Chelonian Conservation and Biology, 1996, 2(1):55–59
© 1996 by Chelonian Research Foundation

A Six Season Study of Marine Turtle Nesting at Praia do Forte, Bahia, Brazil, with Implications for Conservation and Management

Maria Ângela Marcovaldi[1] and Antônio Laurent[2]

[1]*Projeto TAMAR-IBAMA, Fundação Pró-TAMAR, Caixa Postal 2219, Salvador, Bahia 40.210.970 Brazil [Fax: 55-71-876-1067; E-mail: TAMAR@sunrnp.ufba.br];*
[2]*Travessa Alfredo Bufren, 140, terreo, Centro de Estudos do Mar, UFPR, Curitiba, Paraná 80.020.240 Brazil*

Abstract. – Four species of marine turtles nest at Praia do Forte, Bahia, Brazil. This paper provides a summary of information obtained by Projeto TAMAR over six nesting seasons (1987–93) concerning relative abundance and size of nesting females, seasonal and spatial distribution of nesting, hatching success, emergence period, and clutch size. The Praia do Forte field station protects a total of 43 km of coastline, divided into an intensive study area of 14 km and two conservation areas of 10 and 19 km. Eggs from nests in the conservation areas were transferred to an open air hatchery emulating natural conditions, and nests in the intensive study area were monitored *in situ*. *Caretta caretta* (1932 nests) and *Eretmochelys imbricata* (265 nests) were the most abundant species, together constituting more than 90% of total nesting. Other species found nesting were *Lepidochelys olivacea* and *Chelonia mydas*. The overall nesting season for all species extended from August to April, but peak nesting for *C. caretta* was October to December and for *E. imbricata* January to February. Nesting occurred more frequently at sites along the beach where fringing reefs were not present and where the beach was wider. The emergence period for *in situ* and transferred nests was about the same, but hatch success was usually higher *in situ*. Hatch success was also significantly higher when eggs were transferred less than 6 hours after oviposition. Comparison of hatchery and *in situ* nests shows an open air hatchery emulating natural conditions to be an adequate conservation tool in areas where threats to natural nest survivorship are high.

Key words. – Reptilia; Testudines; Cheloniidae; *Caretta caretta*; *Eretmochelys imbricata*; sea turtle; nesting; hatch success; conservation; Brazil

Brazil has more than 8000 km of marine coastline, largely fringed by sandy beach. Although there have been numerous studies of marine turtles nesting in neighboring countries, notably French Guiana (Fretey, 1981) and Suriname (Schulz, 1975), little has been published about these reptiles in Brazil, where five species are known to nest (Wied-Neuwied, 1820; Hartt, 1870; Menezes, 1972; Sá, 1980; Marcovaldi and Marcovaldi, submitted).

Four of these five species are considered endangered by the World Conservation Union (IUCN) (Groombridge, 1982; Marcovaldi and Marcovaldi, submitted). However, although all sea turtles have been protected in Brazil under federal regulations since 1986, killing of nesting females and taking of eggs along the entire coastline have been conspicuous and common activities for decades. In 1980 Projeto TAMAR (TArtaruga MARinha) was initiated to investigate the distribution and abundance of nesting sea turtle populations, to evaluate the conservation status and threats to these animals, and to plan and develop conservation actions. Field monitoring began at Praia do Forte in the State of Bahia (Fig. 1) in 1982; since then the project has grown steadily to include 22 bases in 9 states on both continental beaches and oceanic islands. A data base has been maintained since the establishment of the program, with information focused on nesting females and other aspects of nesting biology.

During the early years of the project, while field methods were developed, logistic support was organized along a vast area of remote coast with poor to no communication. In 1987 data recording techniques were standardized on a nationwide basis. Praia do Forte is not only the site with by far the longest period of continuous study, but also is the continental beach with the greatest density of nesting. This paper presents a preliminary analysis of this key nesting site, with special emphasis on the information obtained between 1987 and 1993. Reports on other aspects of marine turtle biology and conservation in Brazil are also in preparation.

MATERIALS AND METHODS

Study Area. — Praia do Forte is located in the State of Bahia, Brazil, at 12°34'56"S, 38°00'02"W. Personnel from the local TAMAR station patrol 43 km of continuous coastline, between Guarajuba Beach, located 14 km south of the station, and Porto de Sauípe, which is 29 km to the north (Fig. 1). This shoreline is characterized by gently sloping, medium to coarse quartz sand beaches. Partially submerged beach rock bars occur intermittently in the sublittoral, and reefs, dominated by calcarious algae and bryozoa, with very few scleractinian corals, are found off approximately 12 km of the beach. The supralittoral beach is characterized by dunes which rise to over 10 m in the north to a low, gently rising beach platform in the south. The more common beach vegetation includes *Ipomoea* spp., *Sporobolous virginicus*, and *Cyperaceae* spp.; however, coconut plantations dominate much of the central expanse of the study area.

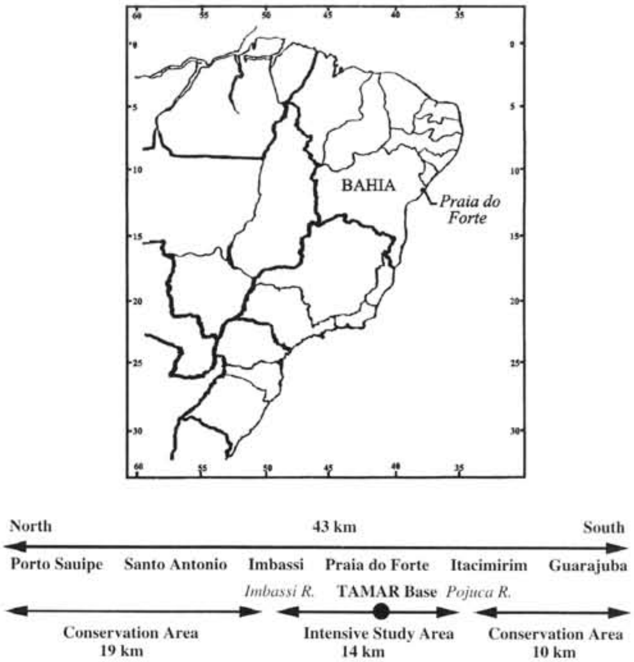


Figure 1. Map of the study area indicating location in eastern Brazil, schematic local geography, and extent of the Intensive Study Area and Conservation Areas.

Data Collection. — The 43 km beach was divided into a central "Intensive Study Area" (ISA) of 14 km, with two contiguous "Conservation Areas" (CAs): one 10 km long to the south and the other 19 km long to the north (Fig. 1). The ISA was in turn divided into 1 km sectors marked by stakes. Each year, fieldwork began in early September and ended in early May, a period which incudes more than 95% of the nesting activity.

Intensive Study Area. — The ISA was patrolled by either TAMAR staff or students at least once daily during the nesting season. Transportation along the beach was mainly by 4-wheel-drive vehicle but was occasionally on foot or by bicycle. Nests were identified from tracks and nesting signs and eggs were located either by carefully probing with a stick (with care being taken not to break any eggs) and then digging by hand, or by observing oviposition during the night (in which case morphometric data from the adult female were collected and tags attached to the front flippers, see below). In those cases where nests were judged to be safe from predation or damage, they were left *in situ*, and the eggs were covered over with sand and the site marked by placing a 2.5 x 10 cm, 2.4 m high, numbered stake into the sand approximately 50 cm from the eggs. For all *in situ* nests, where pressure from land predators such as the South American gray fox (*Dusycion vetulus*) was severe, a protective plastic mesh (at least 1 x 1 m and with a minimum mesh opening of 7 cm) was placed over the eggs. Nearly all nests in the ISA were left to incubate *in situ*. Nests considered to be threatened by tidal inundation or human activity were transferred to the station's open air hatchery or to suitable locations on the beach.

Carapace lengths for nesting adult females were measured over the curve with a flexible tape measure from the precentral scute in the carapace midline to the posterior margin of the postcentrals. Carapace widths also were measured over the curve, across the widest part of the carapace, perpendicular to the longitudinal body axis.

Conservation Areas. — The CAs were patrolled daily by local residents hired by TAMAR. Before the project started these same residents killed nesting females and dug up nests. Each of these people was assigned approximately 5 km of beach to patrol daily and record every nesting crawl and collect and turn over to TAMAR all the eggs laid during the previous night. Their shifts began between 0300 and 0500 hrs.

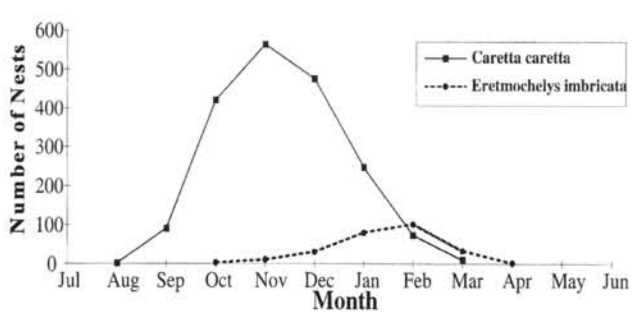
Table 1. Number of nests per species and percentage of total nests per season at Praia do Forte Beach (43 km) each season from 1987 to 1993; *C.c.* = *Caretta caretta*, *E.i.* = *Eretmochelys imbricata*, *C.m.* = *Chelonia mydas*, *L.o.* = *Lepidochelys olivacea*, N.I. = Not identified.

	C.c.	*E.i.*	*C.m.*	*L.o.*	N.I.	TOTAL
1987/1988	284 72.0%	62 16.0%	8 2.0%	9 2.3%	30 7.6%	393
1988/1989	333 83.2%	47 11.8%	4 1.0%	4 1.0%	12 3.0%	400
1989/1990	274 77.6%	40 11.3%	4 1.1%	5 1.4%	30 8.5%	353
1990/1991	328 84.7%	30 7.8%	7 1.8%	8 2.0%	14 3.6%	387
1991/1992	348 82.2%	56 13.2%	0 0.0%	1 0.2%	18 4.3%	423
1992/1993	365 89.6%	30 7.4%	0 0.0%	4 1.0%	8 2.0%	407
TOTAL	1932 81.8%	265 11.2%	23 1.0%	31 1.3%	112 4.7%	2363

Table 2. Selected morphometric and reproductive data for sea turtle species (abbreviations as in Table 1) nesting at Praia do Forte, Bahia, Brazil. Carapace length and width measured over the curve in cm; n = number of observations.

Parameter		*C.c.*	*E.i.*	*C.m.*	*L.o.*
Carapace length	mean	102.8	93.3	123.3	70.0
	SD	±0.04	±0.20	±0.04	±0.01
	n	176	9	4	2
Carapace width	mean	94.2	83.8	107.0	68.0
	SD	±0.05	±0.17	±0.08	±0.01
	n	161	9	4	2
Clutch size	mean	126.7	140.0	127.8	111.6
	SD	±25.03	±32.51	±28.19	±26.38
	n	1921	265	25	31

Figure 2. Total monthly frequency of the number of nests for the two most abundant species (*C. caretta* and *E. imbricata*) from 1987 to 1993.



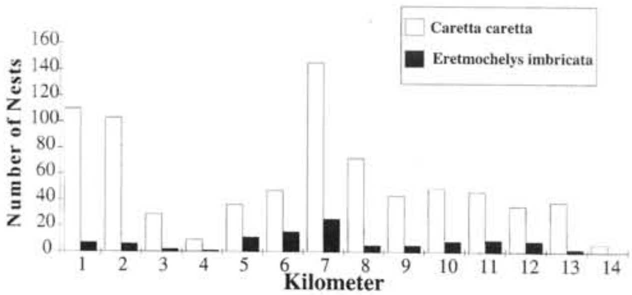


Figure 3. Nesting frequency geographic distribution in the Intensive Study Area for the two most abundant species (*C. caretta* and *E. imbricata*) from 1987 to 1993.

All the eggs collected were transfered to styrofoam boxes (one nest per box) and brought to transfer points at either the northern or southern border of the ISA, where they were normally picked up before 0800 hrs by TAMAR field staff in a 4-wheel-drive vehicle for immediate transfer to the hatchery in the ISA.

Hatchery and Management Practices. — The location of the hatchery was chosen so that its physical characteristics would emulate natural conditions of nests, such as sand type and shading. The hatchery was located 7 m from the high water mark, at the top of the beach slope. The same site was used each year. The hatchery always measured more than 18 m long by 7 m wide and was surrounded by a plastic mesh, 10 cm deep and 170 cm high. Transferred eggs were retrieved from natural nests without rotating and carefully placed in styrofoam boxes 34 x 28 x 23 cm, one clutch per box, and packed with moist sand from the bottom of the natural nest. Transferred eggs were placed in a man-made nest (one clutch per nest), the dimensions of which were made to resemble a normal turtle nest: 55 cm deep and 30 cm in diameter. Each nest in the hatchery was located no less than 50 cm from the nearest nest. A plastic mesh (0.75 cm) cylinder, 35 cm high and 60 cm in diameter, was placed around each hatchery nest and buried 15 cm in the sand.

The time interval between original oviposition and reburial of the eggs in the hatchery was designated as the "relocation period" and classified as one of the following: I - up to 6 hours; II - from 6 to 12 hours; and III - more than 12 hours.

All hatchery and *in situ* nests were excavated within 24 hours after the majority of hatchlings emerged, as judged by the number of hatchlings in the mesh cylinder (hatchery) or by the number of hatchling tracks emerging from a nest (*in situ*). For hatchery nests live hatchlings were identified to species, counted, and immediately released on the beach. In the case of *in situ* nests, the egg shells from hatched eggs were quantified to estimate the total number of live hatchlings that were produced. For all nests dead hatchlings and unhatched eggs were counted. Hatchling success was calculated for each nest as the ratio of the total number of live hatchlings produced as compared to the total number of yolked eggs. The emergence period was calculated as the period between oviposition (day zero) and time of emergence (when the majority of hatchlings emerged from the nest onto the sand surface).

Data Analysis. — All data are stored in a dBase-III+ file. Frequencies and descriptive statistics for all species were calculated using SPSSPC+ (version 3.1) and MS Excel. Clutch sizes for all species were evaluated on the basis of the nests which were collected and transferred to the hatchery. Occasional broken eggs were not included in any calculations. Seasonal and spatial distribution of nesting, emergence period, and hatching success were analyzed for *Caretta caretta* and *Eretmochelys imbricata*, the two most abundant species at Praia do Forte. The analysis of spatial distribution was restricted to the 14 km of the ISA.

Comparisons were made with two tailed t-tests between *in situ* and hatchery nests for both emergence periods and hatching success. Hatching success data were tranformed using the arcsine transformation before statistical analysis. Analysis of variance was performed to test for differences in hatching success between nests transferred using the three different relocation periods. Scheffé's *a posteriori* test was used to test for differences between the three means of the relocation periods, since differences among means were unplanned and sample sizes not equal (Sokal and Rohlf, 1981).

RESULTS AND DISCUSSION

Species. — Four sea turtle species, *Caretta caretta* (loggerhead), *Eretmochelys imbricata* (hawksbill), *Lepidochelys olivacea* (olive ridley), and *Chelonia mydas* (green turtle) nested at Praia do Forte nearly every year from 1982 to 1993 (Table 1). By far the most common species was *C. caretta* which contributed between 72 and 89% of the nests during each season. Second in abundance was *E. imbricata*, with 7 to 16% of the nests each year; this species showed its highest nesting frequencies during the 1987–88 and 1991–92 seasons. Nesting by *L. olivacea* and *C. mydas* was rare, and for that reason, little more will be discussed here for these species. Morphometrics and clutch size data for the four species nesting at Praia do Forte are presented in Table 2.

Seasonal Distribution of Nesting. — The nesting season at Praia do Forte extends from late August until early April.

Table 3. T-test (two tailed) comparison of emergence period (time interval in days between oviposition and hatchling emergence) and hatch success (ratio of live hatchlings to total yolked eggs, per nest) between *in situ* and hatchery transferred nests for *Caretta caretta* and *Eretmochelys imbricata* at Praia do Forte, Bahia, Brazil; n = number of observations.

Parameter	Treatment		*Caretta caretta*	*Eretmochelys imbricata*
Incubation time	*in situ*	mean	53.2	55.1
		SD	4.27	3.87
		n	432	48
	hatchery	mean	52.7	55.7
		SD	3.03	3.24
		n	1426	211
	t-test (P)		0.025	0.378
Hatching success	*in situ*	mean	73.1	61.0
		SD	22.90	27.80
		n	466	48
	hatchery	mean	63.2	51.7
		SD	21.50	22.95
		n	1442	217
	t-test (P)		< 0.0001	0.067

Peak nesting occurred between mid-October and mid-December for *C. caretta* and between early January and late February for *E. imbricata* (Fig. 2). Hence, the season for E. *imbricata* peaks as the season for *C. caretta* is ending. The relative frequency of nesting per month for both *C. caretta* and *E. imbricata* was comparable for each of the 6 seasons for which there are detailed data.

Spatial Distribution. — Cumulative nesting frequency along the 14 km ISA was densest within km 1, 2, and 7 for *C. caretta*, and within km 7 for *E. imbricata*. Little to no nesting for either species occurred within km 4 and 14 (Fig. 3).

Spatial distribution of nesting is related to physical characteristics of the coast. The areas of concentrated nesting (km 1, 2, and 7) are characterized by the absence of beach rock bars and fringing reefs and the presence of relatively wide beaches with strong wave action. In contrast, km 4 and 14 have fringing reefs. Turtles that nest at sites where there is an unhindered approach to the beach are relatively independent of the state of the tide for nesting and avoid the risks of being injured on reefs and rocks. Indeed, during low tides reefs may constitute a physical barrier to emergence. Exposed beaches are subjected to strong wave action, which may result in the creation of wide supralittoral beaches, a common characteristic of marine turtle nesting sites. In contrast, narrow beaches, such as at km 4 where high tides cover most of the supralittoral, are unlikely to harbor successful nests.

Emergence Period. — Average emergence periods for both *in situ* and hatchery nests of *C. caretta* were about 53 days, and although the difference between the two samples was small, hatchery nests had slightly (but significantly) longer periods (Table 3). The average emergence period for *E. imbricata* was just under 56 days, and there was no significant difference between the two nest types (Table 3).

Since emergence period (often incorrectly called "incubation period") is influenced by incubation temperature (Mrosovsky and Yntema, 1980), our results indicate that our hatchery and *in situ* nests are incubating at similar temperatures. This is desirable considering that in *C. caretta* (Yntema and Mrosovsky, 1980) and other sea turtles (Miller and Limpus, 1981; Morreale et al., 1982), the direction of sexual differentiation in embryos is dependent on incubation temperature.

Hatching Success. — Hatching success (defined as the ratio of live hatchlings to total yolked eggs in a single nest)

Table 4. Analysis of variance table and Scheffé multiple range test ($\alpha = 0.05$) comparing the average hatch success for nests transferred using different relocation periods (I = < 6 hours, II = 6–12 hours, III = > 12 hours) for *Caretta caretta* and *Eretmochelys imbricata*; DF = degrees of freedom.

Species/Source	DF	Sum of squares	F. Ratio	F. Prob.
Caretta caretta				
Between groups	2	0.9388	7.8946	$P < 0.001$
Within groups	1412	83.9538		
Total	1412	84.8926		
Scheffé		I	II	III
Eretmochelys imbricata				
Between groups	2	0.0768	0.593	$P = 0.554$
Within groups	205	13.2747		
Total	207	13.3515		

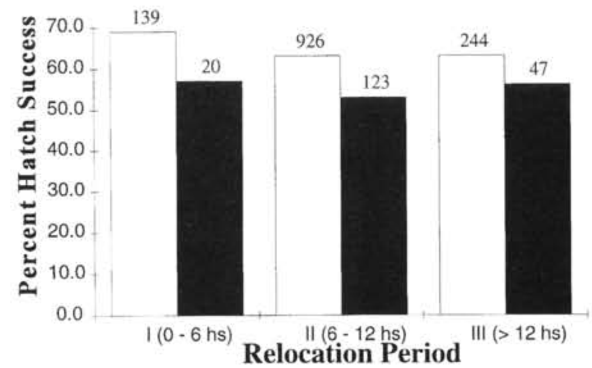


Figure 4. Hatching success in relation to relocation period from 1987 through 1993 for the two most abundant species, *C. caretta* (open bars) and *E. imbricata* (solid bars). Numbers above bars refer to sample sizes.

was significantly greater *in situ* than in hatchery nests for both species (Table 3). *Caretta caretta* had an average success rate of 73.1% for *in situ* and 63.2% for hatchery nests, and *E. imbricata* had an average hatching success of 61.0% *in situ* and 51.7% in hatchery nests. Similar results for *E. imbricata* were found in the Yucatán Peninsula in Mexico (Frazier, 1993). However, other studies comparing *in situ* to relocated nests showed that hatch success is usually higher for the latter (Blanck and Sawyer, 1981; Wyneken et al., 1988; Swimmer, 1993; but see also Schulz, 1975; Limpus et al., 1979; Eckert and Eckert, 1990).

The movement and rotation associated with relocation of the eggs during critical moments of yolk migration and adhesion of the vitelline membrane (Bustard, 1973; Limpus et al., 1979; Blanck and Sawyer, 1981; Whitmore and Dutton, 1985; LeBuff, 1990) may have lowered hatching success in the hatchery group. Hatching success in relation to length of relocation period is depicted in Fig. 4. Analysis of variance (Table 4) detected significant differences in hatching success between the means of relocation periods for *C. caretta*. The result of Scheffé's multiple range test indicated that the average hatch success for this species was significantly higher when eggs were transferred to the hatchery less than 6 hours following oviposition (relocation period I); no significant difference was found between relocation periods II (6–12 hrs) and III (> 12 hrs). The analysis demonstrated no significant difference in hatching success for different relocation periods for *E. imbricata*.

The results are consistent with previous findings indicating orientation of eggs should be carefully maintained between 36 hours and 45 days following oviposition (Blanck and Sawyer, 1981). The significantly higher hatch success for eggs transferred before 6 hours for *C. caretta*, however, suggests egg orientation should be maintained even earlier, at least for this species. This is further supported by higher hatching success rates for nests relocated less than 4 hours following oviposition (Wyneken et al., 1988).

CONSERVATION AND MANAGEMENT

Although hatching success was higher for *in situ* nests, it is important to point out that few of the nests transplanted to the hatchery would have survived tidal flooding or predation, so whatever emerged from these hatchery nests represented an improvement over what would have emerged had they been left *in situ*. Furthermore, several factors were important in lowering overall hatching success of those nests left *in situ*, notably tidal inundation and predators such as the gray fox, which even managed to predate some nests which had been protected with a plastic mesh.

Relocation of marine turtle eggs to protected hatcheries is a common conservation practice used to reduce embryo and hatchling mortality and increase hatchling recruitment (Morreale et al., 1982; Swimmer, 1993). Nonetheless, the use of open air hatcheries has been criticized since it may inadvertently bias the sex ratios of the hatchlings produced from the hatchery (Mrosovsky and Yntema, 1980; Morreale et al., 1982; Mrosovsky, 1982; Swimmer, 1993). The results of the present study indicate that hatcheries can be used to successfully increase hatchling recruitment without greatly affecting the emergence period and, possibly, without causing modifications in the natural sex ratio. Sea turtle hatcheries are especially important as conservation tools in places such as Brazil, where nest predation is the major source of mortality (Marcovaldi and Marcovaldi, submitted). Effective use of hatcheries in the future should always include comparisons with *in situ* nests.

In addition, the impact of the hatcheries on public awareness has contributed towards the attainment of TAMAR's goals to expand the area of the ISA and augment the number of nests left *in situ*. Most TAMAR hatcheries are focal points in visitor centers, where both members of local communities and tourists learn about sea turtle conservation.

Furthermore, the maintenance of hatcheries also benefits longterm *in situ* conservation because the collection of eggs for hatcheries is conducted primarily by people who formerly exploited this resource, but who now have been provided with an economic alternative. Today 30% of the nests protected by TAMAR in all of Brazil must be relocated, far fewer than the numbers required when the program was first established. The long term goal is for only those nests threatened by tidal inundation or located in areas affected by artificial lighting to be relocated to hatcheries or to appropriate areas of the beach.

Acknowledgments

Special thanks to all the members of the TAMAR team, past and present. Also, thanks to Cassiano Monteiro Neto for his help with the writing and statistical analysis. We are grateful for the editorial advice of Anders Rhodin and Peter Pritchard, the constructive comments of N. Mrosovsky and Jack Frazier, and the help of Matthew Godfrey in reaching the final form of the manuscript.

LITERATURE CITED

BLANCK, C.E., AND SAWYER, R.H. 1981. Hatchery practices in relation to early embryology of the loggerhead sea turtle, *Caretta caretta* (Linné). J. Exper. Mar. Biol. Ecol. 49:163-177.

BUSTARD, H.R. 1972. Sea Turtles. Their Natural History and Conservation. London: W. Collins and Sons, 220 pp.

ECKERT, K.L., AND ECKERT, S.A. 1990. Embryo mortality and hatch success in *in situ* and translocated leatherback sea turtle *Dermochelys coriacea* eggs. Biol. Conserv. 53:37-46.

FRAZIER, J. 1993. Una evaluación del manejo de nidos de tortugas marinas en la Península de Yucatán. In: Frazier, J. (Ed.). Memorias del IV Taller Regional sobre Programas de Conservación de Tortugas Marinas de la Península de Yucatán. Universidad Autónoma de Yucatán, pp. 37-76.

FRETEY, J. 1981. Tortues Marines de Guyane. Paris: Éditions du Léopard d'Or, 136 pp.

GROOMBRIDGE, B. 1982. The IUCN Amphibia-Reptilia Red Data Book. Part I. Testudines, Crocodylia, Rhynchocephalia. Gland, Switzerland: IUCN, 426 pp.

HARTT, C.F. 1870. Thayer Expedition: Scientific Results of a Journey in Brazil by Louis Agassiz and his Travelling Companions. Geology and Physical Geography of Brazil. Boston: Fields, Osgood and Co.

LEBUFF, C.R., JR. 1990. The Loggerhead Turtle in the Eastern Gulf of Mexico. Sanibel, FL: Caretta Research, Inc., 216 pp.

LIMPUS, C.J., BAKER, V., AND MILLER, J.D. 1979. Movement induced mortality of loggerhead eggs. Herpetologica 35:335-338.

MARCOVALDI, M.A.G. DEI, AND MARCOVALDI, G.G. DEI. Submitted. Marine turtles of Brazil I. The history and structure of Projeto TAMAR-IBAMA.

MENEZES, M.F. DE. 1972. As tartarugas marinhas de Brasil. Arq. Ciên. Mar. 12:17-20.

MILLER, J.D., AND LIMPUS, C.J. 1981. Incubation period and sexual differentiation in the green turtle *Chelonia mydas* L. In: Banks, C.B., and Martin, A.A. (Eds.). Proceedings of the Melbourne Herpetological Symposium. Parkville, Australia: Zoological Board of Victoria, pp. 66-73.

MORREALE, S.J., RUIZ, G.J., SPOTILA, J.R., AND STANDORA, E.A. 1982. Temperature dependent sex determination: current practices threaten conservation of sea turtles. Science 216:1245-1247.

MROSOVSKY, N. 1982. Sex ratio bias in hatchling sea turtles from artificially incubated eggs. Biol. Conserv. 23:309-314.

MROSOVSKY, N., AND YNTEMA, C.L. 1980. Temperature dependence of sexual differentiation in sea turtles: implications for conservation. Biol. Conserv. 18:271-280.

SÁ, R.S. DE. 1980. Tartarugas marinhas quelônios das costas Brasileiras. Cadernos do Museu de Pesca 1:1-15.

SCHULZ, J.P. 1975. Sea turtles nesting in Surinam. Nederl. Comm. Internatl. Natuurbesch. Meded. 23:1-143.

SOKAL, R.R., AND ROHLF, F.J. 1981. Biometry (2nd ed.). New York: W.H. Freeman and Company.

SWIMMER, J.Y. 1993. Comparisons of *in situ* and relocated loggerhead sea turtle (*Caretta caretta*) nests at Projeto TAMAR, Brazil. M.S. Thesis, University of Michigan, Ann Arbor.

WHITMORE, C.P., AND DUTTON, P.H. 1985. Infertility, embryonic mortality and nest site selection in the leatherback and green sea turtles in Suriname. Biol. Conserv. 34:251-272.

WIED-NEUWIED, M. 1820. Reise nach Brasilien in den Jahren 1815 bis 1817. Frankfurt: H. Bronner, 2 vols.

WYNEKEN, J., BURKE, T.J., SALMON, M., AND PEDERSON, D.K. 1988. Egg failure in natural and relocated sea turtle nests. J. Herp. 22:88-96.

YNTEMA, C.L., AND MROSOVSKY, N. 1980. Sexual differentiation in hatchling loggerheads (*Caretta caretta*) incubated at different controlled temperatures. Herpetologica 36:33-36.

Received: 12 June 1995. *Accepted*: 21 September 1995.