000	500	14,996
1990	1182	2660	0.261	15,138	3000	500	22,480
1991	1482	3817	0.261	21,075	3000	500	29,874
1992	2732	8052	0.261	43,412	3000	500	57,696
1993	159	607	0.1	9025	3000	500	13,291
1994	361	1456	0.1	26,962	3000	500	32,279
1995	2618	1176	0.261	22,581	3000	500	30,425
1996	448	2048	0.261	23,249	3000	500	30,245
1997	5467	3016	0.261	14,318	7000	500	31,801
1998	1578	1970	0.261	7398	9000	500	25,446
1999	2000	2500	0.4	11,381	5000	1170	34,051
2000	2169	7783	0.4	11,047	6000	1139	32,323
2001	3700	12,250	0.4	10,191	11,941	2796	55,378
2002	2243	2600	0.4	4694	6039	408	23,934