An analysis of the role of local fishermen in the conservation of the loggerhead turtle (Caretta caretta) in Pontal do Ipiranga, Linhares, ES, Brazil

Antonio de Padua Almeida, Sérgio Lucena Mendes

A ARTICLE INFO

Article history:
Received 7 August 2005
Received in revised form 22 July 2006
Accepted 24 July 2006

Keywords:
Sea turtle
Conservation
Fishermen
Management
Clutch size
Relocation

A ABSTRACT

The role of researchers and fishermen in the clutch management of loggerhead sea turtles was evaluated for 10 nesting seasons at Pontal do Ipiranga TAMAR station, Linhares, ES. The comparison of nests transferred by researchers and locals (carebeiros) showed that clutches transferred by researchers presented higher clutch size. Clutch size between nests transferred by carebeiros and left in situ did not show significant differences. Hatching success was significantly higher for clutches left in situ than for those transferred to other places in the beach or to hatcheries. The clutches transferred exclusively by researchers achieved a higher hatching success than those transferred partially or totally by carebeiros. The relocation time of clutches collected by carebeiros and handed to researchers affected hatching success. It is recommended that clutches be left in situ, provided they have adequate conditions for monitoring, but careful clutch translocation, independent of the interval elapsed after laying, may also constitute a viable technique for the conservation of sea turtles in the region.

1. Introduction

Conservation activities of sea turtles in Brazil began in 1980, with the creation of the Brazilian Sea Turtle Conservation Program – Projeto TAMAR-IBAMA. Initial surveys revealed that there were three main continental nesting sites of sea turtles, in Praia do Forte, state of Bahia (BA); Comboios, state of Espírito Santo (ES) and Pirambu, state of Sergipe. Since then, the Program has gradually expanded and currently covers 1100 monitored kilometers of coastline (Marcovaldi and Marcovaldi, 1999). All species of marine turtles are considered threatened in Brazil, and the loggerhead Caretta caretta is classified as vulnerable (Ministério do Meio Ambiente, 2003).

The second largest nesting site of the loggerhead turtle in Brazil is located in Espírito Santo northern coast (Baptistotte et al., 2003), between the municipal districts of Aracruz, ES (19°, 50’S) and Nova Viçosa, BA (17°, 55’S). There is a TAMAR station in Pontal do Ipiranga, located north of Comboios, in the central portion of the Doce River Coastal Plain (Fig. 1). The beaches monitored by this station are visited annually by more than 40 nesting loggerheads (Almeida, 2002). The Pontal do Ipiranga station, where activities are now carried out seasonally, was created in response to the occupation pressure following the 1990 human occupation of a previously uninhabited beach.

Since the beginning of the station’s activities, the local fishermen, who were former predators of the turtles (locally...
called carebeiros), have been involved in turtle conservation activities, being trained and contracted to protect the nests, to monitor the nests maintained in situ or to collect the clutches to be transferred to open air hatcheries. This study evaluates the participation of the carebeiros in the conservation of the sea turtles in Pontal do Ipiranga.

2. Materials and methods

2.1. Study area

The southern limit of the study area is located in the region of Degredo, in Linhares (19°22′S, 39°42′W), and the northern limit is situated at Barra Seca, at the municipal boundary of the district of São Mateus (19°09′S, 39°42′W) (Fig. 1).

2.2. Field work

Field work was carried out from 1988 to 1998. Every year, from October to January, 26 km of beach were monitored daily at dawn by carebeiros. Each carebeiro monitored about 5 km either on foot, by horse, or by bicycle (during low tide). Under normal circumstances, TAMAR’S research team travelled the whole extension nightly with a 4-wheel-drive vehicle to tag females and demarcate/transfer nests. The timing of the trips with the vehicle was accomplished according to tide schedule and height, as high tides did not allow the passage of the car. The jeep was used daily in the reproductive seasons of 1988/1989, 1989/1990, 1991/1992, 1992/1993, 1993/1994 and 1994/1995, almost daily (with some gaps) in the 1990/1991 season and only sporadically during the 1995/1996, 1996/1997 and 1997/1998 seasons.

2.3. Demarcation and transfer of the clutches

Once located, the nests were marked with a wood stake placed one meter away. This was usually done with the aid of a fine wooden probe. (The probing was gradually abandoned, but was largely adopted during the first years; however, it was not possible to assure which nest was probed in the study, although we can state that mostly nests were probed.) The nests deemed at risk of predation (by men or by animals), over washing or erosion by the tides were transferred to more protected locations on the beach or to hatcheries, which are located in the supra-coastal beach zone, enclosed with screen and fully exposed to sun and rain (daily beach patrolling allows to detect possible risks to the nests, such as the presence of predators and beach erosion, the main reasons to decide for a nest relocation). During transfer, the eggs of one clutch were initially placed in a styrofoam box, in layers, surrounded with sand to minimize rotation, with a thicker layer of sand on the top of the clutch. The box was then taken to the open air hatchery, where the eggs were removed and deposited in a chamber that resembles the depth and shape of the nest cavity dug by the female, approximately 50 cm deep and 30 cm in diameter. Once all the eggs were placed in the hatchery cavity, the hole was filled with sand and a partially buried screen was placed around the nest to avoid the dispersion of hatchlings after emergence.

When the patrol car was in use, clutches were delivered by the carebeiros to the researchers at the beach. During seasons where vehicle availability was sporadic or absent, the clutches were passed along among carebeiros in a “chain” system until they reached the hatchery. Sometimes, the carebeiros who operated near hatcheries buried the nests directly, without the researchers’ participation.

2.4. Relocation period

The time interval between when the nest was laid and when the clutch was transferred was recorded. The relocation period was classified into four time intervals: Time A – Up to 6 h after oviposition; Time B – From 6 to 12 h after oviposition; Time C – From 12 to 24 h after oviposition; Time D – Over 24 h after oviposition. Both egg collector and depositor were recorded (as researcher or carebeiro) for each clutch.
2.5. **Nest location**

Clutches were classified according to three different treatments: (a) in situ, when the eggs were not moved from their original place; (b) transferred within the same beach, when the clutch was moved to a more suitable location on the original nesting beach and; (c) transferred to the hatchery, when the eggs were reburied at the hatchery.

2.6. **Nest opening**

Nests transferred to the hatchery were immediately opened on the day subsequent to the appearance of the first hatchlings (the emergence date); for nests in situ and those transferred on the beach this period was longer, given that patrolling was not constant. For nests kept in situ, the number of hatchlings was estimated from the number of empty egg shells that remained in the nest. Clutch size of in situ nests included the number of empty egg shells, unhatched and occasionally broken eggs.

2.7. **Hatching success**

The hatching success was determined by the ratio between the number of live hatchlings (dead hatched animals under sand surface not included) and the total number of eggs. The hatching success was calculated for different transfer times, for different types of collector/depositor of the clutches and for the situation of the nests (in situ, transferred to the beach and transferred to the hatchery).

2.8. **Incubation period**

The incubation time was determined by the interval between the nesting date and the date of emergence of hatchlings. Emergence date was recorded as the night where hatchlings reached the surface of the sand. The incubation time was analyzed in relation to the location of nests (in situ, transferred within the beach and transferred to the hatchery).

2.9. **Data analysis**

Analyses of variance (ANOVs) were used when data satisfied the requirements of homogeneity of variances among groups; significant differences among groups were tested by planned comparisons (analysis for/by contrasts; Snedecor and Cochran, 1972). Data tested by proportion analysis were previously Arc-sine transformed. When variances were not homogeneous among groups, the non-parametric Kruskal–Wallis test was used. Paired t-tests (Zar, 1984) were used to compare the incubation time among nests transferred to the hatchery and those maintained in situ. To do so, each in situ nest of known incubation time was paired with a transferred nest of similar oviposition date (21 nests with the same date, 23 nests with 1-day, 6 with 2-days, 3 with 3-days and 2 with a 4-days difference).

3. **Results**

3.1. **Clutch size**

The mean clutch size was 114.51 (sd = 23.88; n = 1131, range 6–186).

There was a significant difference between the clutch size of transferred clutches collected by researchers and those collected by *carebeiros* (ANOVA: *F* = 7.80; df = 2; *p* < 0.005). There was a significant difference among clutch size of nests collected and deposited by researchers and those collected by the *carebeiros* and deposited by the researchers (planned comparison: *F* = 12.6014; df = 1; *p* = 0.0004) (Fig. 2). Clutches collected by *carebeiros* and deposited by researchers and those collected and deposited by *carebeiros* were not statistically significantly different in their clutch size (planned comparison: *F* = 0.3877; df = 1; *p* = 0.5337). Clutch size (Table 1) did not show

![Fig. 2 – Mean clutch size (±standard error) of loggerhead clutches transferred by researchers and *carebeiros* at Pontal do Ipiranga, Linhares, between 1988 and 1998.](image-url)
significant differences between the clutches maintained in situ and those transferred by carebeiros to the beach (Kruskal–Wallis: \( \chi^2 = 0.7608; \) df = 1; \( p = 0.787 \)) or to the hatchery (planned comparison: \( F = 4.7659; \) df = 1; \( p = 0.0292 \)) (Table 1). There was no significant difference in hatching success rates between clutches transferred within the beach and those transferred to the hatchery (planned comparison: \( F = 2.1061; \) df = 1; \( p = 0.1469 \)).

Hatching success varied as a function of the collector/depositor pair type (Table 2). Clutches collected and deposited by the researchers had a higher hatching success than those collected by carebeiros and deposited by researchers (Kruskal–Wallis, \( \chi^2 = 7.8003; \) df = 1; \( p = 0.0052 \)) and than those collected and deposited by carebeiros (\( \chi^2 = 4.5544; \) df = 1; \( p = 0.0326 \)).

The analysis of hatching success in relation to transfer time (Fig. 3) indicated that the hatching success of clutches collected by carebeiros and passed to researchers presented significant differences (ANOVA of Kruskal–Wallis, \( \chi^2 = 19.9111; \) df = 2; \( p = 0.0000 \)). Significant differences were not detected for clutches collected and deposited by the researchers (\( \chi^2 = 2.1151; \) df = 2; \( p = 0.3478 \)) or those collected and deposited by carebeiros (\( \chi^2 = 0.8243; \) df = 2; \( p = 0.6622 \)).

3.3. Incubation time

The incubation time did not show significant differences between the clutches transferred to the hatchery and those maintained in situ (t-test for paired samples: \( t_{calc} = 0.2879; \) df = 109; \( p > 0.05 \)). The time intervals varied from 45 to 70 days in the nests in situ (\( n = 55 \); average of 58.54 days), and from 48 to 70 days in the nests transferred to a hatchery (\( n = 55 \); average 58.36 days).

4. Discussion

The mean clutch size (114.5) is within the range of those reported for other populations in the Atlantic (Dodd, 1988; Crouse et al., 1987), but smaller than the mean clutch size reported for other populations in the Atlantic (Dodd, 1988; Crouse et al., 1987), but smaller than the mean clutch size reg-
istered in the five TAMAR Stations in northern Espírito Santo as a whole – Pontal do Ipiranga included – (119.7 eggs, Baptis
totte et al., 2003) and in Bahia State (126.7 eggs, Marcovaldi and Laurent, 1996; 130.5 eggs, Tiwari and Bjorndal, 2000).

The data obtained at Pontal do Ipiranga show that clutches transferred by carebeiros without the researchers’ participation were smaller on average by 11 eggs, and that clutches passed to researchers for deposition in the hatchery were smaller on average by seven eggs relative to clutches transferred only by researchers (Table 2). Gil et al. (1993), evaluating the handling of nests of Eretmochelys imbricata in Isla Holbox, in Mexico, mentioned a similar situation and concluded that the fishermen removed some eggs before delivering the transferred clutches to the researchers. Frazier (1993) mentioned the participation of fishermen in the clutch transfer when discussing the lower fecundity of transferred loggerhead nests in relation to those maintained in situ in Cozumel, Mexico, according to data provided by Zurita and Miranda (1993). The possibility that carebeiros ignore some eggs in the nests is unlikely, considering that the researchers carefully instructed the carebeiros in the collection techniques. The breaking of eggs with the wood probe during the nest search might explain this difference. However, the lack of a significant difference in number of eggs between transferred nests and those maintained in situ makes this an unlikely explanation. Also, the broken egg shells found after nest excavation were added to obtain the clutch size. Thus, a more suitable explanation would be the use of these eggs for consumption. Turtle eggs were, for many years, an important food resource for the local communities. Generations of carebeiros were fed in that manner. It is possible that they continued to use this resource, through the strategy of removing just a few eggs from each nest, in an attempt to mask the effects of this collection. The absence of significant differences between the mean clutch size for nests in situ and that transferred by carebeiros also suggests the use of this strategy in the nests maintained in situ.

The lower hatching success of nests transferred within the same beach (at Pontal do Ipiranga, transferred by carebeiros only) in relation to those transferred to the hatchery diverge from results obtained at other TAMAR Stations in Espírito Santo (Rieth, 1998) and Bahia (Gonchorosky et al., 1995; Marcovaldi and Laurent, 1996), where the hatching success of nests transferred within the beach is intermediate between in situ nests and those transferred to the hatchery. This suggests the possibility that carebeiros are not as careful as researchers in relation to the manipulation of eggs. Gil et al. (1993) mentioned a similar pattern in a conservation program developed in Isla Holbox, in Mexico.

Limpus et al. (1979) showed an inversely proportional relationship between transfer time and hatching success. The authors worked with sub-samples of four nests, which were relocated carefully over a short distance (150 m) within the same beach. The data from Pontal do Ipiranga suggest the influence of other factors. The absence of significant variation in the hatching success of clutches transferred by researchers for different transfer times indicates that a careful manipulation can minimize the impacts of the transfer – there was no significant difference in hatching success between clutches transferred by the researchers and nests maintained in situ (Tables 1 and 2). The nests transferred exclusively by carebeiros were essentially limited to those located in the hatchery vicinity, for which transport was mostly less than 5 km, and predominantly within 12 h after laying, without participation of another person. Also in this case, there were no significant variations between different transfer times (Fig. 3).

The hatching success of clutches collected by carebeiros and sent to researchers, however, showed a similar pattern to that of Limpus et al. (1979), so that higher hatching success was related to lower transfer time. This suggests a possible influence of the distance travelled or the means of transportation. In fact, a clutch transferred within one hour would travel a greater distance (exposed, possibly, to more movement) if the transfer were accomplished by car or horse, than by foot. More research examining the different factors related to hatching success would increase our understanding of these issues.

The data suggest that careful manipulation of the clutches during collection, transport and deposition in the hatchery can minimize the effects on hatching success.

Both lower clutch size and hatching success translate into a lower hatching production. Despite the lower elasticity attributed to these stages (eggs and hatchlings) in the life cycle of sea turtles (Crowder et al., 1994), a 10% reduction in offspring production is an important factor to consider when recovering depleted populations. However, the direct participation of carebeiros in activities related to the protection of nests is fundamental. Monitoring of in situ nests would be hindered without their daily presence on the beach; decisions on the transfer of clutches threatened by the tides, for instance, would be very difficult without their contribution based on practical experience on beach dynamics. Finally, the enormous gains from local participation and understanding of the need for sea turtle conservation would never be reached, maintained and deepened without the participation of the carebeiros.

The challenge, therefore, is to combine their participation with an adequate management of the nests. The need for a closer attendance of the carebeiros’ activities to obtain results similar to those of nests managed by researchers is stressed in this study. Periodical meetings to evaluate and to compare results from different Stations and for different carebeiros in the same Station are proposed as a strategy to avoid the observed discrepancies in the future, reinforcing the importance of each egg and hatching for recovering the local loggerhead population. Garcia et al. (2003) reported the successful participation of laypeople in transferring nests with no significant impacts in hatching success.

The pivotal incubation time is the one at which males and females are produced in equal proportions (Marcovaldi et al., 2003). Analysis of incubation time allows for estimation of the natural sex ratio of a sea turtle population (Mosovsky et al., 1999). Comparison of incubation times for in situ and transferred nests can help detect any distortion in the natural sex ratio caused by nest relocation (Marcovaldi et al., 1997).

The absence of any difference in incubation times for in situ and transferred nests at Pontal do Ipiranga indicates that sex ratios of offspring do not differ between treatments.

Despite incubation time and hatching success of clutches transferred by the researchers presenting very similar values...
to those observed in situ, we strive to maintain as many sea
turtle nests in the original sites of oviposition (Marcovaldi
and Marcovaldi, 1999) for various reasons, including
the avoidance of localized catastrophes in the hatchery that could
result in concentrated embryonic mortality and/or the alter-
ation of the natural sex ratio. Also, it has been suggested that
near-shore mortality due to fish predation is lower for hatch-
ings that emerge from natural nests compared to those
released from hatcheries (Stewart and Wyneken, 2004).
Finally, it has also been suggested that the byproducts of
post-emergent sea turtle nests are an important source of en-
ergy for beach dune systems (Bouchard and Bjornal, 2000).
However, in some places the risk of nest losses by environ-
mental factors outweighs any possible disadvantages that
might be caused by nest translocation (e.g. Garcia et al., 2003).

5. Conclusions

The differences observed in the hatching success of clutches
transferred by researchers and by carebeiros emphasize the
importance of a careful manipulation of the eggs. The trans-
fer of clutches, when accomplished by researchers, was an
efficient alternative to maintenance of nests in situ in areas
with high predation or erosion risks, independently of the
time elapsed since oviposition. This demands, however, a
daily presence of the carebeiros in the activities related to sea
turtle cons-
ervation, which would allow the maintenance of the clutches in situ, the best choice to
avoid several potential negative effects.

The probable interference of carebeiros on about 10% of
eggs by removal could bring additional difficulties to the
recovery of local loggerhead stocks, considering the reduced
population size. However, the importance of directly invol-
ving the carebeiros in the activities related to sea turtle conser-
vation requires adopting strategies which conciliate their
work while attaining the best possible indices of hatching
production. We suggest a close attendance of carebeiros, with
continuous evaluation of each one’s results, aiming similar
values to those obtained by researchers. The comparison be-
tween clutch size at Pontal do Ipiranga and other contiguous
targets of incubation (Baptistotte et al., 2003) suggests that this
was a localized problem. The increasing trends in Brazilian
loggerhead nesting areas (Marcovaldi and Chaloupka, in
press) reinforce this suggestion.

Acknowledgements

We are grateful to João Carlos Thomé, Cecília Baptistotte,
Luciana M.P. Moreira, Juarez T. Scalfoni and Denise B. Rieth,
members of the TAMAR staff in Espírito Santo, for contribut-
ing to this work. We also thank all researchers, university stu-
dents and carebeiros involved with sea turtle conservation
activities. Special thanks to José Alberto Perezzin Schneider,
Víctor Roque Pancieri, César Augusto de Campos Lima, Lis-
dra Alonso Lopes and César Augusto de Borba Mattos, for
their help in field work and data collection at Pontal do Ipi-
ranga. Paulo DeMarco Jr. kindly provided assistance with data
analysis. Matthew Godfrey, Paulo Barata, John Frazier, Ari-
dne Angulo and Luciano Soares made valuable suggestions on
various stages of the manuscript, besides helping with the
English version. Three anonymous reviewers provided
helpful suggestions. FACITEC – Fundo de Apoio à Ciência e
Tecnologia, from the municipal government of Vitória (Prefei-
tura Municipal de Vitória) provided a research grant to APA.

References

Almeida, A.P., 2002. Avaliação do manejo de desovas da careba-
amarela, Caretta caretta (Linnaeus, 1758) (Testudines: Cheloniidae) em Pontal do Ipiranga, Linhares, ES. Master’s
biology and conservation status of the loggerhead sea turtle
(Caretta caretta) in Espírito Santo state, Brazil. Chelonian
transporters of nutrients and energy from marine to terrestrial
ecosystems. Ecology 81, 2305–2313.
population model for loggerhead sea turtles and implications
Predicting the impact of turtle excluder devices on loggerhead
Dodd jr, C.K., 1988. Synopsis of the biological data on the loggerhead
sea turtle Caretta caretta (Linnaeus 1758). United States Fish and Wildlife Service Biological Report 88 (14),
110.
Frazier, J.G., 1993. Una evaluación del manejo de nidos de tortugas
marinas en la Península de Yucatán. Memorias Del IV Taller
Regional sobre Programas de Conservación de Tortugas
Marinas en la Península de Yucatán, 11–13 de Marzo de 1991,
Mérida, Yucatán, México, pp. 37–76.
management as an improved sea turtle conservation strategy
investigación de la tortuga carey, Eretmochelys imbricata
(Linnaeus, 1766), en la Isla Holbox, Quintana Roo, Temporada
1990. Memorias Del IV Taller Regional sobre Programas de
Conservación de Tortugas Marinas en la Península de Yucatán,
Gonchorosky, J.C., Campaña, C., Santos D.S., 1995. Avaliação das
técnicas de manejo de desovas de tartarugas marinas no
litoral Norte do Estado da Bahia, Brasil. Resumos da VIII
Marcovaldi, M.A., Chaloupka, M., in press. Conservation status of
the loggerhead sea turtle in Brazil: an encouraging outlook.
Endangered Species Research.
turtle nesting at Praia do Forte, Bahia, Brazil, with implications
for conservation and management. Chelonia Conservation
and Biology 2 (1), 55–59.
Marcovaldi, M.A., Marcovaldi, G.G., 1999. Marine turtles of Brazil:
the history and structure of Projeto TAMAR-IBAMA. Biological
Conservation 91, 35–41.
sex ratios of loggerhead turtles in Brazil from pivotal
incubation durations. Canadian Journal of Zoology 75, 755–
770.