

## The effects of tourism, beachfront development and increased light pollution on nesting Loggerhead turtles *Caretta caretta* (Linnaeus, 1758) on Sal, Cape Verde Islands

Harriette Taylor<sup>1</sup> & Jacquie Cozens<sup>1</sup>

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### ABSTRACT

Loggerhead *Caretta caretta* is now the only species of marine turtle nesting on the island of Sal, Cape Verde Islands. Since 2008, ADTMA - SOS Tartarugas has patrolled all the southern beaches of the island in order to protect nesting females and to collect nesting data. Although hunting is still a major issue, with 90 turtles killed in 2009, habitat loss and light pollution are becoming an ever more serious threat. Construction sites, hotels, apartment buildings and restaurants close to beaches, bright lights and illegal removal of sand are contributing to a marked decrease in the total number of nesting turtles on some beaches. In 2009, beaches on Sal experienced an average increase in nests of 200%, while the beach most affected by construction (Tortuga Beach) saw a decrease of nests of 7.3% (from 19.1% of total number of nests in 2008 to 11.8% in 2010). This beach also recorded a much lower nest to emergence ratio than normal (17.6% of emergences resulting in nests compared to 29.9% in other areas), indicating reluctance to nest due to light pollution and other disturbances.

### RESUMO

Actualmente, a tartaruga-comum *Caretta caretta* é a única tartaruga marinha a nidificar na ilha do Sal, Cabo Verde. A organização ADTMA-SOS Tartarugas tem vindo, desde 2008, a monitorizar todas as praias do sul da ilha de forma a proteger as fêmeas e a recolher dados relativos à nidificação. Apesar da caça continuar a ser um problema, com 90 tartarugas mortas em 2009, a perda de habitats e a poluição luminosa são ameaças cada vez mais significativas. Estaleiros de construção, hotéis, blocos de apartamentos e restaurantes perto das praias, a iluminação intensa e a remoção ilegal de areias têm vindo a contribuir para um acentuado decréscimo no número total de tartarugas em algumas praias. Em 2009, as praias do Sal tiveram um aumento médio do número de ninhos de 200%, embora a praia mais afectada pela construção (Tortuga Beach) teve um decréscimo de ninhos de 7.3% (19.1% em 2008 para 11.8% em 2010 no número total de ninhos). Esta praia também registou uma razão entre rastos e ninhos muito mais baixa do que é normal (17.6% de rastos resultantes em ninhos, comparado com 29.9% noutras áreas), indicativa de uma relutância em nidificar devido à poluição luminosa e a outras perturbações.

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<sup>1</sup> ADTMA-SOS Tartarugas, Café Cultural, Santa Maria, Sal, Republic of Cape Verde;  
email: Harriette Taylor [hattie\\_megs@hotmail.com](mailto:hattie_megs@hotmail.com), Jacquie Cozens [jacquie@sostartarugas.org](mailto:jacquie@sostartarugas.org)

## INTRODUCTION

In 2008, the *Associação das Amigos das Tartarugas do Ambiente (ADTMA) - SOS Tartarugas* was founded to protect nesting Loggerhead turtles *Caretta caretta* on the island of Sal, Cape Verde Islands. When the project began only occasional surveys of the nesting population had been done and no work had taken place regarding the impact of tourism development on habitat and the behaviour of turtles. Prior to 2008, the Câmara Municipal (City Hall) of Sal island, implemented patrols in conjunction with the National Armed Forces. However, this did not include data collection, so no information existed on the number of turtles, nests or turtles being killed.

The island of Sal has few resources and must exploit the good weather and long, sandy beaches for tourism. This has resulted in a dramatic increase in apartments and hotels on the south and south-western side of the island (cf. Fig. 16). Marine turtles are protected by law (Decreto Lei No 7/002) and any disturbance could (in theory) result in a fine or a jail sentence. The law allows construction 80 m from the high water mark, but this regulation is not always adhered to or enforced.

The south-western shore of the island has, in the past, been the highest density nesting area on the island (Gonçalves 2007), but construction has had a significant impact on the quality and availability of beaches available to turtles.



Fig. 1. Algodoeiro in 2008.

At the start of the 2008 nesting season, Algodoeiro was undisturbed by construction (Fig. 1), but during the season, work on the

resort of Paradise Beach began (Fig. 2), soon to be followed by Cotton Bay (cf. Fig. 16). During 2009, construction of Tortuga Beach began, as well as work on desalination facilities by Aguas Ponta Preta which led to open ditches for a large part of 2009 and 2010.



Fig. 2. Algodoeiro in 2010.

In 2010, some parts of Tortuga Beach are occupied, work has begun on Dunas Beach resort and continues on Paradise Beach and Cotton Bay. Throughout the various phases of building there has been disturbances through increased lighting, noise from night-time work, compaction of sand and loss of habitat due to ditches, debris and fences (Fig. 3-4).

It has previously been noted that coastal development is a major hazard to marine turtles, as the destruction of nesting space can result in decline and local extinction. Light pollution has been noted to affect the site choice of nesting females and to disorientate hatchlings. This leads to an increase in hatchling mortality and a decrease in nesting attempts by females (Witherington 1992).

The increase of tourists to Sal island has also seen more unregulated turtle walks on the beaches at night. Due to lack of knowledge, unauthorised guides often interrupt nesting or destroy nests through not following established international guidelines for viewing nesting turtles. Even worse, guides have been known to allow turtles to be killed by hunters. Further loss of habitat is caused by increased amount of beach furniture and permanent structures as more beach bars and restaurants are constructed (Fig. 5-6).

In this study, three years of data have been analysed specifically comparing areas with tourism development and areas without, to give an indication of the effects of

construction and lights on nesting behaviour, the number of nests and any disorientation of adults and hatchlings turtles.

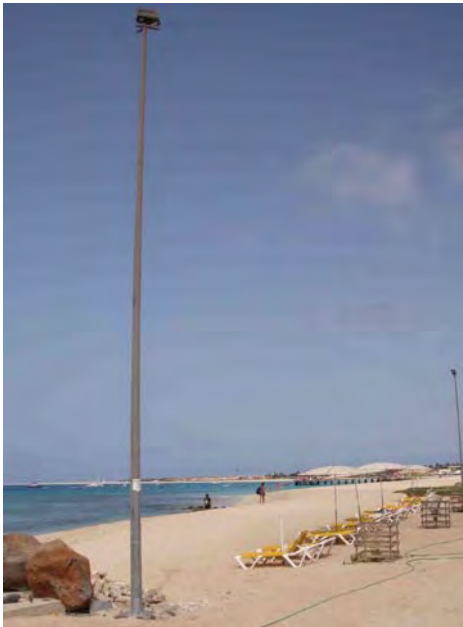


Fig. 3-6. In clockwise order: Open ditches at Algodoeiro; Paradise beach fence, 40 m from sea; Watersports centre increasingly encroaching on nesting beach (Angulo's Surf Centre, Santa Maria); Beach furniture and inappropriate lighting (Odjo D'Agua Hotel, Santa Maria).

## METHODS

During the years 2008-2010, patrols have been conducted working in two shifts during the night from the beginning of June until the end of October (21.00 PM – 01.00 AM & 01.00 AM – 06.00 AM) on Algodoeiro, Costa Fragata and Serra Negra (Fig. 7). In addition, morning surveys were conducted between 06.00 and 10.00 AM from the beginning of June until the end of November to collect data from smaller beaches and beaches not patrolled regularly at night. A bi-weekly island survey was conducted to collect data from all northern nesting beaches. Data are collected for every turtle emergence. Rangers record a minimum of time, date, beach, high

water mark, activity type and GPS position as well as additional observations, including disorientation or difficulty in constructing a nest. Nests in areas where emerging hatchlings are likely to be affected by lights were relocated to one of two hatcheries or to another part of the beach. Hatchling orientation was evaluated by analysing the direction of tracks after hatching for those left *in situ*. Data have been collected for two full nesting seasons in 2008 and 2009 and data collection is underway in 2010. For the purposes of this paper, data from 12 June to 7 September are being compared for all three years.

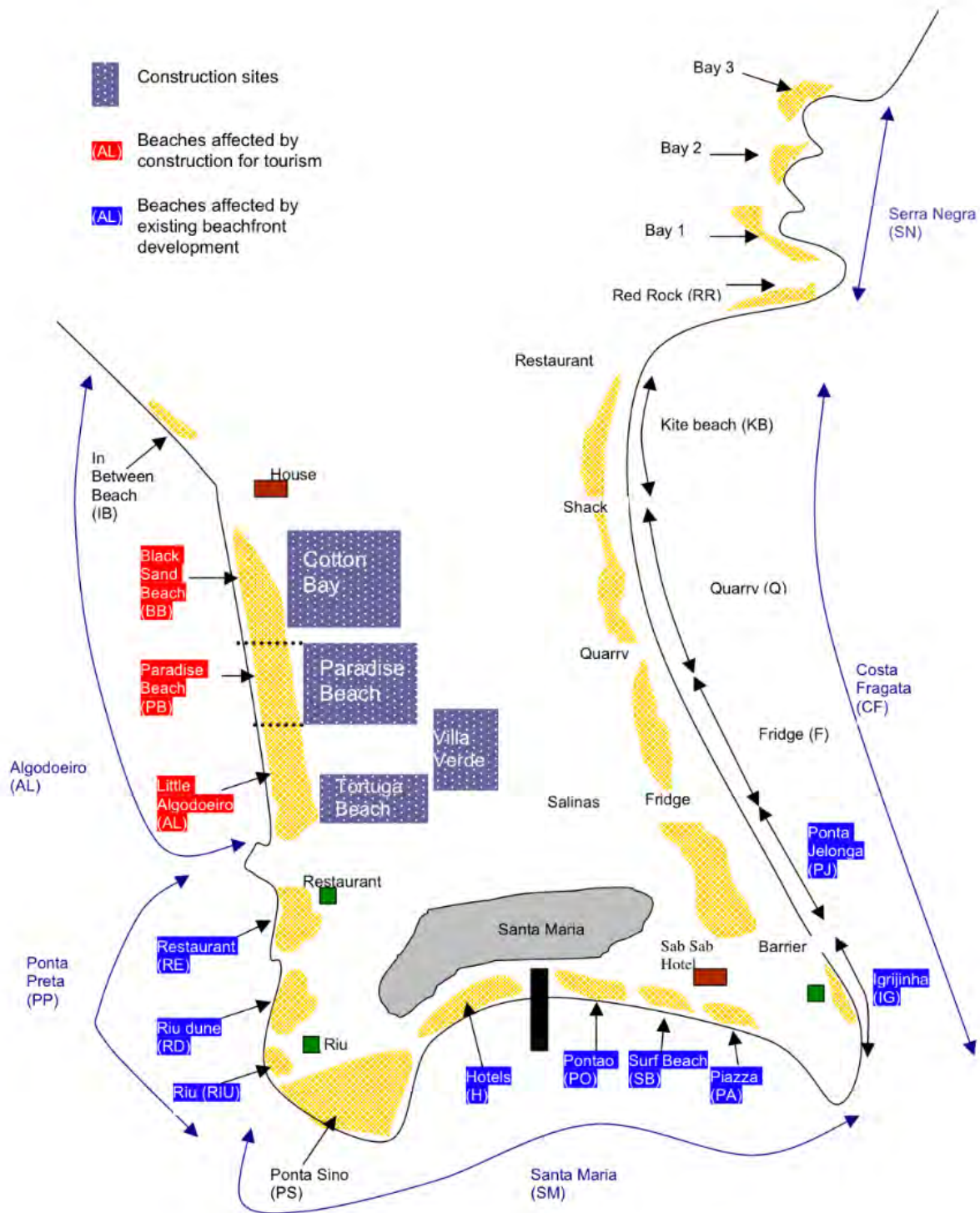


Fig. 7. Map showing the locality of Loggerhead nesting beaches in the southern part of Sal.

RESULTS

In the first year of the project (2008), a total of 1238 tracks and 347 nests were recorded (Cozens 2009). In 2009, in common with all islands in Cape Verde, the number of nests increased substantially to 3590 tracks, of

which 1037 were nests (Lino *et al.* 2010). Preliminary data on turtle activities in 2010 show a slight increase when compared to 2008, with a current total of 1369 activities, 357 of which are nests (Fig. 8).

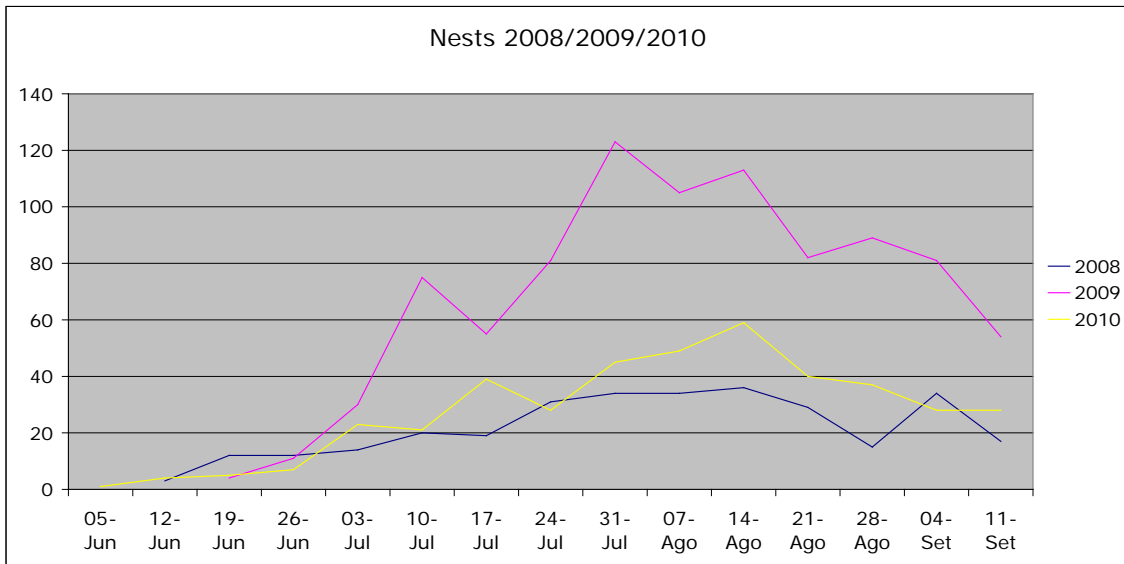


Fig. 8. Number of nests on Sal, 2008-2010.

Over the last three years, the sections of the beach known as Ponta Jelonga (Costa Fragata/east coast) and Black Sand Beach (Algodoeiro/west coast) (Fig. 7) have consistently had the highest percentage of the total number of nests, accounting for 25% of

all nests on Sal (Table 1). However, if Serra Negra is taken as a whole (since the sections are much smaller than those on Costa Fragata or Algodoeiro), it accounts for between 15% and 29% of all nests and shows a marked increase over the three years (Fig. 9).

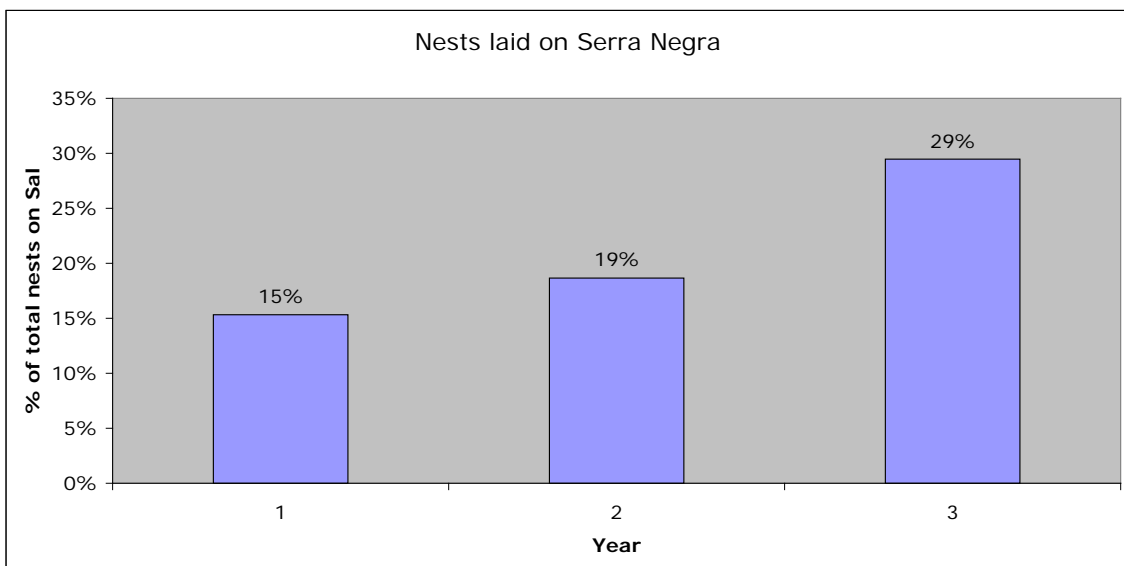


Fig. 9. Number of nests on Serra Negra, Sal, 2008-2010.

| Beach            | Section of beach | Number of nests |      |       | % of total nests |        |        |
|------------------|------------------|-----------------|------|-------|------------------|--------|--------|
|                  |                  | 2008            | 2009 | 2010  | 2008             | 2009   | 2010   |
| Serra Negra      | B1               | 12              | 49   | 35    | 3,50%            | 4,60%  | 9,60%  |
|                  | B2               | 20              | 56   | 27    | 5,80%            | 5,20%  | 7,40%  |
|                  | B3               | 12              | 52   | 26    | 3,50%            | 4,90%  | 7,20%  |
|                  | RR               | 9               | 43   | 19    | 2,60%            | 4,00%  | 5,20%  |
| Costa Fragata    | KB               | 7               | 68   | 19    | 15,30%           | 6,30%  | 5,20%  |
|                  | Q                | 18              | 111  | 29    | 5,20%            | 10,40% | 8,00%  |
|                  | F                | 24              | 57   | 20    | 6,90%            | 5,30%  | 5,50%  |
|                  | PJ               | 47              | 151  | 45    | 13,60%           | 14,10% | 12,40% |
| Santa Maria      | PA               | 8               | 1    | 1     | 2,30%            | 0,10%  | 0,30%  |
|                  | SB               | 5               | 27   | 3     | 1,40%            | 2,50%  | 0,80%  |
|                  | PO               | 1               |      | 0     | 0,30%            | 0,00%  | 0,00%  |
|                  | H                | 1               | 9    | 0     | 0,30%            | 0,80%  | 0,00%  |
|                  | PS               | 9               | 20   | 8     | 2,60%            | 1,90%  | 2,20%  |
| Ponta Preta      | RIU              | 5               | 24   | 6     | 1,40%            | 2,20%  | 1,70%  |
|                  | RD               | 13              | 14   | 5     | 3,80%            | 1,30%  | 1,40%  |
|                  | RE               | 6               | 9    | 7     | 1,70%            | 0,80%  | 1,90%  |
| Algodoeiro       | AL               | 27              | 54   | 15    | 7,80%            | 5,00%  | 4,10%  |
|                  | PB               | 39              | 136  | 28    | 11,30%           | 12,70% | 7,70%  |
|                  | BB               | 38              | 119  | 48    | 11,00%           | 11,10% | 13,20% |
|                  | IB               | 10              | 8    | 1     | 2,90%            | 0,70%  | 0,30%  |
| Northern Beaches | CADJ             | 5               | 5    | 4     | 1,45%            | 0,47%  | 1,10%  |
|                  | CFUND            | 3               | 15   | 3     | 0,87%            | 1,40%  | 0,83%  |
|                  | MUD              | 4               | 6    | 1     | 1,16%            | 0,56%  | 0,28%  |
|                  | MAD              |                 | 1    | 1     | 0,00%            | 0,09%  | 0,28%  |
|                  | ML               | 20              | 32   | 5     | 5,78%            | 2,99%  | 1,38%  |
|                  | PL               | 0               | 1    |       | 0,00%            | 0,09%  | 0,00%  |
|                  | JP               | 1               | 2    | 2     | 0,29%            | 0,19%  | 0,55%  |
|                  | CAL              | 1               |      | 2     | 0,29%            | 0,00%  | 0,55%  |
|                  | FJ               |                 | 1    | 1     | 0,00%            | 0,09%  | 0,28%  |
| PAR              | 1                | 1               | 2    | 0,29% | 0,09%            | 0,55%  |        |

Table 1. Distribution of Loggerhead nests on Sal Island, 2008-2010. The two sections with the most nests are highlighted (consistently accounting for 25% of all nests).

Over the past three years, Paradise Beach (PB) and Little Algodoeiro (AL), the areas most affected by construction sites (Cotton Bay, Paradise Beach, Tortuga Beach and

Dunas Beach resort) have shown a decreasing trend in the total percentage of nests being laid in the area (Fig. 10).

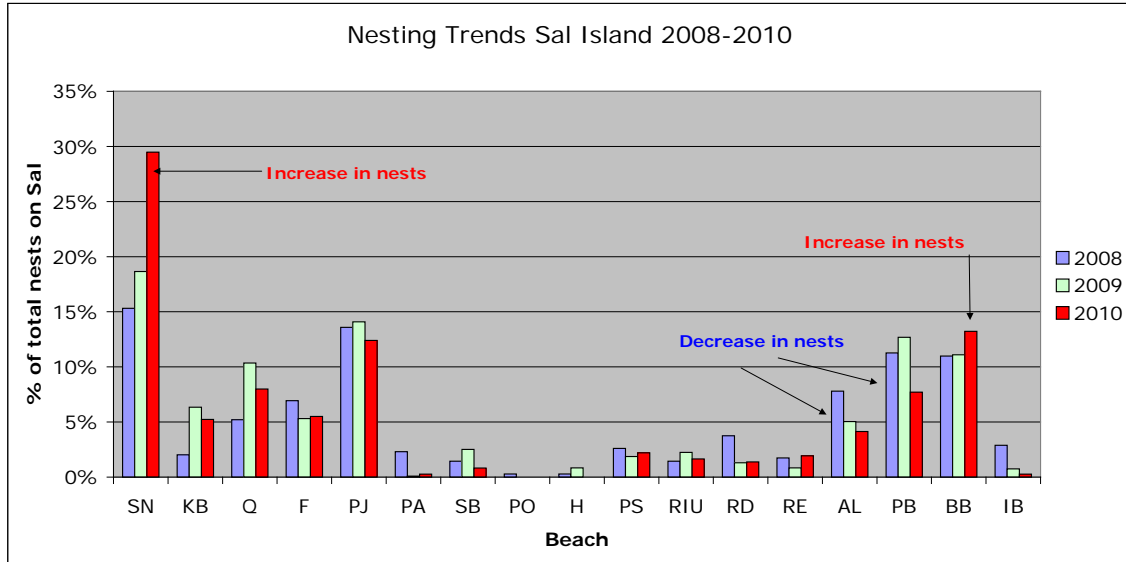


Fig. 10. Increasing number of nests laid on beaches with no development versus decreasing number laid on those with development, Sal, 2008-2010.

Nesting on Little Algodoeiro (AL) has almost halved since 2008 and Paradise Beach (PB) saw a small increase in 2009, but has now dropped below 2008 figures by around 3%, almost 5% lower than 2009. Santa Maria

(SM), the area most affected by existing hotels, restaurants and bars has also seen a marked decrease in nesting over the three years (Fig. 11).

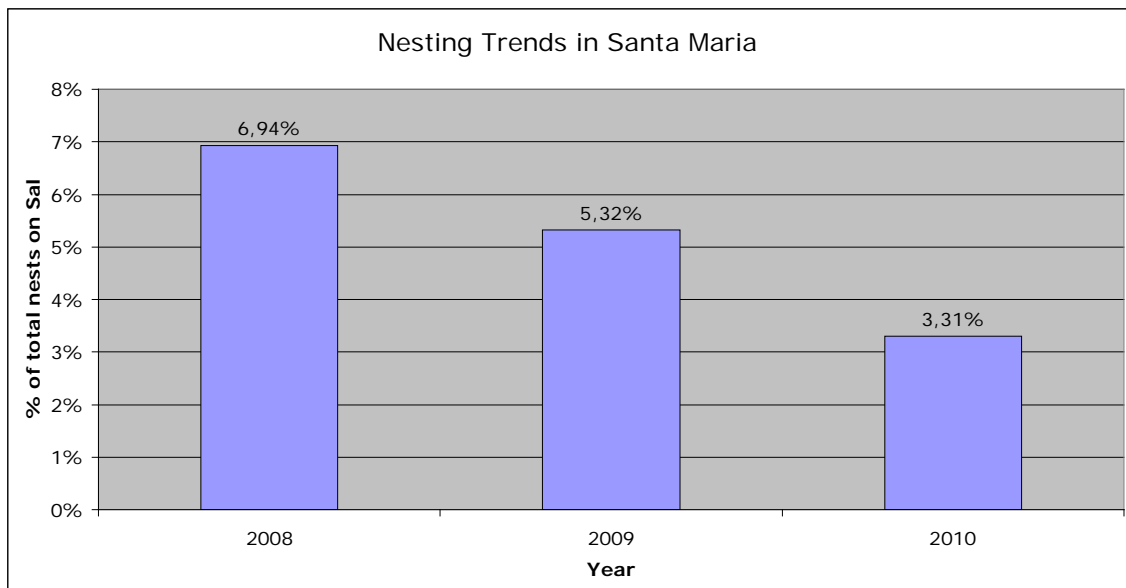


Fig. 11. Decreasing number of nests laid on beaches in Santa Maria with tourism facilities (bars, restaurants, hotels, apartments etc.), 2008-2010.

Over the last three seasons, nests that have left in these brightly lit areas have seen emergent hatchlings become disorientated by the lights, heading to construction sites, bars, hotels and restaurants instead of the sea (Cozens 2009). An increasing number of nests have required relocation in the area around the construction sites due to the threat of light pollution and in 2009 and 2010 removal of every nest outside Tortuga Beach/Resort Group (AL) was necessary. This is also the

case for nests in Santa Maria (SM). By contrast, no nests have ever been relocated from Serra Negra (SN) due to lights and very few on Costa Fragata (CF) require relocation for this reason. On the island as a whole, there is an increasing need for nests to be relocated due to light pollution. Between 2008 and 2010, there was an increase of 23.76% in the number of nests moved due to the threat of hatchling disorientation caused by lights, from 7.23% in 2008 to 30.99% in 2010 (Fig. 12).

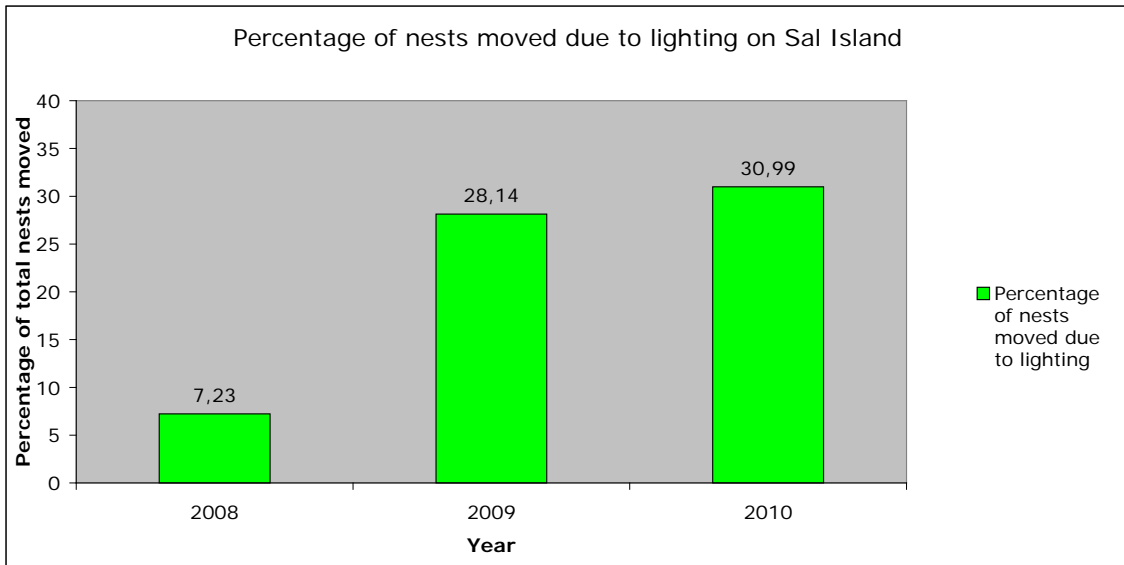


Fig. 12. Increasing number of nests requiring relocation due to light pollution.

This becomes even more alarming when comparing the east coast (CF) with the west coast (AL). The percentage of nests that experienced hatchling disorientation and had

therefore been affected by lights on the west coast has almost doubled from 26.67% in 2008 to 75.46% in 2010 (48% increase) (Fig. 13).

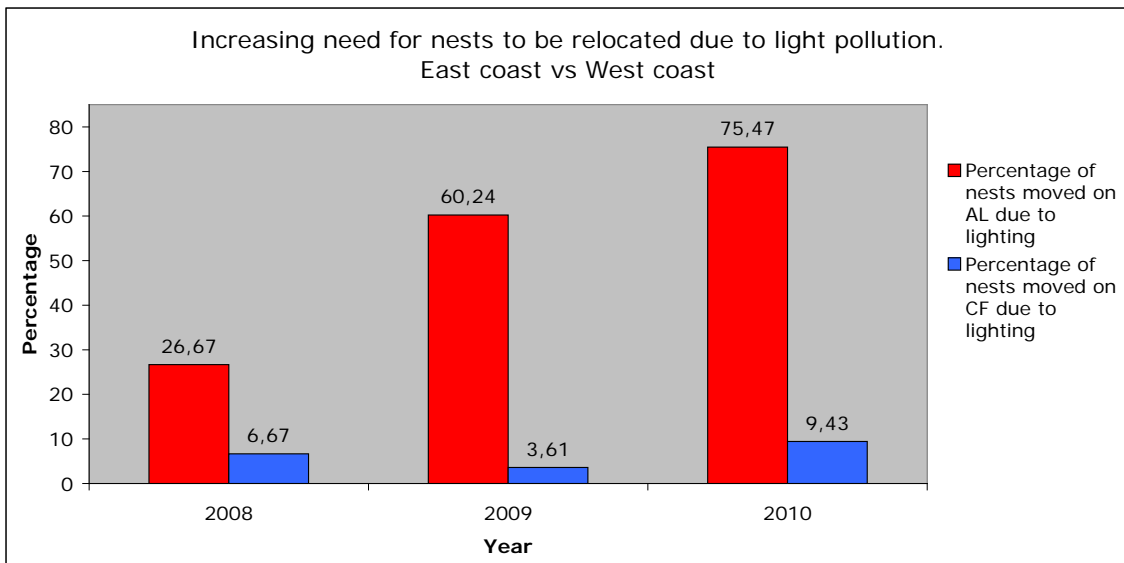


Fig. 13. Comparison of nests requiring relocation due to lights on east and west coasts of Sal.





Fig. 14. Rangers rescue turtle hatchlings that have fallen into open pits on Algodoeiro.

Open ditches due to construction close to the high water mark pose a threat to both hatchlings and adult females and has led to hatchlings falling into cement pits (Fig. 14). Live and dead hatchlings are also frequently

found on construction sites and the ditches in front of them. Construction traffic has caused compaction of the sand and debris and heavy machinery left on the beaches have further limited available nesting areas (Fig. 15).



Fig. 15. Compaction of sand due to construction traffic on Algodoeiro.

Disruption to nesting through lighting also contributed to a higher than usual ratio of false crawls and nesting attempts on the beach in front of The Resort Group development of Tortuga Beach (AL). It is generally accepted that the number of nests laid in a season will

equal around 30% of total tracks without nests. The average ratio on Sal is 28-30%, but on this particularly beach the ratio is much lower (17.86%) indicating a reluctance to nest in this area, most likely because of light pollution or noise (Table 2).

| BEACH | TOTAL TRACKS | FALSE CRAWLS | NESTS | % NESTS |
|-------|--------------|--------------|-------|---------|
| AL    | 84           | 69           | 15    | 17,86%  |
| PB    | 97           | 68           | 29    | 29,90%  |
| SN    | 476          | 334          | 142   | 29,83%  |

Table 2. Comparison of false crawl/nesting ratio on Sal, 2010. AL has a significant lower ratio of nests to false crawls than other beaches with no disturbance, indicating a reluctance to nest on this beach.

## DISCUSSION

Coastal development is a major hazard to marine turtles – the destruction of nesting space can result in decline and local extinction. Light pollution has been recorded to affect the site choice of nesting females and to disorientate hatchlings leading to an increase in hatchling mortality and a decrease in nesting attempts by females (Witherington 1992).

The results on Sal during 2008-2010 indicate a trend towards decreasing nesting activity in areas where there is tourism activity or where there is construction or development for tourism. This is particularly the case on Little Algodoeiro (AL) and Paradise Beach (PB) where nesting has decreased by 4% from 2008 to 2010. Beaches such as Ponta Jelonga or Serra Negra (up 6%) on the south-eastern side of Sal are mostly unaffected by lights or tourism development and the percentage of nests has remained stable or increased over the last three years. Black Sand Beach (BB) on the east coast has also shown an increase, possibly due to disturbance on Algodoeiro (AL) and Paradise Beach (PB) causing turtles to move further north along the same coast. However, the possibility exists that turtles on Sal will travel further north to find beaches free of lighting and be at risk of being killed by hunters on unpatrolled beaches. Unfortunately, the next beach north of this area is Monte Leão, an undeveloped but also unprotected beach with a high mortality rate of nesting turtles, i.e. 87% of all turtles killed on Sal were killed on

northern, unprotected beaches and 41% of those were at Monte Leão. Therefore a tendency to swim north to Monte Leão after being unable to nest on Algodoeiro may result in the turtle being killed.

With four large resorts under construction, one of which is starting to be occupied, these sites are rapidly encroaching on some of the most important nesting beaches on Sal. Black Sand Beach is of particular concern. This section of beach has a consistently high percentage of the total number of nests and a good hatching success rate, yet planning permission has been given to create a marina at the northern end. It seems possible that if this project goes ahead and all the resorts open, loss of one of the most important nesting beaches in Sal is inevitable (Fig. 16). Degradation of the south-western coastline has become more apparent over the three years that SOS Tartarugas has been patrolling the beaches. Compacted sand on Paradise beach has led to a decrease in the available space that nesting turtles have left to lay their eggs. A construction fence towards the back of the beach has made it easier for vehicles to drive along causing the compaction of sand, leaving only a few metres of sand suitable for nesting turtles. These few metres are prone to inundation later in the season when large swells cause higher than usual tides.

Security spotlights used by all of the construction sites are far from turtle friendly. These lights create problems not only in front

of the sites, but along the entire south-western coast. As more resorts open and roads are built to service these resorts, more lighting will be installed and the problems will increase. Lighting pollution may be considered as a form of habitat loss. When females are unable to nest, they may choose another less suitable nesting site outside of their normal range. If a suitable nesting site is not found, it could be possible for the turtle to release her eggs at sea. Other issues, such as the number of hatchlings produced, sex ratios and hatchling fitness may all be affected by the choice of a less suitable nesting location (Witherington & Martin 1986). It also seems likely that disturbance will be caused by tourists and residents visiting the beaches unsupervised during the turtle nesting season. Increased habitation invariably brings issues of pollution and litter and there are already problems with nest predation by dogs living on construction sites.

Turtles tend to nest on dark beaches, but many still nest on beaches where the influences of lights are present. When this occurs, the female turtles are putting the lives of their offspring under threat due to the disorientation caused when the hatchling

emerges from the nest. On an unlit beach hatchlings will instinctively head towards the sea, however lighting can disrupt this nocturnal behavior (Witherington & Martin 1986). Therefore turtles may continue to nest in areas affected by light pollution on Sal, but increasing amounts of intervention will be required by SOS Tartarugas and the Câmara Municipal of Sal since more nests will need to be relocated to hatcheries, creating strain on already limited resources of finance and manpower.

Tourism on Sal is a necessity for economic growth and it is possible for turtle friendly lighting to be installed and development to continue in a way that minimises disturbance. However, in order for this to happen there has to be the will from developers to preserve the natural beauty of Sal's beaches and for the laws that protect this endangered species' habitat to be upheld. Surveys conducted by SOS Tartarugas amongst tourists and residents have shown a clear indication that once they are aware of the issues, the majority of people will choose a turtle friendly business over one that contributes to the extinction of Loggerheads on Sal.



Fig. 16. The growth of tourists resorts on the island of Sal showing the site of the planned marina.

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