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

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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

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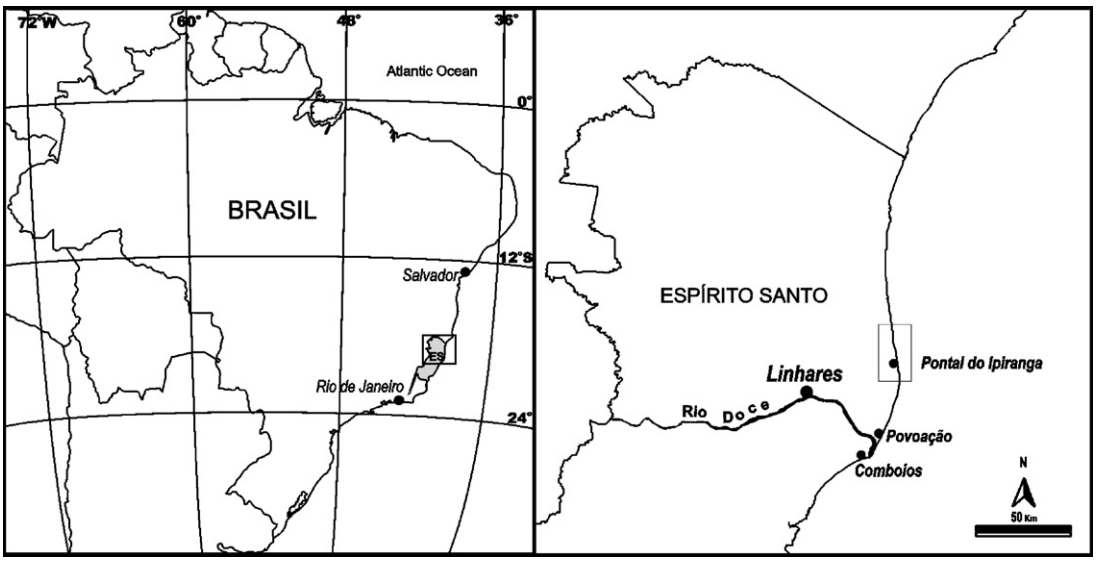


**Fig. 1 – Location of the study area.**

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.

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### 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 (ANOVAs) 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

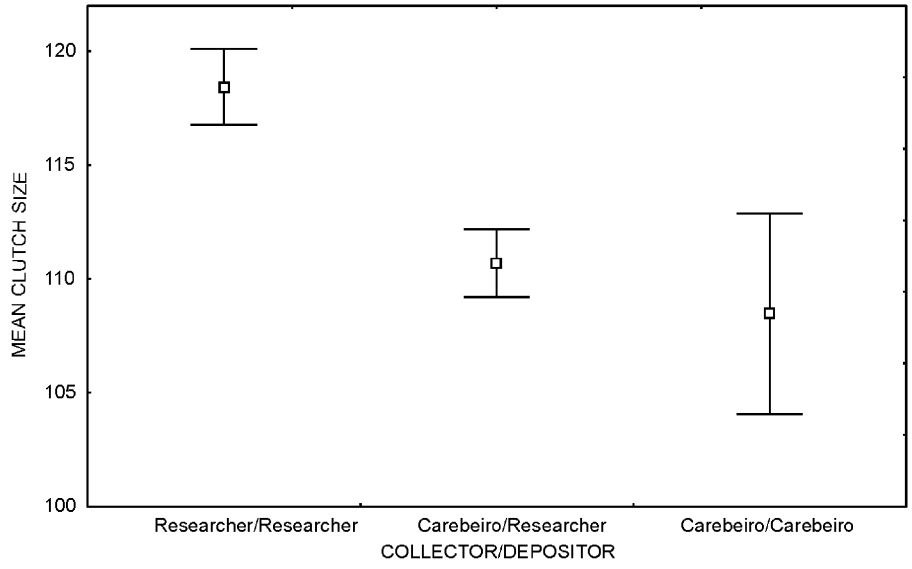


**Fig. 2 – Mean clutch size (±standard error) of loggerhead clutches transferred by researchers and *carebeiros* at Pontal do Ipiranga, Linhares, between 1988 and 1998.**

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**Table 1 – Loggerhead hatching success and clutch size (mean ± sd) as a function of nest location at Pontal do Ipiranga, Linhares, between 1988 and 1998**

| Location | *n* | Hatching success | Mean clutch size |
|---|---|---|---|
| *In situ* | 139 | 72.56 ± 27.29 | 109.37 ± 28.08 |
| Beach | 45 | 60.33 ± 27.96 | 107.22 ± 21.71 |
| Hatchery | 277 | 67.29 ± 27.49 | 110.66 ± 22.87 |

Only nests transferred with participation of *carebeiros* are included in the table.

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 ($\chi^2 = 1.8178$; df = 1; $p = 0.1776$). Clutch size of nests transferred by researchers was significantly higher than those maintained *in situ* ($\chi^2 = 3.8256$; df = 1; $p = 0.0124$).

### 3.2. *Hatching success*

The location of nests had a significant effect on hatching success (ANOVA: $F = 3.73$; df = 2; $p = 0.0243$). The nests maintained *in situ* had significantly higher rates of hatching success than nests transferred within the beach (planned comparison: $F = 6.2697$; df = 1; $p = 0.0124$) 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: $F = 2.10615$; df = 1; $p = 0.1469$).

**Table 2 – Hatching success and clutch size (mean ± sd) as a function of the participation of carebeiros in collecting and relocating loggerhead clutches at Pontal do Ipiranga, Linhares, between 1988 and 1998**

| Collector/depositor | *n* | Hatching success | Mean clutch size |
|---|---|---|---|
| Researcher/Researcher | 238 | 73.18 ± 22.70 | 118.70 ± 24.97 |
| *Carebeiro*/Researcher | 239 | 66.79 ± 27.65 | 111.11 ± 22.06 |
| *Carebeiro*/*Carebeiro* | 83 | 64.96 ± 28.10 | 107.50 ± 24.44 |

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 ($\chi^2 = 2.11513$; df = 2; $p = 0.3478$) or those collected and deposited by *carebeiros* ($\chi^2 = 0.82438$; 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 reg-

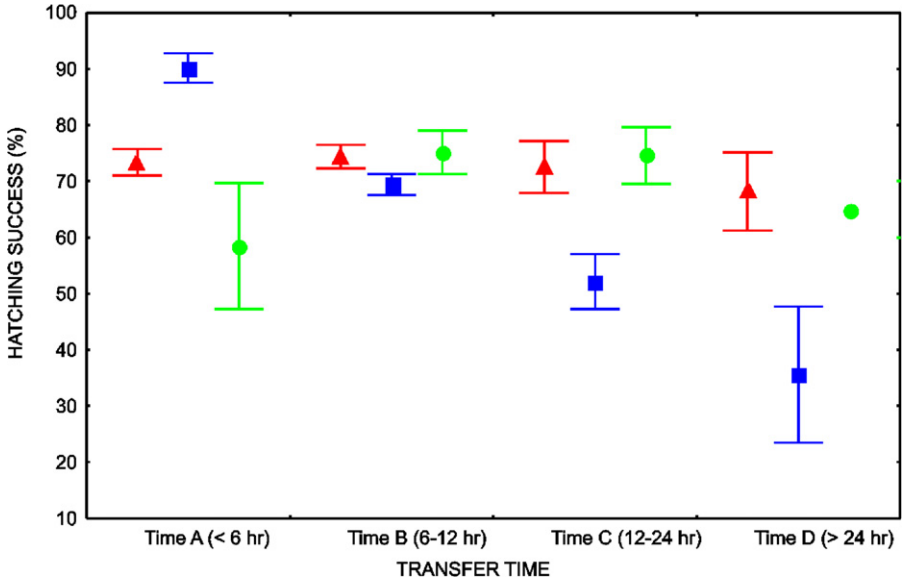


**Fig. 3 – Hatching success of clutches as a function of collector/depositor for different transfer times (±standard error): ▲, Researcher/Researcher; ■, *Carebeiro*/Researcher; ●, *Carebeiro*/*Carebeiro*.**

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istered in the five TAMAR Stations in northern Espírito Santo as a whole – Pontal do Ipiranga included – (119.7 eggs, Baptistotte 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 hatchling 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 hatchling 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., 1997). Analysis of incubation time allows for estimation of the natural sex ratio of a sea turtle population (Mrosovsky 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

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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 alteration of the natural sex ratio. Also, it has been suggested that near-shore mortality due to fish predation is lower for hatchlings 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 energy for beach dune systems (Bouchard and Bjorndal, 2000).

However, in some places the risk of nest losses by environmental 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 transfer 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 car on the beach, 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 involving the carebeiros in the activities related to sea turtle conservation requires adopting strategies which conciliate their work while attaining the best possible indices of hatchling 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 between clutch size at Pontal do Ipiranga and other contiguous TAMAR's Stations (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.

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