THE MAPUTO BAY ECOSYSTEM

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11 Marine Turtles in Maputo Bay and Surroundings

Cristina Louro

Introduction

For more than 100 million years, marine turtles have roamed the world's oceans. These impressive ocean navigators, although possessing biological characteristics inherent to terrestrial reptiles, have developed a number of morphological and physiological adaptations for living in the sea, such as flat and paddle-shaped like flippers, streamlined body, enlarged lacrimal glands (Limpus, 1997; Meylan and Meylan, 1999; Wyneken, 2000a) and elastic lungs (Lutz, 1988).

The life cycle of a marine turtle begins on the shores of sandy beaches when hatchlings emerge from nests (Meylan and Meylan, 1999). In the sea, they swim in a frenzy towards the open ocean development habitat (Carr, 1986; Luschi *et al.*, 2003; Wyneken, 2000b). After approximately 5 to 20 years, and having reached the juvenile phase (Limpus, 1997), marine turtles make long-distance migrations and take residence in shallow inshore coastal waters, commonly known as foraging habitats (Carr, 1986, 1987; Lohman *et al.*, 2008). At an estimated age of about 30-50 years (or less for some species) (Limpus, 1997), both adult males and females make periodical migrations from their foraging habitats to the breeding and nesting grounds, often hundreds or thousands of kilometres apart (Carr, 1987; Limpus, 1989; Bentivegna, 2002). An interesting aspect is that mating and nesting takes place within the geographic region of their natal beach (Bowen *et al.*, 1989; Bass *et al.*, 2004) or on the way to the nesting beach, showing a great sense of homing ability and fidelity (Addison, 2002; Lohman *et al.*, 2008). In a nesting season, a female will lay multiple clutches of eggs (Owens *et al.*, 1989). After this, females begin the return migration to the foraging grounds (Limpus, 1989) and will not breed for at least two to four years (Owens *et al.*, 1989) depending on the species. Some individuals, however, do return to breed at one year intervals as well (such are the cases of olive ridley and leatherbacks turtles). Thus, the fact that marine turtles are long-lived, slow growing and of late maturity makes them highly vulnerable to the slightest increase in human-induced mortality in any of the different stages of their life cycle (Dobbs, 2001).

The role of marine turtles in the evolution and maintenance of coastal and marine ecosystems has been largely unrecognized and is still poorly known, due to the severe decline of marine turtles worldwide (Allen, 2007). In general, marine turtles affect both the structure and composition of the coastal shallow

ecosystems and contribute to the equilibrium of the food chain by acting as both predators and prey. By grazing on coral competitors, for example, marine turtles have an indirect role of keeping a balanced population structure and dynamic in coral reefs (Leon and Bjorndal, 2002). They also act as nutrient and energy transporters within and between ecosystems (Bjorndal, 2000; Bouchard and Bjorndal, 2000; Allen, 2007). Other ecological functions of marine turtles include hosting parasites and pathogens, providing a substrate for epibionts and being modifiers of landscape. The significance of all these functions to the environment has been greatly affected by the reduction of the global marine turtle populations (Bjorndal and Jackson, 2003). Marine turtles are also excellent environmental health indicators because they occupy different habitats at different stages of their complex life cycle, and are extremely sensitive to anthropogenic environmental degradation, such as increased water temperature, infectious agents and pollutants (Aguirre and Lutz, 2004).

The conservation status of marine turtles varies according to each country. At a global level, the International Union for the Conservation of Nature (IUCN), the Convention of Migratory Species of Wild Animals (CMS) and the Convention on International Trade in endangered Species of Wild Fauna and Flora (CITES) have determined the conservation status of marine turtles (Table 1).

Of the seven species of marine turtles that occur worldwide, five occur and nest along the Mozambique coast, namely the hawksbill turtle *(Eretmochelys imbricata)*, the olive ridley *(Lepidochelys olivacea)*, green turtle *(Chelonia mydas)*, the leatherback turtle *(Dermochelys coriacea)* and the loggerhead turtle *(Caretta caretta)* (Hughes, 1971). However, the last two species only nest in southern Mozambique (Hughes, 1971).

In Maputo Bay and surroundings, only four species of marine turtles occur, namely the green, hawksbill, leatherback and loggerhead (Macnae and Kalk, 1969; Hughes, 1971; Kalk, 1995). The first marine turtle survey which encompassed the whole Mozambican coastline and allowed some insight on the occurrence, distribution and conservation of marine turtles within the Bay and surroundings was conducted by Hughes in 1971. Documented sporadic sightings of marine turtles in the sheltered waters of Inhaca Island by Macnae and Kalk (1969) and Kalk (1995) also provided further understanding. At Macaneta, from 2003 to 2005 a tagging programme of accidentally captured marine turtle in fishing nets was implemented. Extensive marine turtle nest monitoring carried out since 1988/89 nesting season by the Estação de Biologia Maritima da Ilha da Inhaca (EBMI) has also offered some interesting knowledge on the nesting patterns of loggerhead and leatherback turtles in Portuguese and Inhaca Islands. Data generated by these monitoring programmes and by many first degree thesis were compiled by Tarnlünd (1999), Videira *et al.* (2008; 2010) and Pereira *et al.* (2009). Currently, a marine turtle nest monitoring programme is being carried out at Macaneta. Apart from this, two graduate thesis studies were completed by Ng (2001) and Isidoro (2006). The first comprised the

Table 1. Global conservation status of marine turtles species that occur in Mozambique.

Common Name	Scientific Name	IUCN Red List	CMS Appendix	CITES
Loggerhead turtle	Caretta caretta	Endangered	I & II	I
Green turtle	Chelonia mydas	Endangered	I & II	I
Hawksbill turtle	Eretmochelys imbricata	Critically Endangered	I & II	I
Olive ridley	Lepidochelys olivacea	Endangered	I & II	I
Leatherback turtle	Dermochelys coriacea	Critically Endangered	I & II	I

characterization of the nesting sites of both *C. caretta* and *D. coriacea*, while the last involved the description of the nesting population at Inhaca Island. The main nesting areas of marine turtles in Maputo Bay are presented in Figure 1.

The present chapter aims at providing an insight into the occurrence and distribution and the conservation status of these four species of marine turtles around Maputo Bay, as well as to provide some information on the research and monitoring activities developed thus far.

Figure 1. Marine turtle main nesting areas in Maputo Bay.

Occurrence and distribution

The green turtle is the most common marine turtle in Mozambican waters, being more abundant in the central and northern sections of the country (Hughes, 1971; 1974). In Maputo Bay, green turtles can be found in the surrounding waters of Inhaca, Portuguese Islands and Macaneta (Hughes, 1971; Gove and Magane, 1996; Kalk, 1995). At Inhaca Island, they have been found at the mouth of the southern bay, possibly feeding on the seagrass beds of *Zostera capensis*. They have also been spotted feeding on macroalgae, *Caulerpa* spp. and *Gelidium* spp., anchored to the rocks (Kalk, 1995). In Macaneta, 13 green turtles have been accidentally caught in fishing nets and tagged from 2003 to 2005 (Table 2), supporting the theory that these waters are possible foraging and developmental grounds for green turtles.

The hawksbill turtle was considered by Hughes (1974) as the second most common species in Mozambique, occurring mainly in shallow water coral reefs. Hawksbills have also been spotted at Inhaca´s coral reefs. However, it is uncertain if they still occur in these waters (Kalk, 1995), as no quantitative data exists so far for this region. This species does not nest in Maputo Bay.

The loggerhead turtle is found throughout the waters of the entire coastline of Mozambique, being most common from south of Beira in central Mozambique (Hughes, 1971), and recent sightings confirm that the leatherback is not only found in the waters of southern Mozambique, but also in the northern sections of the country. In Maputo Bay, loggerhead and leatherback turtles are commonly found in the waters of the eastern shores of Inhaca Island (Kalk, 1995). Both species have been accidentally caught in fishing nets, tagged and released in Macaneta (Table 2) and they nest in Maputo Bay.

Loggerhead and leatherback turtles share the same nesting grounds in southern Mozambique, more precisely from Ponta do Ouro to Bazaruto Archipelago, covering basically the whole region of southern Mozambique (Hughes, 1971; Costa *et al.*, 2007). Between 1988-1989 and 2009-2010 nesting seasons, 555 marine turtle crawls were observed at Inhaca Island, of which 69.01% were from loggerhead turtle and 30.99% from leatherback turtle. A total of 515 nests were observed in the area, of which 349 are from loggerhead turtle and 172 from leatherback turtle. An average of 15.86 ± 9.90 Loggerhead turtle

Table 2. Number of green, loggerhead and leatherback turtles tagged at Macaneta (2003-2005).

Year	Green	Loggerhead	Leatherback
2003	1	-	1
2004	4	-	1
2005	8	3	1

nests were laid annually at Inhaca east coast with an average of 1.55 ± 1.76 failed nesting attempts (false crawls). According to Impacto (1997), Inhaca Island's 12 km east coast nesting season is more intense between November and January and the two species (*Caretta caretta* and *Dermochelys coriacea*) laid together 40 nests per annum on average. On Barreira Vermelha, on the western coast of Inhaca Island, during the 2007-2008 season, five loggerhead turtle "crawls" were recorded, of which four resulted in successful nesting. On the other hand, an average of 7.55 ± 7.54 leatherback nests were laid annually at Inhaca Island, with 0.86 ± 0.69 failed nesting attempts (Figure 2). For Inhaca Island, it is still difficult to determine if nesting by loggerhead and leatherback is increasing, as results did not show any significant increase (ANOVA, $F(1,20) = 1.857$, $p = 0.188$; ANOVA, $F(1,20) = 0.691$, $p = 0.416$, respectively). Around Portuguese Island, four nests have been laid over the above mentioned 20 year period, of which two are from loggerhead and the remaining two from leatherback. At Macaneta, for the 2007–2008 season only, a total of nine nesting crawls have been observed, of which only three have resulted in nesting: one undetermined (2007-2008), one loggerhead and one leatherback (2009 - 2010).

Nesting activity for both species occurred from October to February, but for loggerhead turtle was greatest from November to January, when 92.83% of the nests were laid, whereas for leatherbacks it was greatest from October to January, when 93.59% of nests were laid (Figure 3). For Macaneta, both nests were laid during the month of November.

Conservation status

All five species of marine turtles are protected by law in Mozambique, through the following Laws and Regulations: the Forestry and Wildlife Law (Law 10/1999), the Forestry and Wildlife Regulation (Decree 12/2002), the Prevention of Pollution and Protection of the Coastal and Marine Environment Regulation (Decree 45/2006), the General Maritime Fisheries Regulation (Decree 43/2003), and the Recreational and Sports Fishing Regulation (Decree 51/1999).

The necessary legal arrangements have been in place since 1965 (Hughes, 1971) for the effective conservation of marine turtles, not only by acts and regulations but also through the declaration of marine protected areas and respective management plans. The most recently declared was in 2009, and of which Inhaca Island is part of the Ponta do Ouro Partial Marine Reserve. There is an urgent need to improve and strengthen control by effectively implementing the law whenever necessary, as currently this is almost non-existent, especially in non-protected areas such as Macaneta.

Some 15-20 years ago 4% of eggs laid on Inhaca Island's east coast were reported stolen, an indication of the effectiveness of control of marine turtle nests at this site (Impacto, 1997). It appears however that Inhaca marine turtles continue to face a constant threat, as almost every nesting season egg collection and incidents of poaching of nesting females contin-

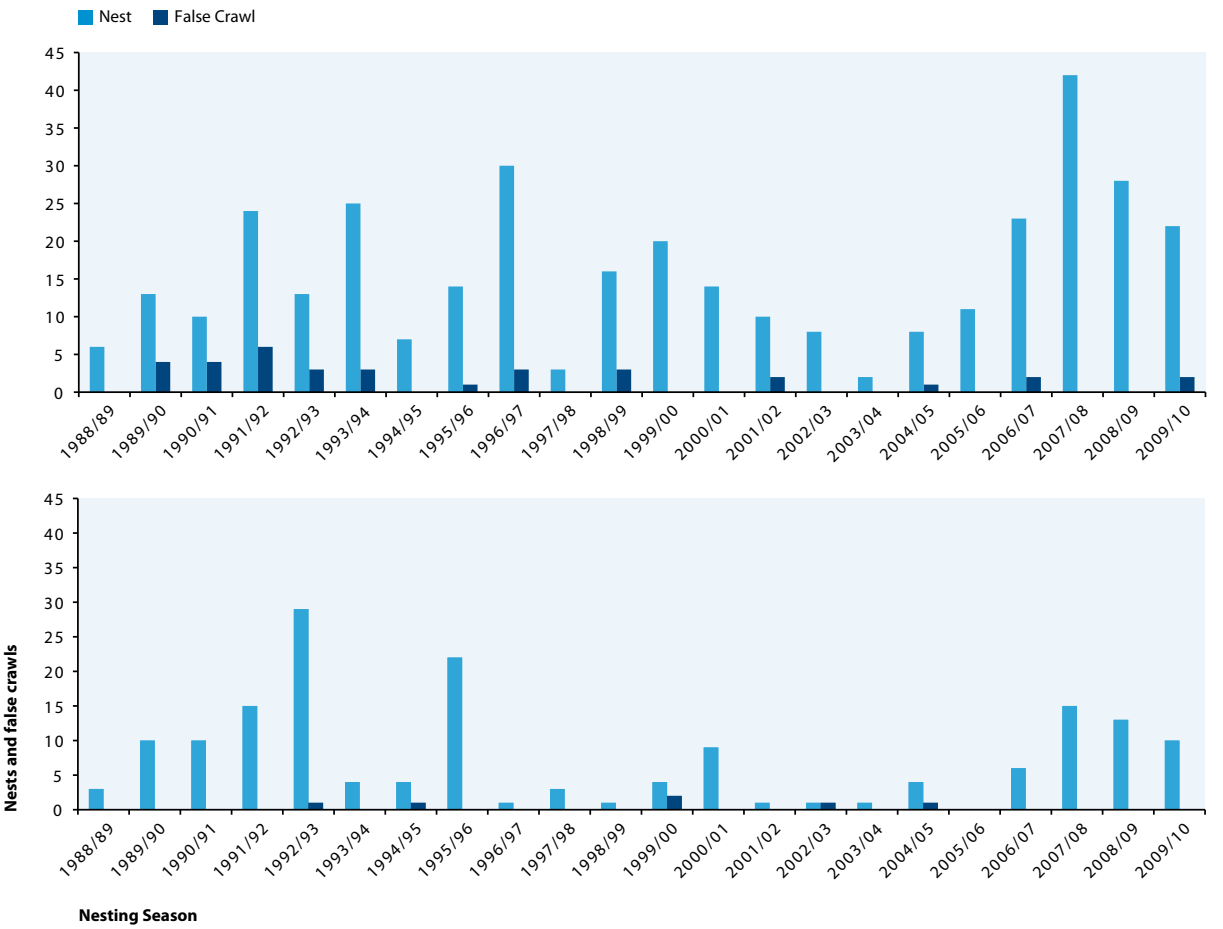

Figure 2. Total number of marine turtle nests and false crawls by *Caretta caretta* and *Dermochelys coriacea* from 1988-1989 to 2009-2010 season at Inhaca Island.

ues to occur. Marine turtle mortality at Inhaca Island is of concern because this is an area of the coastline that is protected since 1951 (Inhaca Reserves) and where a marine turtle monitoring programme has been implemented by University Eduardo Mondlane (UEM) for more than 20 years. On the other hand, Macaneta faces the issue of incidental capture of green turtles and leatherbacks in nets of artisanal fisheries (Table 3). However, the fact that there are no data on accidental captures in fishing nets at Inhaca Island does not reduce the concern.

Data provided in Table 3 is not fully indicative of the current conservation status of marine turtles

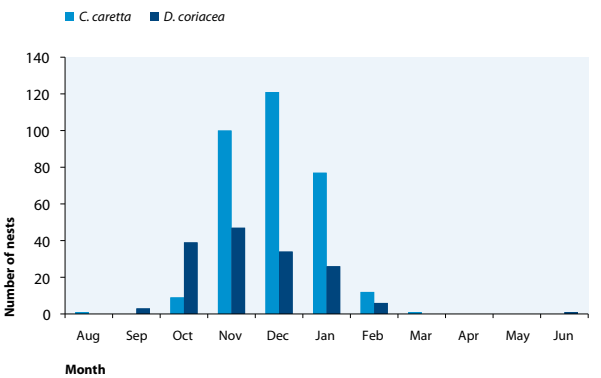

Figure 3. Distribution of nests by month, Inhaca and Portuguese Islands, 1988-1989 through 2009 – 2010 (*C. caretta* n = 351; *D. coriacea* n = 168).

Table 3. Marine turtle mortality at Inhaca Island season 1988-1989 to 2009-2010 and Macaneta season 1991-1992 to 2009 – 2010. Unidentified cause includes stranded animals with no signs of injury and situations where only part of the animal was found, and thus cause of death was difficult to determine.

Cause	Loggerhead		Leatherback		Green	
	Inhaca	Macaneta	Inhaca	Macaneta	Inhaca	Macaneta
Nests						
Robbed	19	-	8	-	-	-
Destroyed by natural causes	5	-	3	-	-	-
Adults						
Unidentified cause	7	-	3	-	-	-
Fishing nets	-	-	-	4	-	9

Note: Data provided here are not indicative of the current conservation status of marine turtles within Maputo Bay and surroundings.

within Maputo Bay and surroundings, since monitoring was deficient in many cases and thus the quantitative data provided might not reflect real current status. However, observations in the environment and talks with local fishing communities, and happens all along the Mozambican coastline, with Maputo Bay no exception, indicate with some confidence that marine turtle populations are possibly undergoing a steady and significant decline. It can be assumed that it is due either to unknown natural causes, or most probably due to uncontrolled anthropogenic impacts such as pollution (e.g. water pollution as result of sewage discharge, accidental oil spills, solid waste, etc.; see also chapter 16 - Pollution in Maputo Bay), increased accidental or intentional capture in gill and trawling nets by semi-industrial and artisanal fisheries and also exploitation of nests and females on the beach. Other possible explanations for the reduction of the marine turtle's population in Maputo Bay include destruction of their natural habitats such as seagrass beds (e.g. disturbance as a consequence of invertebrate harvesting) and coastal dunes (nesting areas). The growing tourism industry might also pose a threat by increase human presence in Macaneta and Inhaca Island.

Perspectives on future monitoring and research

In terms of perspectives on future monitoring and research there is a need for the following: (1) Improve the existent marine turtle monitoring and protection activities and programs, by guaranteeing that these are consistent and long-term run, to detect population trends; (2) Promote research on aspects related to the occurrence, distribution, size and status of the populations of the marine turtle species found in Maputo Bay and surroundings; (3) Promote research to assess the causes and impacts of marine turtle mortality, especially mortality of marine turtles as bycatch in semi-industrial and artisanal fisheries; (4) Identify the different marine turtle habitats (e.g. nesting beach, inter-nesting and pelagic areas) that are critical for the survival of Maputo Bay populations. It is also important to work with coastal communities on conservation issues, since their support is crucial for the success of any conservation plan. Nonetheless, and due to the lack of much needed information, is important to urgently develop and implement a threat-based national marine turtle recovery plan that clearly sets out its objectives, specific actions and recovery criteria. This plan should also be regularly assessed in order to determine and improve (if necessary) its effectiveness.

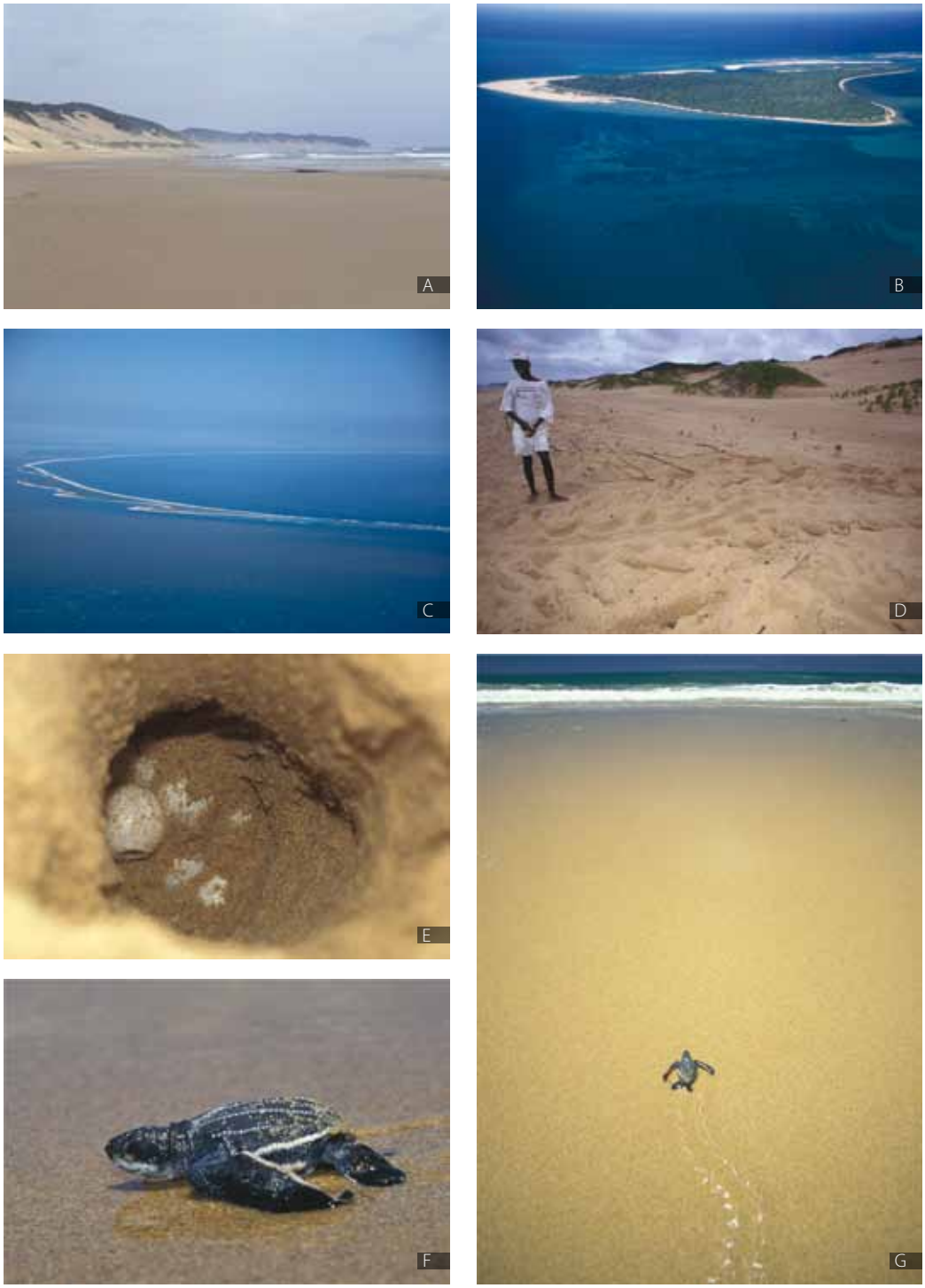

Figure 4. The main areas of nesting of marine turtles in the Maputo Bay region are **(A)** the east Inhaca Island 12 km beach, **(B)** the Portuguese Island, and **(C)** the Macaneta Peninsula in the mouth of the Incomati estuary. The Inhaca Island Marine Biological Station technician controls a track of a large female of leatherback turtle *Dermochelys coriacea* **(D)**, and later monitors the nests **(E),** hatchlings **(F)** and successful return migration to the sea. Photographs by José Paula.

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