



# Marine Turtles

Paulo Catry, Castro Barbosa, Bucar Indjai

of Guinea-Bissau





*“Turtles in those parts of the coast of Guinea are often as large as a saddle, and others are even larger, with a shell that can be as tall as a man (...)”*

Valentim Fernandes in *ca.* 1500,  
in Ferronha *et al.* 1993 [translated].

# Marine Turtles of Guinea-Bissau

Status, biology and conservation

Paulo Catry  
Castro Barbosa  
Bucar Indjai

# SENEGAL





Cambaju

Pirada

Sare Bacar

Buruntuma

Sonaco

Contuboeil

Farim

Mansaba

Capé

Gabú

Bafatá

GUINEA-BISSAU

Bambadinca

Béli

Fulacunda

Xitole

Boé

Buba

Quebo

GUINEA

Cacine

**Title**

Marine Turtles of Guinea-Bissau.  
Status, biology and Conservation.

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Green turtles and the islet of Poilão  
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## Summary

This is a book on the marine turtles of Guinea-Bissau, their status, biology and conservation. The book was written with a wide audience in mind, from researchers and managers of natural resources, to school teachers, students and the general public with an interest in natural history and conservation. The book is scientifically rigorous, but written in a way that can be understood by the lay reader. It results from two decades of research and conservation work on the sea turtles of Guinea-Bissau, carried out by a wide range of people.

The main text includes comprehensive reviews, including recent published and unpublished studies and data on marine turtle ecology, behaviour, evolution, threats and conservation, with particular emphasis on the history of sea turtle research, monitoring and conservation efforts in Guinea-Bissau.

There are five species of sea turtles that occur regularly in Guinea-Bissau. Only one of them, the green turtle *Chelonia mydas*, is numerous and widespread. Green turtles probably nest, at least occasionally, in virtually all the open sandy beaches of the country. Nevertheless, the large majority of the nesting takes place at Poilão, a small and remote islet sited at the southern edge of the Bijagós archipelago. Here, between ca. 7,000 and 30,000 clutches are laid per year.

Other species are much scarcer. Olive ridley turtles *Lepidochelys olivacea* are mostly found nesting in the Orango National Park, where several hundred nests are laid per year. Hawksbill *Eretmochelys imbricata* and leatherback turtles *Dermochelys coriacea* seem to have a wide distribution, but their numbers are small. Loggerhead turtles *Caretta caretta* are known to migrate to Guinea-Bissau waters and recently reports were obtained from local villagers of their nesting on a remote part of the Bijagós (the Unhocomo Group).

Interestingly, there are important differences in the timing of nesting between the various turtle species. Green and hawksbill turtles nest mostly during the rainy season, whereas olive ridley and leatherback turtles come ashore to lay during the driest months of the year.

The main sea turtle nesting beaches and mating grounds in Guinea-Bissau have been included within a protected areas network. Furthermore, temporary settlements of foreign fishermen have been removed from national parks and marine protected areas, alleviating the pressure they exerted on important

nesting grounds. Nevertheless, significant threats remain, including illegal harvesting of eggs and nesting females, accidental mortality in fishing nets and, of course, ecosystem changes due to global warming. More interdisciplinary and participatory work needs to take place if we are to leave the magnificent natural legacy that sea turtles represent for future generations to enjoy.

# Résumé

Fr

Ceci est un livre sur les tortues marines de Guinée-Bissau, leur statut, biologie et conservation. Le texte s'adresse à un public élargi, depuis les chercheurs et administrateurs de ressources naturelles aux professeurs, élèves et public intéressé par les thèmes abordant l'histoire naturelle et la conservation de la nature. Les contenus sont scientifiquement rigoureux mais ont été écrits de façon à pouvoir être compris par des lecteurs qui n'ont pas une formation technique spécialisée. Ce livre est le résultat de deux décennies de recherches et de travail sur les tortues de Guinée-Bissau, efforts dispensés par un large ensemble d'acteurs et intervenants.

Le texte comprend des sections générales sur l'écologie, le comportement, l'évolution, les menaces et la conservation des tortues marines. Il comprend aussi une révision actualisée et complète des connaissances sur le statut, la biologie et les efforts de conservation en Guinée-Bissau, appuyée sur une compilation de toute l'information disponible, publiée ou en phase de publication, sur ce thème. Il présente aussi un compte-rendu historique de la recherche et du suivi des tortues marines en Guinée-Bissau.

Il existe cinq espèces de tortues marines qui apparaissent régulièrement en Guinée-Bissau. Une seule d'entre elles, la tortue-verte *Chelonia mydas*, est vraiment fréquente et amplement répandue. Cette espèce pond ses œufs, au moins occasionnellement, sur presque toutes les plages de sable ouvertes du pays. Toutefois, la grande majorité des tortues-vertes vont se reproduire à Poilão, un îlot éloigné situé au sud de l'archipel des Bijagós. Par an, entre 7.000 et 30.000 pontes y sont réalisées.

Les autres espèces sont beaucoup plus rares. Les tortues-olivâtre *Lepidochelys olivacea* se trouvent surtout dans le Parc National de Orango, au nombre de centaines de nids par an. Les tortues-imbriquées *Eretmochelys imbricata* et les tortues-luth *Dermochelys coriacea* semblent avoir une distribution plus large mais leur nombre est limité. On sait aussi que les caouannes *Caretta caretta* émigrent jusqu'aux eaux de la Guinée-Bissau et des rapports récents des habitants des îles ont été obtenus sur leur reproduction dans un secteur éloigné de l'archipel des Bijagós (dans le groupe de Unhocomo).

Curieusement, il existe des différences prononcées sur les périodes de

reproduction des différentes espèces. Les tortues-vertes et les tortues-imbriquées pondent surtout à la saison des pluies, tandis que les tortues-olivâtre et les tortues-luth le font durant la saison sèche.

Les principales plages de ponte et zones d'accouplement de tortues en Guinée-Bissau ont été intégrées dans le réseau des aires protégées. De plus, les camps temporaires de pêcheurs étrangers ont été éloignés des parcs nationaux et des aires marines protégées, diminuant la pression exercée sur les zones de reproduction. Toutefois des menaces importantes perdurent, comme le vol d'œufs et la capture de femelles durant la ponte, la mortalité accidentelle dans les filets de pêche et, évidemment, les changements des écosystèmes résultants du réchauffement global. Il est donc nécessaire d'effectuer davantage de travail de conservation, interdisciplinaire et participatif, si nous voulons maintenir ce magnifique patrimoine naturel, que constituent les tortues marines, dans un état de préservation qui permette son usufruit par les générations futures.

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Green turtle at sunrise, just after laying its clutch. *J.F. Hellio & N. Van Ingen*

# Introduction



Virtually everyone will recognize a turtle. And most people who live by the seaside or have access to books, magazines or television know what a sea turtle looks like. In spite of there being no more than 7 species of living sea turtles, and the fact that most people will rarely, if ever, come across one in the wild, marine turtles have great notoriety, which is perhaps well deserved. Their evolutionary history of 100 million years (yes! 100 million years ago, at a time when Earth was dominated by dinosaurs, turtles were already climbing onto sandy beaches, under the cover of darkness, to find a place to lay their clutches), their amazing resilience displayed during times when most other reptiles simply vanished, their mysterious lives in the endless ocean, their vast migrations and the fragile beauty of the hatchlings are all reasons why sea turtles are widely known and appreciated. Also, the fact that they were exploited for several centuries and that they continue to suffer from considerable accidental mortality in nets and longlines, that they are affected by pollutants and are threatened by so many other factors, draws attention to this group of rather special reptiles, of which most species have a globally threatened conservation status.

Guinea-Bissau is a small West African coastal country. Although well known amongst Portuguese speaking communities, it has a low-key role in the wider international scene. Afflicted by all manner of difficulties that have kept the country isolated from the development trends experienced around the globe (with all the disadvantages and benefits that such a reality entails), Guinea-Bissau has preserved a natural and cultural heritage that is, by all means, truly remarkable. Without having explicitly committed itself to doing so, and with little international recognition for it, Guinea-Bissau plays a significant role in the conservation of global biodiversity. In the intricate networks drawn by the flight of migratory birds, for example, Guinea-Bissau presents itself as a crucial stopover and wintering area for hundreds of thousands of individual birds, most of which originate from Europe or the Arctic. The national forests harbour charismatic threatened species, such as the chimpanzees. And the tabancas (villages) hide secrets and traditions, preserved in a multitude of local languages that remain alive, despite all the pressures and factors that tend to obliterate them. In such a rich scenario, marine turtles occupy a prominent place. They are one of the best

known and widely distributed values of the national biodiversity. Nesting populations, particularly those of the Bijagós archipelago, are, at least in the case of one species, very significant. In fact, the Bijagós harbour one of the most important green turtle rookeries in the world. Sea turtle diversity is also remarkable, as five species (out of the seven existing worldwide) have been recorded here.

Given the significance of the marine turtles amongst the national biodiversity values, it is only natural that this group has deserved special consideration by researchers working in Guinea-Bissau and by those who defined the strategies and criteria that led to the creation of a network of protected areas. Over the past two decades, many individuals and institutions involved in the planning and conservation of national coastal environments paid special attention to this group of marine animals. National and foreign scientists worked together or consecutively to collect a plenitude of data and general information that have been compiled in reports, databases, or simply in the memories of those involved. Much progress has been made both in research and conservation work, thanks to those fruitful collaborations and partnerships established between people of a wide variety of origins, cultural and professional backgrounds.

Above all, this book aims to make the marine turtles of Guinea-Bissau better known and to disseminate some of the results of the work mentioned above. Part of the information gathered so far has only been published in scientific papers, which are only easily accessed by scientists. Other results have been kept hidden in the internal reports of several institutions and databases that are mostly inaccessible and that, for various reasons, are gradually being lost. Hence, the necessity was felt to produce a written document that could be of interest to a wide audience, including teachers and their students, government and NGO personnel, tourists and other visitors, naturalists or any interested member of the general public. And so, the idea of this book was born, one that hopes to combine the simplicity of an accessible text with scientific rigour, with useful data and facts, but not presented in such a technical format that it would be difficult to understand or even boring.

There are two conditions that need to be met for the success of any conservation endeavour, such as is the fight for the marine turtles and biodiversity of Guinea-Bissau. On the one hand, without hard data, management decisions will remain merely tentative; conservation needs to be grounded on a sound scientific basis. On the other hand, one only loves what one comes to know and understand, and without emotional bonds linking biodiversity with the public, managers and politicians, it will always be very hard to support any conservation agenda (even if there are other reasons, such as strictly economic ones, that may justify the conservation of biodiversity). In conclusion, this book has two goals: to document and to raise awareness. If it fails to do so, only the authors can be blamed for it. The turtles, on their end, never refused to collaborate!





Estuary with mangrove on the coast of Guinea-Bissau. *P. Campredon*



The coastal zone of Guinea-Bissau, showing the locations of the main places mentioned in the text.

# The coastal zone of Guinea-Bissau

## General description

Guinea-Bissau lies on the coast of West Africa, wedged between Senegal and Guinea-Conakry. It covers an area of 36,125 km<sup>2</sup> of land above the high tide mark. The influence of the marine environment is felt over most of the territory, with the coastline indented by 7 large estuaries that help define the limits of a broad coastal region where the majority of the 1,400,000 strong human population lives. Most of the country is nearly flat, crisscrossed by rivers and seasonally flooded river valleys. Offshore, one can find nearly a hundred islands and islets, most of them making up the Bijagós archipelago. The climate is tropical and humid. Virtually all the rain falls within a well-defined rainy season extending from May to November. Along most of the coastal zone, the annual rainfall amounts to 1500-2000 mm, with the greatest precipitation occurring in the south. Average air temperature in Bissau shows little seasonal variation, with 25°C in the coldest month and 28°C in the hottest.

The line separating land from sea is, in the low areas of the coastal zone, often poorly defined. Particularly along the mainland coast, but also in parts of the Bijagós, vast areas are covered with mangroves (known locally as *tarrafes*) and extensive sandbanks and mudflats that are exposed during low tides. With an estimated surface of 3500 km<sup>2</sup>, the mangroves are possibly the most significant of the African continent. Flat river valleys covered with grassland (the *lalas*) are seasonally flooded, many of which have been converted into rice paddies (*bolanhas*). In areas not subject to flooding, most of the coastal zone is covered with forests or wooded savannas. Many of those forests, however, have been affected by slash and burn agriculture, and represent various forms of secondary growth or, when more intensively used, have the appearance of savannas. Still relatively unimportant, but with a clear trend for expansion, are areas with permanent cultures, where cashew tree plantations clearly dominate.

The continental shelf is vast, with an important area of shallow waters where one finds extensive intertidal areas and the approximately 88 islands and islets of the Bijagós archipelago. In the shallow channels that separate islands and over the sand and mud flats, the waters are mostly turbid and mixed by strong tidal



Village and beach in the Bijagós archipelago. *P. Campredon*

currents. The high productivity of these waters, along with the good state of conservation of most habitats, result in still relatively rich fish stocks that are exploited by artisanal fishermen, most of them originating from neighbouring countries (particularly from Senegal). Offshore from the archipelago, but still on the shelf, there are rich fishing grounds explored by industrial trawlers which target mostly the shrimp stocks of the region.

The outstanding biodiversity value of the coastal zone is reflected, for example, in existence of one of the most important wader communities in the world, involving approximately one million wintering birds (Dodman *et al.* 2004). Rare and threatened animals, such as the West African manatee *Trichechus senegalensis* (Silva & Araújo 2001) or the hippopotamus *Hippopotamus amphibious*, are still relatively common in this region. The hippopotamuses have peculiar habitats in this country, often using marine waters for daytime resting (*e.g.* Campos *et al.* 2001).

The Bijagós archipelago is sparsely populated and is largely undeveloped. The human population is about 25,000 strong and there is only one (rather small) town (Bubaque), with little harbour infrastructure and few social or industrial facilities or services.

Guinea-Bissau is one of the poorest countries in the world, with two thirds of its population living below the poverty limit, surviving on less than 2 dollars per day. Life expectancy at birth is only 43 years. The explosive population growth (the current rate is a doubling of the population every 25 years) worsens the



Bubaque is the only town in the Bijagós archipelago. *G. Rosa*

problems of a country that lives, to a large extent, on foreign aid. Other than this, the main sources of foreign currency are the selling of fishing rights to industrial fishing companies and the export of cashew nuts. Away from the main cities, most people live from self-subsistence agriculture (mostly producing rice, either by slash and burn agriculture or in flooded paddies). The harvest of wild products, including shells, fish, bushmeat, fruits and medicinal plants, plays a vital role in the survival of most households in the countryside.



Mangroves, known locally as *tarrafes*. The mangroves of Guinea-Bissau are amongst the most extensive of the African coast.

*P. Campredon*



A sample of the coastal biodiversity of Guinea-Bissau.

*L. G. d'Escrienne, J.F. Hellio & N. Van Ingen, G. Rosa, H. Monteiro*



## The turtles' environment

As described above, the continental shelf of Guinea-Bissau is wide and made of large shallow and highly productive areas. Almost nothing is known about the distribution of sea turtles and their potential marine habitats. The extensive mangroves seem to provide some food sources, as turtles are sometimes found within creeks and mangrove channels. There are also some seagrass beds, but their surface or precise limits are unknown. Nevertheless, it is likely that the estuarine areas and the shallow creeks and banks, with their high production of shells, crabs and aquatic plants, do provide important food sources for several of the species found nesting in Guinea-Bissau.



Islands (including a small barrier island) and channels in the Bijagós. *J.F. Hellio & N. Van Ingen*

Suitable nesting beaches, even though they are not scarce, are not as numerous as one might be led to think from looking at the extensive coastline. As a matter of fact, most of the coast is fringed by mangroves, sand and mud-banks that would make any nesting attempt impossible. There are very few sandy beaches, particularly on the mainland coast, with clear access from the seaward side. The main exception is the coast of the Varela region, near the Senegalese border. The situation is different on the islands (Bijagós, Jeta, Pecixe, Melo, etc.). In the most sheltered bays and channels, again mangroves dominate, but on the more open coasts there are several long sandy beaches with greater access. It is on such beaches, often placed on outer islands and on small exposed islets, that one can find the main marine turtle nesting grounds.

## The main sea turtle nesting areas

Almost any sandy beach on Guinea-Bissau that is not made inaccessible by mangroves or extensive banks and reefs is used, even if only sporadically, by nesting marine turtles. In this section, a brief description of the most important nesting areas is made. These areas are often mentioned in the species accounts and in the remaining text.

The most important sea turtle site in Guinea-Bissau is Poilão (10° 52' N, 15° 43' W), the southernmost island of the Bijagós archipelago. This site harbours most of the green turtle nesting of the country, as well as one of the few known regular sites for hawksbill turtles. Poilão is a low-lying small island, measuring little more than 1000 m along its widest section. The island is surrounded by a rocky reef that, during low tides, prevents access to the land in most of its perimeter. Most of the island is covered by dense rainforest, where movement is difficult, particularly during the rainy season. Poilão has no regular human settlements, it is not used for agriculture or as a fishing base and the only permanent infrastructure is an old Portuguese lighthouse in ruins. There are no known introduced species to the site. This island is surveyed by patrols on small boats and it regularly hosts teams of researchers and park staff that camp for periods that can go from a few days to several months.

Poilão is the most remote of the islands of the João Vieira group. The nearest one is Meio, at a distance of 11.5 km. Other islands in the group are João Vieira and Cavalos. There are also two islets, Cabras and Aweto, the first one being the most important for turtles. Except for João Vieira, all these islands and islets are uninhabited and covered by forests and wooded savannas. In João Vieira there are some very small tourist infrastructures which are used seasonally. Furthermore, the people from the island of Canhabaque regularly come to João Vieira



The island of Poilão represents the most important site for sea turtles in Guinea-Bissau.  
*P. Campredon & G. Rosa*





The beach of Ancopado, in the Orango National Park, before temporary settlements of foreign fishermen were removed from the area. At this site, 4 of the 5 species of marine turtles that reproduce in Guinea-Bissau can be found nesting. *J.F. Hellio & N. Van Ingen*

(and, to a lesser extent, to Meio) to collect forest products (mostly fruits from the palm *Elaeis guineensis* for palm oil production) and to cultivate rice using the traditional slash and burn method. The temporary settlements that support these activities have recently shown some tendency to become almost permanent on João Vieira. On this island and on Cavalos there are feral pigs. The entire João Vieira group has been classified as a Marine National Park (PNMJVP).

The second most important national area for sea turtles is the Orango group of islands (also classified as a National Park), particularly the island of Orango Grande (notably the beaches of Acapa-Orango, An-ôr and Ancopado) and the islet of Adonga. Here, the main beaches are wide and backed by sand dunes, which contrast with the shorter beaches of the João Vieira group that are backed by tropical forest. On Orango Grande, most of the land is covered by wooded savannas of variable tree density, while Adonga is a barrier island that separates the open sea from a lagunar section with sand banks, mudflats and some mangroves. The main islands of the Orango Group are inhabited and used for agriculture. Adonga has no permanent occupation, but some slash and burn agriculture has taken place.

Other potentially important sea turtle beaches exist on the outer islands of the Bijagós (such as Unhocomo, Unhocomozinho and Caravela) or in the Geba

channel (such as Jeta or Pecixe). These areas have been the subject of little study and surveying, but it is nevertheless clear that the numbers of nesting turtles to be found at those sites are much inferior to those recorded in the Orango and João Vieira groups.



Beach on the island of Unhocomo, one of the most remote islands of the Bijagós. In this area, several species of marine turtles can be found nesting. *L. G. d'Escricienne*

There are several other islands where sea turtle nesting has been recorded, but numbers involved seem to be very low. On the mainland coast, special reference must be made to the beaches at the extreme north and extreme south of the country, namely around Varela and around Cacine.

## Historical notes on the research concerning marine turtles in Guinea-Bissau

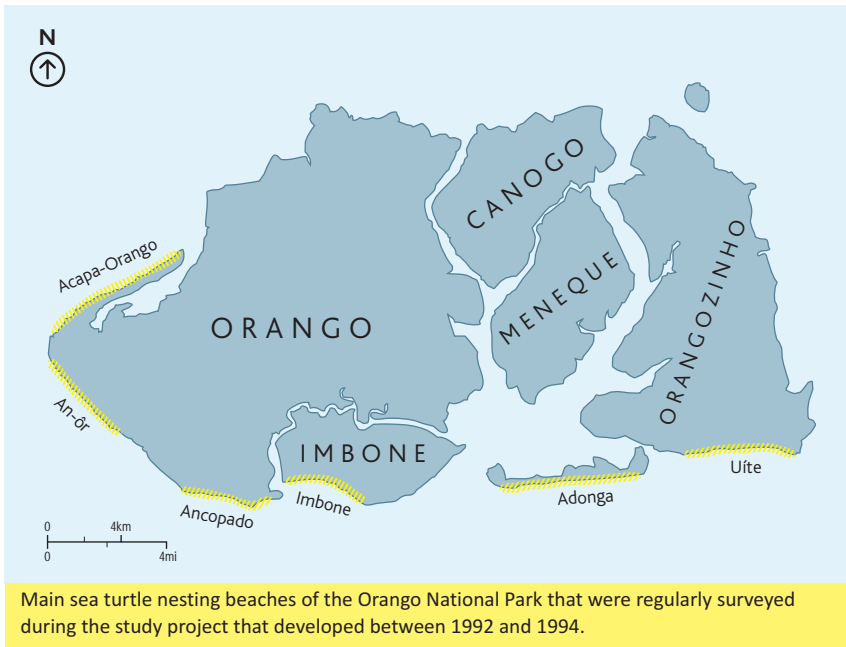
3

Until as recently as 20 years ago, virtually nothing was known about the sea turtles of Guinea-Bissau. The only available information concerns some passing remarks on the existence of marine turtles in the region, as part of general zoological inventories (Frade *et al.* 1946, Limoges 1989). Such brief references provided no information on the status, distribution or biology of the different species. In 1989, for example, the existence of an important nesting site at Poilão was still to be described in the technical or scientific literature (see Limoges 1989), even though such a fact was obviously well known by the inhabitants of Canhabaque, as well as by other Bijagós people and some fishermen.

In 1990, Benoit Limoges (from the Canadian Centre of Studies and International Cooperation – CECI), with the support of national staff from different institutions, namely from the Direção Geral das Florestas (forestry department) and from the IUCN (namely Honório Pereira), carried out the first dedicated marine turtle surveys in the country. He started by attempting a general inventory of the main fauna of the Bijagós, from February to April 1990. Then, between 11 and 27 August 1990, Limoges surveyed 23 islands and islets of the Bijagós, covering 118 km of beaches, either by walking them or by sailing a zodiac just offshore, at a distance allowing the detection of turtle tracks on the sand. It was during this dedicated fieldwork that Poilão was “discovered” for the scientific community.

In 1992, Bruno Paris (CECI) started working in the Bijagós. His main task was to organise studies, negotiations and other activities necessary for the creation and management of what one day would be the Orango National Park (PNO). Bruno set up a research program on marine turtles. For this, he got technical assistance from Tundy Agardy (WWF), who visited the country in 1992 and 1993, teaching on training courses that included practical fieldwork on Adonga and Poilão. In the Orango Group, further fieldwork and training of local collaborators was carried out by Bruno Paris with the support of Honório Pereira, a Bijagó from Orango Grande that later was to become the first director of the National Park. A systematic survey of the main beaches of the Orango Group took place from December 1992 to November 1994. Such work relied heavily on collaborators from several villages of the area. Castro Barbosa, having recently completed his

biology studies in the former Soviet Union, joined this group in 1993. Many of the local collaborators were later recruited as park guards, initially under an IUCN contract and, after, as official guards of the Institute for Biodiversity and Protected Areas (IBAP). It was also during that early period, particularly from December 1993 to March 1994, that special efforts were made to tag and study the reproductive biology of olive ridley turtles at Adonga. During those 3-4 months, the research team camped at Orangozinho and made nightly visits to the barrier island.



Sea turtle research on Orango developed as part of the national Guinea-Bissau programs of institutions such as CECI, IUCN and GPC (Coastal Planning Cabinet – Guinea-Bissau). At about the same time, work on Poilão also started developing, generally under the umbrella of INEP (the National Research Institute). Between 1991 and 1993, several short but relatively regular visits were made to the João Vieira – Poilão group, with the view to count turtle tracks (*e.g.* Fortes 1995). In 1994, between 7 July and 23 September, the first comprehensive Poilão turtle survey took place, with two teams of four people each taking turns on the island to ensure a complete coverage of the main nesting season (Fortes 1995). At the time, the emphasis was on tagging nesting females. Fieldwork was coordinated by Olívio Fortes and António José Pires (both from INEP). In 1995, a second survey was organised. In 1996, Claudio Bellini (Projecto TAMAR – Brazil)



Research team camping site in a small clearing of the Poilão forest. *Castro Barbosa*

came to Guinea-Bissau, as a consultant, and helped the national team from INEP prepare the first paper presenting results from the research on Poilão (Fortes *et al.* 1998).

In early 1998, Annette Broderick and Paulo Catry (University of Glasgow) came to Bissau, by invitation of the IUCN, to assess the current state of affairs and prepare a “National Strategy for the Conservation of Marine

Turtles in Guinea-Bissau”. They also supported Castro Barbosa in the preparation of a first paper on the sea turtles of the Orango National Park (Barbosa *et al.* 1998). At that time, and since at least the last months of 1995, there was no field research on marine turtles taking place. The war that lasted from June 1998 to early 1999 meant that things were to remain at a stand-still for a little longer.

In the year 2000, an agreement was signed between GPC and the *Fondation Internationale du Banc d'Arguin* (FIBA) for the re-launching of the turtle monitoring in the João Vieira – Poilão Marine National Park. With the funding provided by FIBA and the technical assistance linked to the IUCN and GPC, research gathered momentum. In that same year, the most intensive Poilão survey carried out to that date was organised. Work in the field was coordinated by Castro Barbosa, with the direct support of Amadeu Almeida and Bucar Indjai. The results obtained showed, in a conclusive manner, Poilão to be one of the most important green turtle nesting sites in the Atlantic Ocean. Still in 2000, the National Strategy for the Conservation of Marine Turtles was updated and a new document, entitled Action Plan, was produced (Catry 2000).

In 2001, Guinea-Bissau sent a delegation to the 21<sup>st</sup> Annual Symposium on Sea Turtle Biology and Conservation (Philadelphia, USA) and Castro Barbosa and Justino Biai presented two posters at the conference. It was also in 2001 that the first proper assessment of any of beaches of the mainland took place. Beaches in the Varela region were surveyed and evidence of the existence of juvenile feeding areas on this coast was also obtained (Dontaine & Schwarz 2001). Still in 2001, the first satellite tags were attached to turtles that had finished laying on Poilão. Their migratory tracks confirmed the importance of the shallow waters of other countries in the region (particularly Mauritania) as feeding areas for turtles that nest in Guinea-Bissau (Godley *et al.* 2003).

In 2002 and 2003 several short expeditions targeted the Unhocomo group and another juvenile feeding area was identified. Local collaborators reported what appear to be the first records of nesting loggerhead turtles in Guinea-Bissau.



Checking the contents of a hatched green turtle nest on Poilão. *G. Rosa*

From 2000 until the present, monitoring continued in the João Vieira / Poilão group, generally coordinated by Castro Barbosa, now as an IBAP employee and as Director of the JVP Marine Park. Other long-term members of the survey team include Bucar Indjai, Amadeu Almeida, João Pereira (Preto) and Januário.



Research team sailing past the island of João Vieira. *G. Rosa*

# Biology of marine turtles

## general aspects

The oldest known turtle fossils are about 220 million years old which means this peculiar group of animals was already around at a time when most terrestrial vertebrates were yet to start their evolutionary process. The first “modern” marine turtles (the direct ancestors of present day species) appeared some 110 million years ago, during the Cretaceous period, in the days when dinosaurs reigned on land and formidable beasts such as plesiosaurs and ichthyosaurs roamed the seas. Nowadays, only two families of marine turtles survive: the Cheloniidae, with 6 living species, and the Dermochelyidae, with a single extant species, the leatherback turtle. The small number of extant species should not lead one to conclude that this is an evolutionarily marginal group, possibly condemned to naturally disappear in a not too distant future. On the contrary, marine turtles survived the transition from the Mesozoic to the Cenozoic, when most other reptile species of the time disappeared. And it is not only their evolutionary history of 100 million years that confirms their success. As far as the evidence goes, before the catastrophic declines of the last few centuries, which were undoubtedly caused by humans, marine turtles were extremely abundant and made up a sizeable fraction of the biomass of many coastal ecosystems. On top of that, some of them were keystone species, which played an important role in the ecosystems where they lived. Hawksbill turtles, for example, as major sponge consumers, helped to regulate the balance of coral reefs, whose composition may now change as a result of their scarcity. Green turtles, in their turn, were amongst the main grazers in tropical seas, and hence were critical regulators of the composition of ecosystems dominated by algae and other aquatic plants, including areas largely covered by seagrass beds of *Zoostera*, *Cymodocea*, *Thalassia* and *Posidonia*, amongst others.

## Life cycle

Sea turtles are truly marine creatures. Males, once they leave the nest where they hatched and reach the surf, dive into the ocean to never come out again, in a life that may well exceed half a century. Females, in their turn, may also live dozens of years in the sea without ever coming out onto dry land. Exceptionally, green turtles can be seen crawling up onto beaches and sunbathing on remote Pacific islands, but such behaviour is unknown in other species or populations.

Only after they mature and the nesting season approaches do the females feel the need to seek those beaches where they were born and return to the terrestrial environment. They almost always do this under the cover of darkness, which hides them from predators and provides protection against over-heating. They choose, in most cases, the very beach where they were born, although such philopatry seems not to be so strict in the case of leatherback turtles. In the waters that surround the nesting site they meet the males who chase them until they succeed in securing copulation or are forced to give up. Each female will usually mate with several males, which results in clutches of multiple paternity, meaning that within each nest many turtles are half-siblings.

Each sea turtle species has its own preferences when it comes to selecting a beach for nesting, as well as the specific spot or area within a beach where it will dig the nest pit. Nevertheless, there is some overlap between species and different turtles can be found within the same stretch of sand. Once the specific site is chosen, the female starts digging a crater-shaped depression in the sand. At the bottom of this depression, she excavates a narrow and deep pit that is to become the egg chamber. Here, 50 to 150 eggs will be laid, the exact number depending on the characteristics of the particular clutch, the individual female and the species that it belongs to. The eggs are approximately spherical. Their shell is not rigid and brittle, as in a bird, but it is rather leathery and flexible. Once the laying has finished, the female covers the nest and tries to hide its exact location from potential predators by mixing and moving the sand all around the site.

Should an object, such as a large stone or a stick, interfere with the digging process, or should the sand present a consistency that may lead to the collapse of



Sea turtles normally copulate at sea, but occasionally the waves can drag a mating pair to the shore, where it will stay until the female can liberate itself from the keen embrace of the male. *C. Barbosa*



Green turtle during the first stages of nest excavation. *J.F. Hellio & N. Van Ingen*

the nest chamber during excavation, the nesting attempt may be aborted, even if it is considerably advanced. After one or more such unsuccessful attempts, the female turtle may return to the sea, from where she will later emerge to, once again, try to lay. Sometimes the laying process cannot be delayed any longer, and the eggs will just be wasted on the beach surface or in the incoming waves.

The incubation period is highly variable and depends, above all, on environmental conditions, particularly temperature. The higher the temperature in the nest chamber, the shorter the incubation will be. At 25° C, for example, incubation may take just over 2 months, whereas at 35° C the eggs may hatch 45 days after being laid. It must be said, however, that temperatures around 35° C are approaching a limit where embryo viability may become compromised. Should it get warmer than this, extensive mortality is likely to occur.

Incubation temperatures have another fascinating influence on the development of the embryos. Contrary to what happens in humans and most other vertebrates we are familiar with, the sex of turtles is not genetically determined by the chromosome composition of the fertilized egg (XX or XY, in the case of humans). In reality, the sex of the little turtles is only defined during the incubation period (in the middle third of the incubation period, to be more exact) and is completely dependent on the incubation temperature. At temperatures above 29-30° C, only female turtles will hatch. If the egg is cooler than this, males will be produced. It must be noted that one single clutch may produce turtles of both sexes, given that the egg metabolism will make temperatures at the core of the

clutch higher than the ones experienced by eggs placed on the periphery of that same nest. Such temperature dependent sex determination is part of the biology of other reptiles, such as crocodiles and some lizards, and it has important implications for the conservation management of sea turtle populations, as will be discussed further on.

Many clutches never hatch, which may result from a variety of reasons. Often, for example, nests are placed too close to the sea and get flooded or even washed away during periods of beach erosion. Other nests are invaded by fungi or by the roots of plants which usually results in the complete loss of the clutch. Eggs can also be destroyed by other turtles when they excavate to build their own nests. There are also parasites, such as insects, which attack the buried eggs. Important natural predators include carnivores (foxes, jackals, racoons, etc) and monitor lizards. When present in and around the nesting beaches, dogs and pigs may also cause significant destruction. Nowadays, man is the most important nest predator in many regions.

After hatching, the little turtles must make their way out, through the sand, until they reach the beach surface. This is carried out as a joint effort by the simultaneous movements of many hatchlings that together work their way up the sand column. Periods of coordinated movement are separated by long pauses for resting, which means that 2 or 3 days may separate hatching from the moment when the little turtles reach the surface.

The newly hatched turtles are extremely vulnerable to all sorts of predators. For this reason they avoid leaving the nest in daylight, usually doing so only after dark. If, on their way up from the nest chamber, they reach the sand surface when it is still broad daylight, they will wait patiently for darkness and only then attempt crossing the beach towards the sea. Once on the sand surface, each little turtle moves by itself. They have a strong instinct to move towards light. On a dark tropical beach, the sky is usually lighter on the seaward side, while landward it may be obscured by higher ground or vegetation. Hence, moving towards the light usually means that the sea will be reached after a short period of crawling along the beach. This orientation system can be severely disrupted by artificial lights causing widespread disorientation and mortality.

While crossing the beach hatchlings may be taken by a range of predators, such as crabs, foxes or, during the day, several types of birds. Once the sea is reached, dangers are not over. Predation rates by fishes and by seabirds may be very high. It is only natural, then, that the young turtles choose to swim as quickly as possible to offshore waters, where dangerous predators occur at much lower densities.

In the first few days at sea, the little turtles swim continuously so that they rapidly become clear of shallow waters. At first, they orientate themselves



Recently hatched turtles emerging from the sand. *G. Rosa*

towards incoming waves, which tends to lead them to the open sea. Body reserves give them the necessary energy to keep swimming without the need to stop to forage. When they reach deeper waters they will then engage in long resting periods, between swimming or foraging bouts. They feed on small pelagic invertebrates (such as crabs, jellyfish, comb jellies, molluscs) that they pick without much selectivity. Often they find their prey near kelp, seaweed or other floating objects. Once in high seas, the turtles seem to orientate themselves using the Earth's magnetic field. At this point, their life becomes rather mysterious and enigmatic. Little turtles are, with current technology, more or less impossible to track and one seldom comes across any in the wide expanses of the open ocean.

In the pelagic realm of the deep sea, food is usually relatively scarce and the little turtles will not grow quickly. They drift on marine currents over huge distances, covering thousands of kilometres during their pelagic stage. In loggerhead turtles, for example, this pelagic wandering may last 6 to 9 years, while in hawksbills it is shorter, "just" 1 to 3 years. When at last their shells reach 30-40 cm, some turtles will return to coastal environments, to reefs or other shallow places close to the coast. They may then remain within the limits of a small home range during months or years, often coming to sleep at the same spot every night. However, not all of them become completely sedentary, and they may switch from one growth area to another, which are sometimes widely

separated places. Furthermore, some turtles seem to retain pelagic lives during the whole growth period and, in some cases, during their entire life. This is certainly always the case in leatherback turtles, but it also happens with many olive ridley, loggerhead and green turtles.

The length of time taken for a turtle to reach sexual maturity is highly variable, and it changes from one species to another or even between populations of the same taxa. In the case of green turtles, sexual maturity is attained somewhere between 25 to 35 years of age (this period may be considerably shortened in captive turtles raised on rich diets). Leatherbacks may hold the record for rapid maturation, as they can start nesting between 5 to 15 years of age.



Recently hatched turtle immediately after entering the sea. *J.F. Hellio & N. Van Ingen*

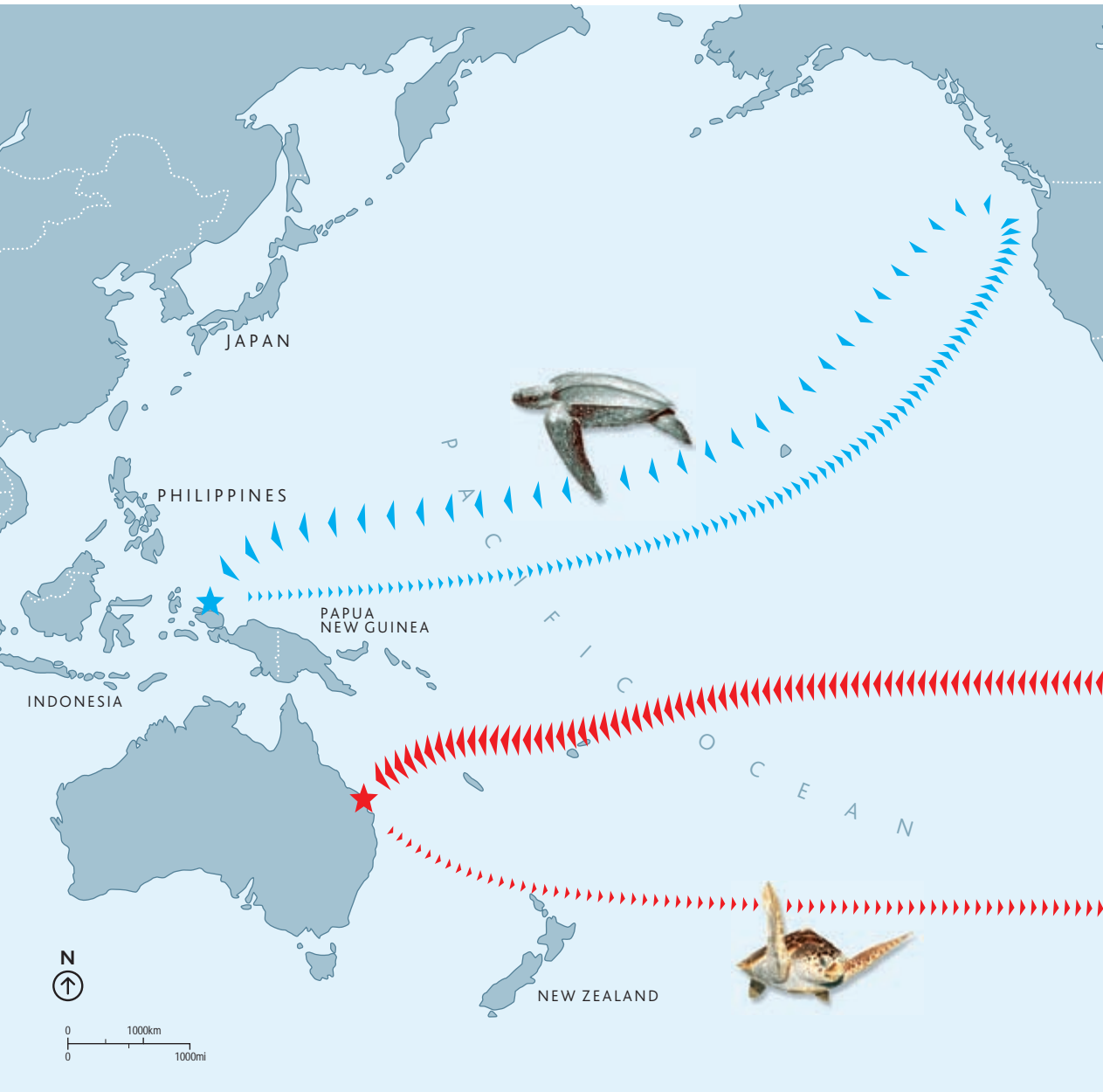
## Fantastic migrations

If we exclude the flatback turtle *Natator depressus*, marine turtles can be said to be, in essence, migratory animals. As described above, the first years of life are mostly spent wandering the high seas, some individuals eventually settling down in coastal habitats. Furthermore, all leatherbacks and entire populations of olive ridleys will keep their nomadic pelagic lifestyles throughout their entire lives. Some individual green and loggerhead turtles will also adopt such a strategy, forever wandering in the pelagic domain between nesting bouts. Finally, even those turtles that retreat into coastal environments and live most of the time within relatively confined home ranges still undertake migrations between nesting and foraging grounds. Such regular migratory movements can involve displacements of hundreds or even thousands of kilometres.

Amongst the most spectacular movements recorded through satellite tracking, one may mention the particular case of a leatherback turtle who, after laying on a tropical beach in Indonesia, crossed the entire Pacific Ocean and reached the coast of the United States of America. In the Atlantic, leatherback migrations are also extensive, with some of them reaching the European coasts after reproducing in South American shores. In fact, there are records of turtles of all Atlantic species that link the New and the Old World, although such trans-Atlantic movements are frequent in some populations but relatively rare or exceptional in others. One of the best known examples concerns the loggerhead turtle population that originates from Florida and South Carolina, on the USA's east coast. Those turtles are, during their immature life stages, common on the East Atlantic, for example around the Azores, Madeira and the Canaries (some even reach Mediterranean waters), living pelagic lives while they grow to a size suitable for recruitment into the North American shelf habitats. In the Pacific also, young loggerheads born in Japanese or Australian coasts may be found, while in their juvenile stages, foraging off the North American and South American coasts, respectively. Finally, as one further interesting example, we can mention the case of the green turtles that live along the shores of Brazil and that, when nesting time approaches, embark on a migration across the open sea that takes them to Ascension Island, in the middle of the tropical Atlantic Ocean, where they will nest before returning to the South American coast, where food is more plentiful.

Once the nesting areas are reached, each female will lay several clutches (often 2-5, more in leatherbacks), with a 1-2 week interval between clutches. They will then go without nesting again for a migration, resting and feeding period that often lasts 2-3 years.

Despite their migratory capabilities, some turtles may remain and winter in relatively cold waters (with sea surface temperatures slightly below 15°C), where



Examples of migratory movements of marine turtles in the Atlantic and the Pacific Oceans. The migratory routes of loggerheads (depicted in red) concern movements of young animals. Movements of green and leatherback turtles (in blue) are of adult individuals.



they may enter a hibernation state. They will then stop feeding and keep themselves largely motionless on the sea floor (sometimes partly buried in the sediment), at depths of a few tens of meters. Nevertheless, and contrary to what has been believed to be true, sea turtles cannot engage in anaerobic metabolism during hibernation, which means they still need to come to the surface to breathe, at least a few times per day. Still, their diving performance in such circumstances is quite remarkable, as they can remain at the bottom for up to 7 hours without breathing (*e.g.* Hochscheid *et al.* 2005).

## Diet

Despite the fact that all sea turtles have a broadly similar external morphology, the reality is that they display adaptations and dietary habits that are varied and well differentiated. It is almost as if the 7 extant species evolved in order to occupy all the possible niches available for large sized and relatively slow animals, such as turtles. Of course, many resources are largely inaccessible to them, which to a certain extent may result from the competition with other large aquatic beasts, such as marine mammals or sharks.

Hence, in the Eastern Atlantic, we can find: one grazer of algae and seagrasses (green turtle), one sponge consumer (hawksbill), one predator of large bottom dwelling invertebrates (loggerhead), one generalist predator of not so large invertebrates, both pelagic and benthonic (olive ridley) and one consumer of pelagic gelatinous prey (leatherback). Despite numerous regional variations to the main theme, the fact remains that the feeding ecology of each turtle species is quite distinct, as one can judge from the general diet descriptions just presented. Such trophic segregation is perhaps not so obvious in young turtles living in pelagic environments, which, by and large, consume small animal prey found near the sea surface. Nevertheless, this statement remains to a large extent speculative, as relatively little is known on the foraging behaviour and diet of young turtles that roam the deep sea regions of all three major oceans.

# Status and biology of the species occurring in Guinea-Bissau

## Green turtle *Chelonia mydas*

Bijagó: Etchunko

Creole: Tartaruga-preto

Portuguese: Tartaruga-verde



### Description and identification

Second in size only to the leatherback, this is one of the largest living turtles. Amongst its most distinctive characteristics is the fact that it has 4 lateral scutes on its carapace. In this particular respect, it can be confused with the hawksbill turtle, but the latter has a prominent “beak” (the green turtle has a much rounder head) and two pairs of prefrontal scales between the eyes (only one pair



Green turtle on Poilão. *J.F. Hellio & N. Van Ingen*

in the green turtle). The general colour of the green turtle is variable, but it is rarely greenish! In fact, greenish tones are only obvious in the internal fat layers. Its size varies considerably from one population to another. Normally, adult individuals will weigh between 70 and 250 kg.

The tracks of this species are generally 100 to 130 cm wide. They are deeply cut and the marks made by the forelimbs have a symmetrical disposition. The tail of the turtle leaves a line (continuous or interrupted) that is easily visible in the sand.

### **General ecology**

Green turtles are amongst the major grazers of the ocean. They feed mostly on higher aquatic plants (seagrasses such as *Zoostera* and *Cymodocea*) and algae (including green, red and brown algae) from a wide range of species. Despite being predominantly herbivorous, adult green turtles may eat animal prey, and in some populations this happens rather frequently. Amongst the most often consumed animals are jellyfish, comb jellies and sponges, but molluscs, worms and even fish and their eggs may be occasionally taken. The diet of the juvenile phases is almost unknown, but it is believed to be mostly carnivorous, and composed mainly of small pelagic creatures.

When they reach a curved carapace length of 20-30 cm, most green turtles give up their pelagic lifestyle and settle, even if temporarily, on a shallow area that is rich in algae or other marine plants. From then on, they will become predominantly herbivorous.

As happens with other sea turtles living in shallow seas, green turtles seem to spend long periods of their life in specific coastal sectors where they can find a reliable and abundant food supply, leaving those areas only to engage in reproduction, which can take place in very far away beaches. The most often cited example of this life strategy is given by the above mentioned green turtles that shuttle between foraging grounds on South American coasts and nesting areas on the island of Ascension, on a round trip of several thousand kilometres.

Recent studies suggest that, contrary to what was widely believed, some green turtles keep their juvenile pelagic habitats even after they mature, and will still feed in deep offshore waters between breeding seasons.

### ■ Global status

The green turtle is currently classified as globally *Endangered* (IUCN 2008) but, as happens with some other marine turtles, this official conservation status is far from finding consensus amongst specialists (e.g. Broderick *et al.* 2006). In reality, this species has a very wide distribution in all tropical seas and in many sub-tropical regions. Some populations are made of many thousand reproducing individuals, as happens, for example, with those that nest at Tortuguero (Costa Rica) or at Raine Island, in the Great Barrier Reef (Australia). Fortunately, some of these large populations are stable or even showing positive trends. Nevertheless, in many countries where green turtles reproduce, the species is seriously threatened by a variety of factors. Hence, its global conservation status is not free of concern.



Turtle tracks on Poilão. J.F. Hellio & N. Van Ingen

## ■ Status in Guinea-Bissau

The green turtle is by far the most abundant and widely distributed marine turtle species in Guinea-Bissau. Both our own data and the information obtained by talking to local people indicate that there is no sandy beach (amongst those with an unobstructed access on the seaward side) that, at least occasionally, is not used by this species as a nesting site. Green turtle reproduction has been confirmed in virtually all the Bijagós islands where enquiries or directed surveys have taken place, in places as diverse and far apart as Formosa, Caravela, Unhocomo, Orango, Bubaque, Canhabaque or in the João Vieira group. Furthermore, the species nests along the mainland coasts, from Cabo Roxo and the Varela area, in the north, to the Melo island sector, in the south. Nesting is also said to occur regularly on the islands of Jeta and Pecixe.

Despite its wide distribution, the national breeding population is, to a large extent, concentrated at one single nesting site, the island of Poilão. In most other reproduction areas, such as for example, the coast of Varela or on large Bijagós islands such as the Urok group, Caravela or Bubaque, densities are nowadays very low (*e.g.* Limoges & Robillard 1993c, Dontaine *et al.* 2001, Schwarz 2002, Barbosa & Indjai 2003). Areas with a considerably higher nesting density include the Orango group (particularly the islands of Orango Grande and Adonga) and the João Vieira group (João Vieira, Cavalos, Meio and Cabras).

Non-systematic observations on Unhocomo and Unhocomozinho, in the rainy season of 2003, suggest that on these islands there may be tens (but not hundreds) of nests each year (from data presented in Indjai 2003).

During the 1992-94 survey on the 6 main known nesting beaches of the Orango Group, 126 “recent” nests and 294 “old” nests were recorded. It was estimated from these data that 751 clutches had been laid in the first census year, and 274 in the second (see Annex 3). These results should be taken with caution, given that the temporal coverage of surveys was rather incomplete, with gaps in months and places with likely important nesting



High density of green turtle nests on Poilão.  
*G. Rosa*

activity. Furthermore, not all surveyors had the ideal level of training needed to carry out the work. Less intensive counts in more recent years (namely in 2006) also suggest that the number of annual clutches in the Orango National Park must be of several hundred. In 2007, a year with peak numbers of nesting turtles in the Bijagós, at least 374 nesting females were killed and consumed in the southern part of Orango Grande. Ninety one percent of those had been taken near the village of Ancopado, which is known not to be the main nesting area in the PNO (it had an estimated 22% of the nests in the 1992-94 period). Hence, it seems reasonable to speculate that, in 2007, the number of turtle nests in the PNO may have reached a few thousand.

As mentioned above, Poilão is the main nesting site in Guinea-Bissau. The first quantitative data showing the importance of the site resulted from the intensive tagging campaign during the years of 1994 and 1995, when 314 and 1651 females were marked, respectively (Fortes *et al.* 1998, Annex 2). In the year 2000, the first exhaustive nesting survey, covering most of the breeding season, took place, resulting in an estimate of 7397 clutches laid that year (Catry *et al.* 2002). Counts in the following years confirmed that this intensity of nesting in Poilão is the norm, rather than the exception (Catry *et al.* 2009).

In 2007, great difficulties were met when attempting to count turtles and their tracks on Poilão beaches. This resulted from unusually high numbers of females coming ashore to breed. Just to illustrate this point, on the night of 9 September, 465 turtles were seen ashore in one single night patrol of the main nesting beaches of the island. The following morning 460 individual tracks were recorded, but this statistic must seriously underestimate the actual number of turtles coming ashore, as many would have come ashore and nested without being recorded in the single night patrol mentioned above. The numbers of turtles stuck on the rock reefs of Poilão during morning counts were also impressive, with a record 284 individuals on September the 18<sup>th</sup>.

The total number of tracks counted between 27 June and 18 November 2007 was 33 991, which may correspond to about 29 016 clutches laid (Catry *et al.* 2009). Still, there were quite a lot of occasions (on 43 different dates) when the number of turtles seen ashore (adding those seen on the first night patrol to the ones stuck in the morning – see Annex 1 for rationale) was larger than the number of tracks recorded. If we replace the number of counted tracks by the number of turtles seen on those dates and rework the calculations for the levels of nesting, we come to a total of 32 158 clutches in 2007. Both these methods have shortcomings, but one thing seems certain: in 2007, the total number of turtle nests on Poilão was of the order of 30,000 (perhaps more). In 2008, nesting numbers come down to more usual levels, with 7564 tracks counted between 18 August and 6 December (Barbosa 2009).

## Ecology – data from Guinea-Bissau

### Biometrics and genetics

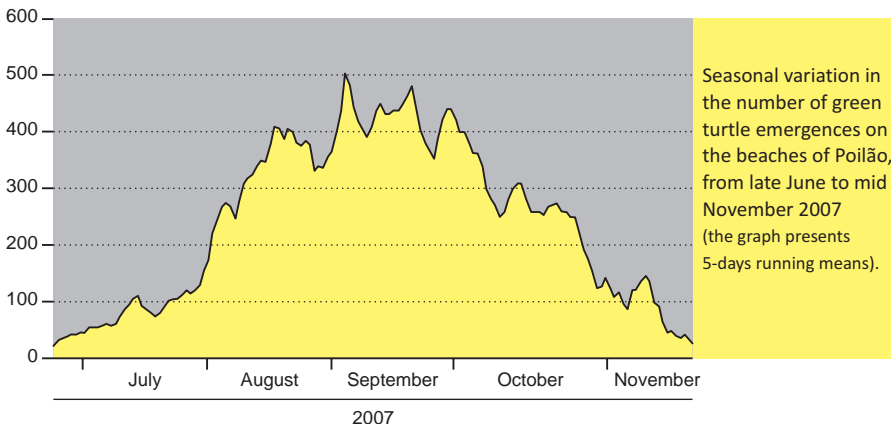
In 2007, 597 adult females measured at Poilão had a mean curved carapace length of  $102.0 \pm 5.6$  cm (range: 85-119) and a mean curve carapace width of  $93.3 \pm 5.4$  cm (range: 75-111). These values are very similar to those presented in Fortes *et al.* (1998) for the years of 1994 and 1995.

Studies using mitochondrial DNA from several populations nesting on the African Coast, including Guinea-Bissau, revealed that the Poilão population has a low genetic diversity, which may be explained by the recent colonization of the area in the context of the evolutionary history of this species (Formia *et al.* 2006). In reality, this fits in with the recent separation of the Bijagós islands from the mainland, to which they were connected during the cooler part of the most recent ice age. However, this cannot be the whole story, as green turtles also nest on the mainland coasts of the region, where they might have maintained an important population before, during and after the last glacial period.

### Reproductive biology

#### *Seasonal distribution of nesting activity*

● In Guinea-Bissau, this species nests mostly during the rainy season, particularly during the months of August and September, when rainfall is abundant. At Poilão, nesting occurs in abundance from July to November, but is scarce in other months of the year, with a possible minimum between April and June. Nevertheless, even during these last months it is possible to come across the occasional female in laying activity.





Turtles stranded in the rocky reef that surrounds Poilão while they wait for the rising tide.  
*C. Barbosa*

As generally happens in sea turtles and in almost all green turtle nesting areas, females mostly come ashore under the cover of darkness. Nevertheless, on Poilão, during periods of peak nesting, it is not unusual to find some turtles crawling up the beaches at around sunset, when there is still much daylight. More occasionally, it is possible to come across turtles coming ashore and successfully nesting with the sun well above the horizon (mostly in the morning). Furthermore, at Poilão, it is common to find turtles that, having emerged from the sea while it was still dark, only complete their nesting after sunrise. Such activities ashore in broad daylight seem to be very rare on other beaches of Guinea-Bissau.

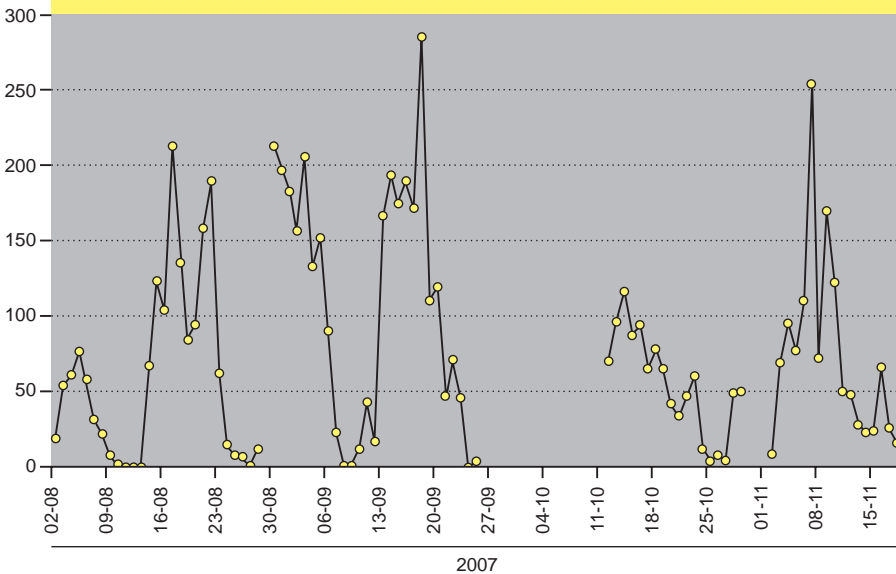
Most of the Poilão shore is protected by a rocky reef that becomes exposed at low tide. During the high tide, turtles can reach the beaches without difficulty. But, given that they take a substantial time ashore digging a nest and laying a clutch, they often face an insurmountable barrier when they attempt returning to the sea. In most cases, they have no other option but to wait for the rise of a new tide. Some individuals will crawl along the beach searching for a gap in the reef that may allow them to return to the sea. Most simply seek a tidal pool, where they will rest with their bodies partly submerged. Generally, they keep their heads underwater, breathing from time to time. Some cannot find a suitable pool and are left on the rocks, apparently lacking enough energy to keep moving.

At dawn, one can usually find green turtles that have laid and are still waiting for the rising tide. The number of individuals found ashore is, of course, influenced by the number of turtles nesting on the previous night but, above all, it is dependent on the level of the tide at sunrise. During peak nesting season, early morning low tides leave dozens of individual females stranded. Almost all of these will eventually return to the sea without major problems, but in rare cases they may get stuck in the rocks and, unable to free themselves, end up dying.

On the islet of Amegue (also known as Cabras, near Meio) stranded turtles can also sometimes be found at low tide, but on most nesting sites in Guinea-Bissau there is free access to and from the sea at all times of the tidal cycle. At a few sites, instead of a rocky reef, the nesting beach may be fringed by a sandbank, where turtles may also get temporarily stranded during low tides.

There is no available information on the numbers of males around Poilão, or on the seasonal distribution of matings. All that can be said is that during most of the rainy season, it is possible to watch mating turtles from the Poilão shores, often in large numbers. Occasionally, mating couples can be driven ashore by the waves, where they remain until the female can free herself from the embracing male.

Daily variation in the number of turtles temporarily stranded (during early morning) on the reef around Poilão. Broken lines depict periods without counts. The cyclic pattern results from regular variations in the times of low and high tides. When the sunrise coincides with a high tide, few or no turtles are found ashore.





Digging a nest hole on Poilão. J.F. Hellio & N. Van Ingen

### *Laying*

As explained above, a clutch is not laid every time a female turtle crawls onto a beach. Thus, a correction factor needs to be applied, in order to estimate the number of nests laid from the counts of tracks on the beaches. The correction factor is given by laying success. In the year 2000, 50 turtles were followed from a distance (without disturbance) from the moment they left the sea to the moment they dove back into the surf. Of these, 38 (76%) laid a clutch (Catry *et al.* 2002). In 2007, further data were obtained and 23 (92%) out of 25 turtles followed laid a clutch. In 2008, the laying success of 97 turtles was 81%. The differences between years are not statistically significant and, from pooling samples, the global estimate for laying success is  $140 / 172 = 81.4\%$ .

Data obtained on Poilão indicate that the complete nesting cycle, from the moment the turtle emerges from the sea until she returns to the ocean after successfully laying, takes approximately 2 hours and 15 minutes (Limoges & Robillard 1991c). This value is representative only for turtles which do not get caught on the rocky reef (*i.e.* for those who do not have to wait for the incoming tide).

The exact location of the nest site is rather variable, but this aspect has not been the object of any detailed study. On several Guinea-Bissau beaches that are

backed by shrubby or arboreal vegetation, it is common to find that the turtles choose to lay in the shade beneath the low branches of shrubs and trees. However, most nests are dug on open beaches, with sparse grasses or bushes or even at sites with bare sand.

Most clutches on Poilão contain 100-150 eggs.

Clutch sizes and inter-nesting interval on Poilão. Differences between years are not statistically significant. (N) – sample size.

	Mean $\pm$ SD (N)	Range	Source
Clutch size in 1990	127 eggs (5)	108-138	Limoges & Robillard 1991c
Clutch size in 2000	124 $\pm$ 26 eggs (68)	62-183	Catry <i>et al.</i> 2002
Clutch size in 2007	131 $\pm$ 27 eggs (96)	51-190	Catry <i>et al.</i> 2009
Clutch size in 2008	122 $\pm$ 24 eggs (94)	56-194	Barbosa 2009
Inter-nesting interval	12.2 $\pm$ 1.6 days (95)	8-17	Catry <i>et al.</i> 2009

#### ● *Incubation and hatching success*

On Poilão, the mean incubation time of clutches where at least some eggs hatched was  $56.0 \pm 3.1$  days (range: 49-61; N = 63). This sample includes clutches laid between 19 August and 10 October 2008. A smaller sample obtained in the year 2000 yielded a mean incubation time of  $60.4 \pm 5.5$  days (range: 50-70, N = 16). It should be noted that the duration of the incubation period may be strongly dependent on the laying date. For example, in 2008, there was a seasonal decline in incubation periods, which can be demonstrated by the negative correlation between laying date and incubation duration ( $r = -0.55$ , N = 60,  $P < 0.001$ ). Thus, while a clutch laid in August had a mean duration of incubation of 57.8 days, the corresponding value in September was 56.4 and in October it was 52.3. Such variation can be explained by changes in relevant environmental conditions. The considerable rain that falls in August and September lowers the temperature of the incubation chamber and slows down the development of the embryos. Clutches laid in October will not experience

The best available estimates suggest that pivotal incubation periods (incubation periods that tend to produce an unbiased sex-ratio) may range from 53.3 to 60.2 days (these estimates are based on limited sampling and should be refined; Broderick *et al.* 2000). Hence, the data gathered so far suggest that Poilão may have a good production of males, particularly in regards to clutches laid in August. This is interesting as evidence is accumulating that in other green turtle populations there is a current excess of female production, which could be an early sign of global warming effects (*e.g.* Broderick *et al.* 2000, Öz *et al.* 2004, Booth & Freeman 2006).

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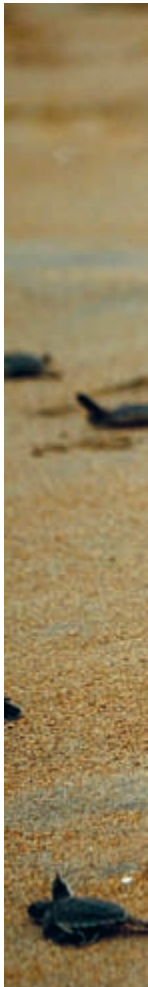


While ashore, turtles produce “tears” that help keep their eyes clean. *G. Rosa*

rence. The mean percentage of eggs that hatched in successful clutches (clutches where at least one egg hatched,  $N = 58$ ) was 93.6% (Catry *et al.* 2002).

Due to the large numbers of laying turtles that were present in 2007, most of the tags and poles used to mark study nests were lost, which prevented any rigorous estimate of nesting success. To obtain a rough estimate of the percentage of nests destroyed by nesting turtles, each night (from early August) 10 laying turtles were randomly selected and the surroundings of their nest were inspected, looking for scattered eggs, to assess if other clutches had been affected by the excavation of the new nest. In a sample of 910 laying turtles, there was evidence for the partial or complete destruction of a previous clutch in 32.6% of the cases (Catry *et al.* 2009). It should be noted that in many cases only very few scattered eggs could be found, which means that it is possible that many affected clutches might have partially survived. However, the destruction of only a few eggs in a nest may also have a large impact on the overall clutch, as rotting eggs may be the starting point for a general infestation of the clutch by fungi or bacteria (Caut *et al.* 2006). On the other hand, as discussed above, predation levels on Poilão seem to be generally low and, in 2007, the large availability of scattered eggs on the beach surface may have swamped any predators, such as monitor lizards, which may have reduced predation levels and still allowed a reasonably high nesting success.

It must be stressed that the high levels of clutch destruction by other turtles reported above occurred in a year with unusually large nesting numbers. With



the help of a GPS, it was estimated that the beach area suitable for nesting was around 22,500 m<sup>2</sup>. Hence, the overall density (including the nests that were destroyed) during peak laying may have approached 1 nest per m<sup>2</sup>.

In 2008, with nesting numbers back to more usual levels, the percentage of laying turtles that had interfered with a previous clutch was 14.4% (N = 731), which represents less than half than those recorded in the previous year (a highly significant difference, Fisher Exact Test,  $P < 0.001$ ). This last estimate is very similar to the one obtained from a sample of 104 marked nests in that same year;



Recently hatched turtles on their way to the ocean. *J.F. Hellio & N. Van Ingen*

after excluding 8 nests for which the tags were lost, 16.7% (N = 96) were destroyed by other turtles, while 1.1% were destroyed by wave action and the remaining 82.2% hatched successfully (Barbosa 2009).

These results strongly suggest that nesting on Poilão is constrained by the size of the beach and that nesting success is limited by density dependent effects (*e.g.* Bustard & Tognetti 1969, Caut *et al.* 2006), which has practical implications for the conservation management of this population. In reality, lack of nesting space may become an even more serious constraint as a result of rising sea levels or the increase of erosion resulting from changes in the frequency of extreme weather events (such as storms) that are predicted to occur as a result of global climate change.

#### ● *Inter-nesting intervals*

Capture-mark-recapture of nesting turtles on Poilão has allowed the estimation of the inter-nesting interval of individual females along the nesting season. This interval is, on average, around 12 days.

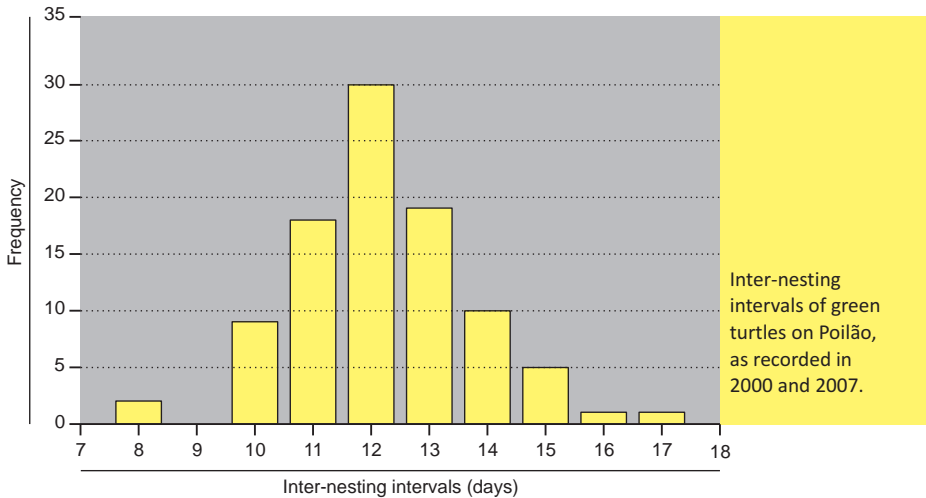
Unfortunately, the capture-recapture effort was not sustained for a period that allows rigorous estimation of the number of clutches laid per female within a nesting season. Data from other areas indicate that, on average, green turtles may lay about 3 clutches per laying season (*e.g.* Broderick *et al.* 2003). On Poilão, there are records of several females laying 4 or even 5 clutches in one season. There are even instances where the inter-nesting intervals suggest that particular females may have laid 6 (or even 7) clutches in one year.

Usually, after a nesting season, female green turtles will wait for 2 or 3 years (sometimes more) before they attempt to nest again. It is likely that this applies to



Patiently waiting for the rising tide on a pool on the rocky reef of Poilão.

*J.F. Hellio &  
N. Van Ingen*



the Bijagós population, but detailed data is lacking. It is nevertheless interesting to note that, in 2001, 4 female turtles were recorded nesting in Poilão after having been tagged at the same site in the previous year. This indicates that some individuals in this population are able to nest in consecutive breeding seasons.

### Migration

Of the 5500 adult females tagged on Poilão from 1994 to 2007, only six were recovered away from the nesting island and reported to researchers: 3 in Mauritania, 1 in Gambia, 1 in southern Senegal and 1 in the Cacine river region (southern Guinea-Bissau). This very low recovery rate can be explained by the high rates of tag loss that have been the norm for this population and batch of tags (there are very few inter-annual recaptures on Poilão, for example) and also by the low reporting rates in Guinea-Bissau and neighbouring countries.

On 21-23 November 2001, 10 satellite transmitters (PTT) were attached to females that had just laid on Poilão. Care was taken to pick out individual turtles that were known to have already laid 3 or more clutches in that particular year, in order to maximize the probability that those females would depart soon after the transmitters were deployed. Four of these turtles migrated to the Banc d'Arguin National Park (PNBA), on the Mauritanian coast, more than 1000 km from Poilão, where they stayed until the transmitters ceased to signal their position. Two other turtles moved to Senegal. In one of these, the transmitter failed at an early stage, while the other turtle returned to Guinea-Bissau without ever settling in Senegalese waters. The remaining four individuals did not leave Guinea-Bissau before (early) transmitter failure and it is not clear whether they were due to migrate or to remain in national waters (Godley *et al.* 2003).

These data, and the fact that green turtles occur in high densities within the PNBA, suggest that the shallow waters of the Mauritanian coast, and particularly the Banc d'Arguin, are one of the main foraging grounds for green turtles that nest in the Bijagós. This also implies that the conservation of this population is conditional on cooperative conservation efforts by at least two countries.

Virtually nothing is known about the movements of young sea turtles originating from Guinea-Bissau. At first, they must live in the high seas, as happens with post-hatchlings from all green turtle populations. After that, the juveniles must start foraging in coastal waters, which may either be very close or quite far away from the birth site. Hence, it is possible that some young turtles will settle in Guinea-Bissau's waters (see more below) while others will stay in much more distant foraging grounds. There is limited evidence, from genetic analyses, that some juveniles may even settle on foraging areas across the Atlantic Ocean, namely around the Bahamas, 5600 km from the Bijagós (Lahanas





Capturing and tagging young green turtles on the Unhocomo group. *C. Barbosa*

*et al.* 1998), but more data is needed to confirm this hypothesis. Although not unlikely, such long distance movements probably involve only a very small proportion of the West African green turtle population (see also Bass & Witzell 2000, Luke *et al.* 2004).

### Feeding areas in Guinea-Bissau

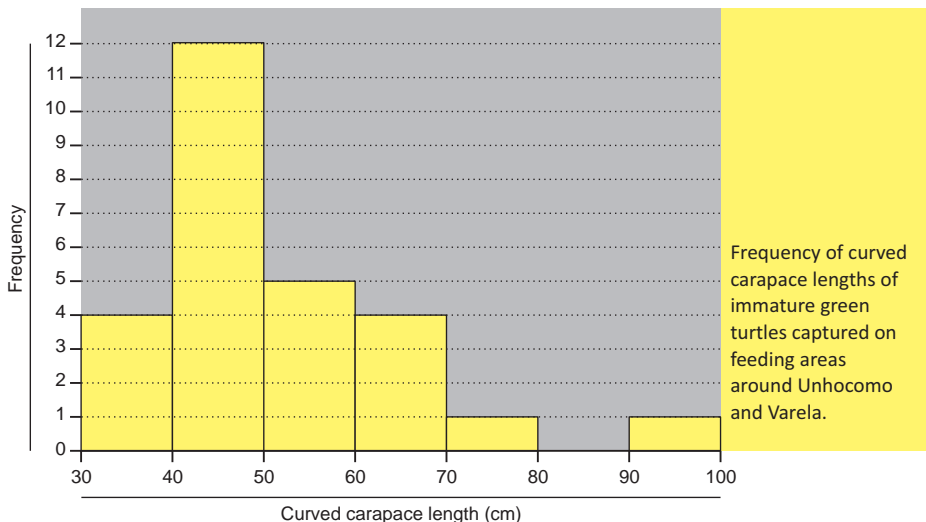
Even during the dry season, when little nesting occurs in Guinea-Bissau, it is common to find green turtles, some of which with large body sizes, in the waters of the Bijagós (for example, around the islands of Bubaque and Orango Grande). This suggests that some adult turtles do not migrate and keep foraging in the shallow waters of the archipelago between nesting seasons. It is also possible that some of those turtles actually nest in other places, but there are relatively few nesting green turtles in countries neighbouring Guinea-Bissau and hence the numbers of external visitors must be rather small.

In shallow waters around the islands of Unhocomo and Unhocomozinho, in the westernmost part of the Bijagós, juvenile green turtles are regularly found, to the extent that, in those remote islands with few resources, people have recently gained the habit of capturing those turtles for consumption. They are caught using nylon fishing nets dragged from canoes, and the turtles are usually captured alive. In May and September 2003, within the framework of a couple of expeditions to this area, the collaboration of local fishermen was sought to capture turtles for research purposes. In just three short fishing sessions, it was

possible to collect 19 green turtles, which suggests that the local density must be quite high (Indjai *et al.* 2003a, b). Excluding one possible adult male (with a curved carapace length of 91 cm), all other turtles were clearly juvenile, with a mean carapace length of 50.1 cm and a mean mass of 18.4 kg (Annex 5).

Besides the foraging area identified in the Unhocomo group, reports from local people indicate that similar feeding grounds may exist in places such as the vicinity of Ancopado (Orango Grande), Uno, Galinhas, Caravela and Chediã. Near the mainland coast, high concentrations of immatures have been reported in the Varela area, on a section with rocky substrates (Dontaine *et al.* 2001). Turtle shells examined in the villages of this area were mostly of juvenile green turtles, with a mean curved carapace length of  $45.4 \pm 13.5$  cm,  $N = 8$  (Dontaine *et al.* 2001, Catry *et al.* 2009).

There must be other important foraging areas for green turtles in national coastal waters, but they have not yet been identified. It must be noted that virtually nothing is known on the abundance and distribution of important habitats, such as seagrass beds or reefs covered with algae, which may provide rich feeding resources for this species.



### Diseases and parasites

Fibropapillomatosis, or fibropapilloma, is a disease that reveals itself by the growth of benign tumours and that can affect most marine turtle species. Its incidence is particularly high in some green turtle populations, where, in extreme cases, most individuals present visible external tumours. Both these growths,



and internal ones, can reach such a size that they frequently lead to the demise of the affected individuals. The disease is present in all major ocean basins, but its prevalence is highly variable from one region to another. Fibropapillomatosis seems to be infectious (the development of tumours may arise after a specific viral infection) and to be more frequent in areas that suffer from a certain degree of pollution. The high prevalence and severity of this disease has led to the belief that fibropapilloma may be one of the most serious threats to green turtle conservation (see also the section devoted to threats; *e.g.* Aguirre & Lutz 2004).

The definite confirmation of this disease requires the collection of samples and histological and microbiological analyses. However, given that the tumours are quite visible and present a distinctive morphology, it is possible, just from an external examination of a sample of turtles, to gather an idea of the prevalence of the disease in different regions. It is most likely that fibropapilloma is present in Guinea-Bissau given that the disease has been detected through microscopic examination in the Atlantic coast of Africa, off Gabon/Equatorial Guinea (Formia *et al.* 2007), and turtles with suspected fibropapillomatosis have been reported in Gambia and Senegal (Barnett *et al.* 2004).

On the João Vieira / Poilão Marine Park, rangers and other park staff have reported at least three cases of suspected fibropapilloma. The first one was at Poilão, in the year 2000. The second record concerns a juvenile green turtle that was captured on the channel between João Vieira and Meio. The third was seen in 2005, and involved a dying turtle on a Meio beach, whose body was, according to João Pereira (Preto) covered with external growths.

In 2007, a first attempt was made to obtain systematic data on the prevalence of fibropapilloma on the green turtles that nest on Poilão. Photos of affected turtles from other regions of the planet were distributed amongst fieldworkers.

In early August, 74 turtles were examined in great detail (mostly in broad daylight, using turtles that were stuck on the rocks at low tide). None of these turtles displayed typical fibropapilloma signs such as pedunculated structures or cauliflower shaped growths. There were no visible tumours around the eyes. In two cases, the examined turtle had a low, 4 cm sessile growth on the shoulder, in the shape of half a melon. Several had small scars or wrinkled patches on the shoulders, but none had the typical fibropapilloma look that was patent in the bibliographic sources. During August 2007, another 200 turtles (at a rate of 10 per night) were examined while they laid and none of them had fibropapilloma like structures (Catry *et al.* 2009). Hence, it seems safe to conclude that the prevalence of the disease in this adult population is extremely low. Such result is very encouraging, and indicates that these animals are living in a healthy and lightly polluted environment, not only in the nesting areas but also in their foraging grounds (*e.g.* Aguirre & Lutz 2004).

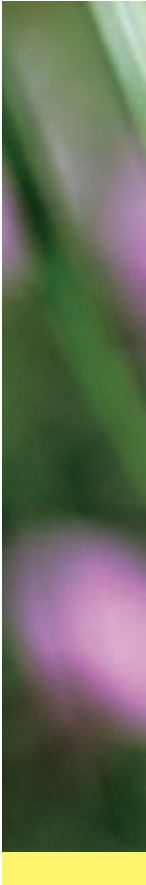
### Natural predators

With the exception of humans, adult green turtles have few predators. Medium sized individuals (immatures) may be attacked by large sharks, but such fish are unfortunately becoming rare and threatened on the West African coasts. The only information on this subject available for Guinea-Bissau concerns the predation of eggs and hatchlings.

In the Orango group, this aspect has been quantified, albeit in a relatively crude fashion. In 1993-94, predation over recent (few days old) clutches was shared by three predators of broadly similar importance: humans, ghost crabs *Ocypode cursor* and monitor lizards *Varanus niloticus*. On Poilão, egg predation seems to be relatively unimportant (see section on incubation success), but some nests are attacked by monitor lizards and by ghost crabs (Catry *et al.* 2002). There is some evidence that lizards and crabs may exert a greater predation pressure on nearby islands (Meio, Cavalos and João Vieira) and this issue deserves better study (Fortes 1995, Pires 1997). It is also relevant to mention that on Cavalos (and also at Imbone), where green turtle nesting is not negligible, feral pigs roam freely, and these animals are known as turtle nest predators in other regions. Despite the fact that there are no records of predation by pigs in Guinea-Bissau, this issue should be the object of a more detailed study.

On Poilão, it is often the case that eggs are unearthed by other turtles or by erosion caused by wave action. Once on the surface, the eggs become accessible to many predators and scavengers, namely a range of birds species that include palm-nut vultures *Gypohierax angolensis*, pied crows *Corvus albus*, turnstones *Arenaria interpres* and sanderlings *Calidris alba*.

It is interesting to note that predation rates by natural predators (lizards and





Monitor lizards often take eggs and turtle hatchlings. *J.F. Hellio & N. Van Ingen*

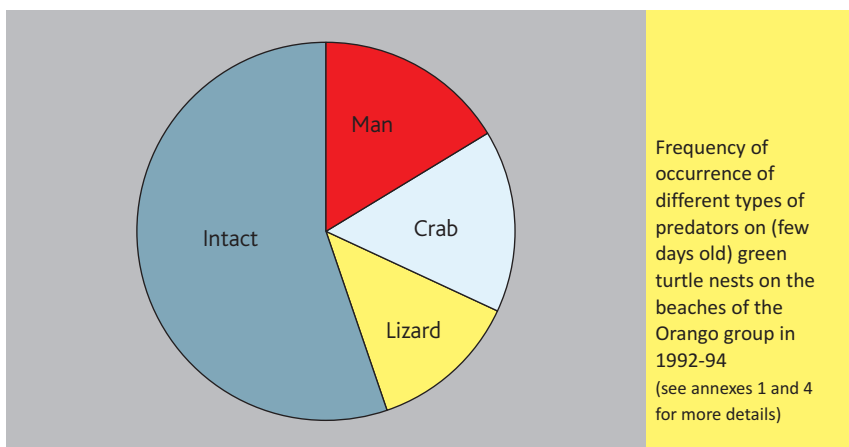
crabs) on Poilão (where they have recorded rates varying between 0 and 4%) seem to be much lower than in the Orango National Park (where they reach *ca* 30%). This may be explained by two factors. Firstly, the large density of clutches on Poilão may swamp predators that become rapidly satiated by an excess offer of eggs and end up having a small impact on the nest population. Secondly, and perhaps more importantly, there are often large numbers of eggs available at the beach surface on Poilão, due to the digging of new nests by the turtles themselves, which represent an important food source for the predators and scavengers that, as a result, do not need to excavate and find intact eggs inside nests.

Once they have left the nest, hatchlings face many potential predators. In Guinea-Bissau this aspect has only been studied on Poilão. While still ashore,

during the night, the little turtles can be taken and eaten by three different species of crab: ghost crabs *Ocypode cursor* (L.) work the open beaches, a crab from the family Grapsidae, *Goniopsis pelii* (Herklots, 1851), patrols mostly rocks and mangrove edges and finally, terrestrial crabs of the species *Cardisoma armatum* (Herklots, 1851), sometimes known as rainbow crabs, live in the forest and prey on hatchlings that move to the edge of wooded areas.

Some turtles dare to attempt crossing from the nest to the sea in broad daylight whilst others get stuck on rocky areas until after sunrise. These individuals are very exposed and can be easily preyed upon by several types of birds, such as pied crows, palm-nut vultures or grey herons *Ardea cinerea*. Once one group of hatchlings is found by the birds, few, if any, will escape being eaten. In fact, it is interesting to note that, during the months of peak hatching, many palm-nut vultures seem to move from other islands of the Bijagós onto Poilão. For example, during early August 2007, when hatching was just beginning, there were no more than 4 such vultures on Poilão; in November 2008, at peak hatching, the number of these birds amounted to 100-150.

When the young turtles reach the sea, their problems are by no means over. Birds can still catch them when they come to the surface to breath or while they swim just below the waves. Various species will prey on hatchlings in those circumstances, such as palm-nut vultures, African fish eagles *Haliaetus vocifer* and, above all, large terns such as the royal tern *Sterna maxima* or the Caspian tern *Sterna caspia*, which are common around Poilão. In fact, the terns may even capture hatchlings before they reach the sea, when crossing a sandy beach. The most important predation possibly takes place under the sea surface. In the





On Poilão, recently hatched green turtles are preyed upon by at least 3 different crab species.  
*G. Rosa*

Bijagós, predatory fish are still abundant and turtle mortality could be extremely high. Around Poilão, at certain times, most medium to large sized fish that have been sampled had one or more hatchlings in their gut. Fish such as snappers *Lujanus* spp., jacks *Caranx* spp. and catfishes *Arius* spp. are frequent predators, and other confirmed predators in this area include barracudas *Sphyræna* spp. and several species of sharks.



During peak hatching, most medium to large-sized fish captured around Poilão show remains of little turtles inside their gut. *G. Rosa*



Several bird species take turtle hatchlings, both on land and at sea. *G. Rosa & H. Monteiro*



The coastal areas of Guinea-Bissau are rich in predatory fishes that prey on the little hatchlings before they reach deeper waters. *G. Rosa*

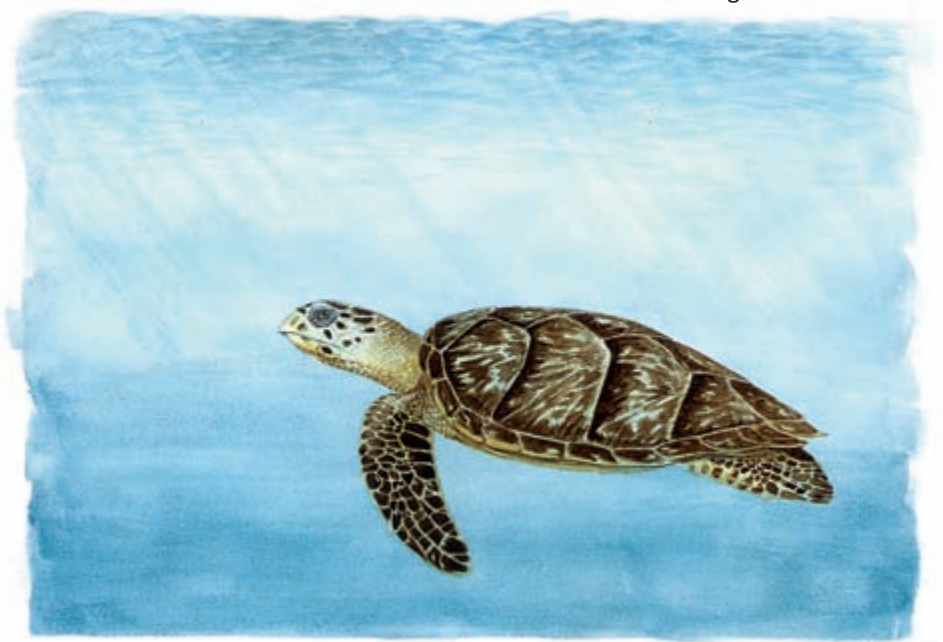


## Hawksbill turtle *Eretmochelys imbricata*

Bijagó: Djassaka

Creole: Tartaruga-burmedjo

Portuguese: Tartaruga-de-escama, Tartaruga-de-pente,  
Tartaruga-verdadeira



### Description and identification

This is a small to medium sized turtle, usually weighing 40 to 80 kg after reaching adulthood. Just like the green turtle, this species has 4 lateral scutes on the carapace, but can be easily identified because it displays 4 prefrontal scales and a protruding “beak”. Furthermore, most individuals have the posterior margin of the shell clearly serrated and dorsal scutes that partially overlap each other.

Contrary to green turtles, hawksbill hatchlings have a dark ventral face and normally do not exhibit a pale edge on the flippers.

The tracks of the present species normally have a width of 70-85 cm. They are lightly cut in the sand. Marks made by the forelimbs are asymmetric. The tail drag mark may be present or absent. Movements of this species on the beach are fast when compared to those of heavier turtles, such as greens.

### ■ General ecology

The hawksbill turtle has very specialized feeding habits, which are truly exceptional amongst vertebrates. It feeds mostly on sponges, although it is quite selective in its choices of sponge species. The contents of most sponges include materials that are aggressive for the guts of any would-be predator, but hawksbills seem to deal with those without any major problems. Other dietary items, some of which can become locally important, include sea cucumbers, sea squirts, bryozoans, anemones, jellyfish, molluscs and even marine plants.

Adult hawksbill turtles are, most of the time, rather sedentary, often living their day-to-day life in a small sector of a reef, where they find all the food they need. They occupy shallow areas and, once they reach a certain age, they seem to only use pelagic environments when commuting from feeding areas to the nesting beaches, to which they are highly faithful. Their migrations can be quite extensive. Interestingly, the monitoring of movements through satellite telemetry has shown that individuals can move hundreds or even thousands of kilometres to reach their chosen nesting beach, although equally suitable beaches (used by other individual hawksbills) can be found at a short distance from their feeding areas. The reasons for such seemingly unnecessary displacements are a mystery.



Contrary to green turtles, hawksbill hatchlings have dark underparts and no pale edges on the flippers.

*R. Rebelo*

## ■ Global status

This species has been classified as Critically Endangered (IUCN 2008), but its wide global distribution and the fact that some populations seem to be apparently stable have led some specialists to criticize the above-mentioned rating.

Historically, this species suffered from intense exploitation all around the globe, justified by the high value of the jewellery or other handicrafts made from its shell. Such exploitation has not yet ceased, but is nowadays considerably curtailed, thanks to the trade ban imposed by CITES. The present day hawksbill numbers are just a tiny fraction of what they must have once been. The most important populations nest in Australia (both on the Pacific and Indian Ocean coasts), in Indonesia, in the Seychelles and in the Caribbean (mostly in Mexico and Cuba).

## ■ Status in Guinea-Bissau

The hawksbill turtle seems to have a wide distribution in the marine waters of Guinea-Bissau and shells from this species can often be found in villages all along the coastal zone (*e.g.* Limoges & Robillard 1991c, Schwarz 2002, Barbosa & Indjai 2003, pers. obs.). Some of those shells are from turtles caught at sea, in fishing nets, whereas others were taken by capturing females while laying. It must be noted that some of these turtles found in shallow national waters may have originated in far away locations, as there are cases, for example, of individuals tagged in Brazil and recovered while foraging on the African coast (*e.g.* Bellini *et al.* 2000).

As a nesting species, the hawksbill seems to be rather scarce in Guinea-Bissau. In the survey carried out by Limoges & Robillard (1991c), from 11 to 27 August 1990, covering 118 km of beaches in the Bijagós (and all the nesting areas known to this day), 5 fresh tracks were found at Poilão and 2 at Adonga, which led to the belief that the population of Guinea-Bissau might be relatively important. However, further surveys did not confirm this initial idea. On Poilão, where surveys lasting several months were carried out in 1993, 1994, 2000, 2001, 2007 and 2008, hawksbills were rarely encountered and can only be said to be quite rare. In 2000, with surveys almost daily (on 85% of the nights) from 19 July to 14 December, no more than 4 turtles were seen ashore (which compares to 1400 green turtles tagged) and only 6 nests were found (Catry *et al.* 2002). In 2007, with a similar field effort, 7 individuals were seen and in 2008, between 18 August and 6 December, only 5. Of course, with their rapid movements, hawksbills do not remain ashore for long, which means that they can be quite easily overlooked amongst the large numbers of green turtles and their tracks. Nevertheless, it is hard to conceive that more than a few dozen clutches could be laid annually on Poilão.



Hawksbill turtle hatchling on Poilão. *G. Rosa*

In the Orango group, during the 1992-94 survey, 17 nests were located (of which 7 were fresh). From these counts an extrapolation was made (see methods in Annex 1) and it was estimated that 50 clutches had been laid in the first 12-month period and 15 in the second. Hence, the initial assessment suggesting that the species was numerous at Adonga (Limoges & Robillard 1991c) was not confirmed. It cannot be shown that this resulted from a relatively sharp population decline although it may be a plausible explanation given that the area saw intensive fishing activity in the 1980s and 1990s. Furthermore, hawksbill turtles often forage in the narrow channels and creeks amongst islands, where they can easily become trapped in fishing nets that are set to block the waterways. There are reports from local people stating that the shell of this species was often harvested in the Bijagós (Limoges & Robillard 1991c), which may suggest that hawksbills used to be more common.

Spotila (2004) offers a figure of 200 nesting females per year in Guinea-Bissau. The basis for this estimate is not given, but comes likely from the preliminary work of Limoges & Robillard (1991c). Knowing that each female may lay, on average, 2.74 clutches per nesting season (Miller 1997), the above estimate would imply a figure of 550 nests per year in Guinea-Bissau. Given the currently available data, as presented above, such an estimate seems too optimistic. On the basis of our own surveys and experience, we would guess-estimate that 50-200 nests are deposited per year. Needless to say, such

estimates need to be taken with precaution and may require revision when more data becomes available.

### **Ecology – data from Guinea-Bissau**

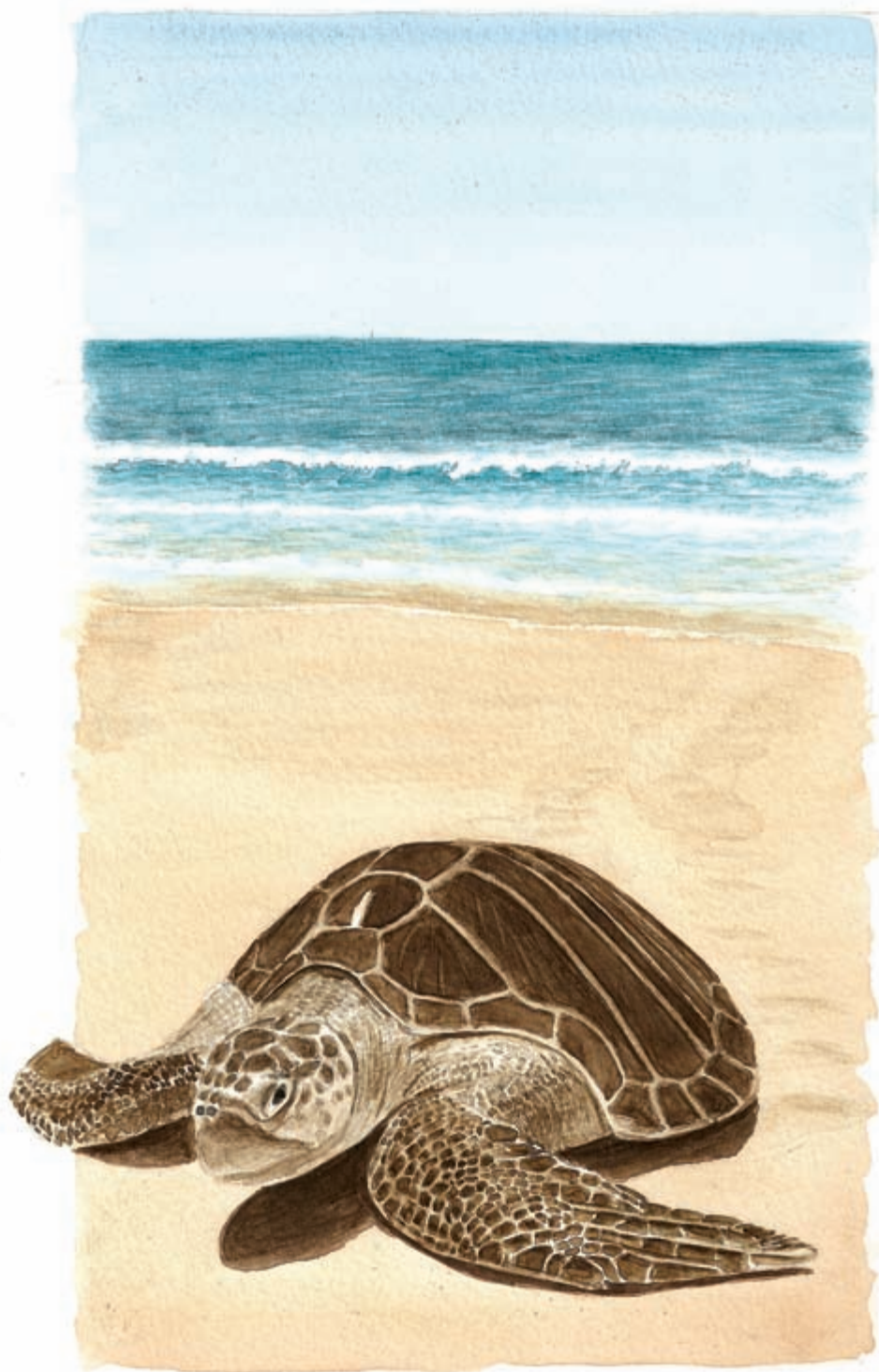
This turtle moves fast ashore, completing its nesting cycle quickly and even running from humans when encountered on a beach (when it is not laying). These traits make it slightly more difficult to gather biological data on this species than is the case for the green turtle, for example.

As happens with the greens, the main nesting season for hawksbill turtles in Guinea-Bissau is during the rainy season (from July to October), with a peak in August and September. However, we have confirmed records of nesting in January and March, in the middle of the dry season. In any case, more data on the nesting phenology of this species is needed and it should be noted that some past records of hawksbills nesting during the dry season may result from misidentified olive ridley turtles.

Biometrics of 3 females measured while nesting on Poilão (curved carapace length  $\times$  curved carapace width) were  $87 \times 77$ ,  $85 \times 77$  and  $81 \times 70$  cm. Ten clutches on the same island contained 147, 163, 142, 215, 152, 177, 56, 140, 194 and 171 eggs, with a mean  $\pm$  SD of  $155.7 \pm 42.4$ . This is a small sample, but the values fit well with the known reproductive parameters of this species at other sites and clearly show that clutch size is much larger than in the green turtle.

In many regions across their range, hawksbill turtles are generally known to choose laying sites where bushes or trees can provide some shade to the nests (e.g. Kamel & Mrosovsky 2006). We have no systematic data on nest site selection in Guinea-Bissau, but in the experience of the park guards and our own, hawksbills reproducing on Orango and on Poilão often nest close to the high tide mark (in open stretches of sand), even on beaches where the sand is backed by a row of tall vegetation a little further away from the sea. This aspect of the biology of this species should be the object of further study, particularly considering the importance of shading in determining incubation success and offspring sex-ratio.

As mentioned above, the hawksbill turtle appears to have a rather wide distribution in the coastal waters of Guinea-Bissau. Unlike other species, it can be often found in narrow channels and creeks within mangroves (Limoges & Robillard 1991c), where it may find sponges and other marine invertebrates that make up most of their diet. This choice of habitat may make these turtles particularly vulnerable to accidental capture in fishing nets that are placed across narrow waterways.



## Olive ridley turtle *Lepidochelys olivacea*

Bijagó: emvara

Creole: tartaruga-pikinino

Portuguese: tartaruga-olivácea, tartaruga-oliva,  
tartaruga-de-ridley

### Description and identification

The shell of this turtle is short and wide, and hence relatively round when compared to other species present in the region. The lateral scutes are often asymmetric, differing on the left and the right hand side. Their number is variable, ranging from 5 to 9 (in Guinea-Bissau, most turtles have 5 to 6 on each side). The shell has an olive green coloration, than can be lighter or darker in different individuals.

This is a small sea turtle, often weighing between 35 and 45 kg when adult. Its tracks are quite difficult to tell apart from the ones left by hawksbills. They are lightly cut in the sand, often with a width of 65 to 80 cm. The traces left by the forelimbs are asymmetric. The tail usually leaves no trace, and if it does, it is hardly visible.

### General ecology

This turtle and its close relative, the Kemp's ridley *Lepidochelys kempí*, are famous for their rather unusual reproductive behaviour. On some beaches, hundreds or even (many) thousands gather and nest simultaneously, in a spectacular phenomenon that is known as *arribada* in Central America. This term has been adopted by researchers and is now part of the technical jargon of sea turtle biologists. Interestingly, the underlying factors that lead to the *arribada* phenomenon are poorly known and, paradoxically, the hatching success of nests laid during *arribadas* is generally much lower than the one enjoyed by solitary nests. In any case, the *arribada* behaviour is rather localized (taking place mostly on the Pacific coast of Central America and in India). There are no known *arribadas* in Africa.

Tracking using satellite transmitters has revealed that, contrary to what was believed until recently, many olive ridley turtles retain the pelagic lifestyle of

young turtles throughout their lives. For example, in the Eastern Pacific, after laying, adult females move to the deep sea, generally following fronts or other oceanographic features where productivity is enhanced and where potential prey tend to accumulate. Other individual turtles remain above continental shelves and therefore have access to benthic resources during relatively deep dives.

The diet of olive ridleys in different habitats is still poorly known, but it includes many salps, jellyfish, molluscs, pelagic crabs and other invertebrates, plus eggs and juveniles from some fish species.

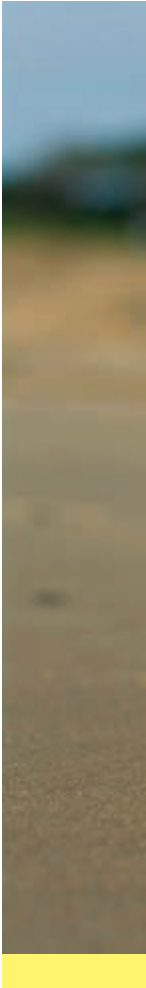
### ■ Global status

The olive ridley is probably the most numerous of the extant sea turtles and presents a wide distribution in the Atlantic, Indian and the Pacific oceans. Its global conservation status is Vulnerable (IUCN 2008), which reflects the fact that, despite being relatively abundant, it is suffering from important population declines driven by various causes, amongst which the most important may be the high mortality caused by accidental drowning when caught in diverse types of fishing gear. Furthermore, a large percentage of the global population gathers to reproduce at no more than half a dozen sites (particularly in Mexico, Costa Rica, Nicaragua and India), which increases its vulnerability. This is a truly tropical species that rarely penetrates into sub-tropical waters.

### ■ Status in Guinea-Bissau

The olive ridley may be the second most numerous marine turtle species in Guinea-Bissau, but we actually have little information on its distribution, which seems to be more localized than in other species. In reality, the only confirmed nesting areas are in the Orango National Park, namely on the islands of Orango Grande, Imbone, Adonga and Orangozinho. There are other beaches in the Bijagós that are similar to the ones of the Orango group, for example on Caravela and Unhocomo, and it is reasonable to expect that olive ridleys will also nest on those, at least occasionally, but this hypothesis needs to be investigated by carrying out surveys at those sites at the most appropriate time of the year.

In the main nesting areas of the Orango group, during the 24 months of the 1992-94 survey (see methods in Annex 1), 263 olive ridley turtle nests were found (40 fresh nests and 223 old nests) and it was estimated, from these values, that 620 were laid in the first 12 month period and 170 in the second (Catry *et al.* 2009). Knowing that each female may lay, on average, 2.2 clutches per nesting season, the above values would correspond to 280 females in the first year and 80 in the second. By far, the main nesting beach was on Adonga, with almost half of the nests that were recorded. Nevertheless, it must be noted that the surveys





Olive ridley turtle. *G. Feuillet / Kwata NGO*

were rather incomplete on some other beaches at the height of the nesting season, which implies that the importance of other sites may have been underestimated, as would have been underestimated the overall nesting numbers on the Orango group. It should also be noted that olive ridleys were present not only on the main beaches where the survey took place (Acapa-Orango, An-ôr, Ancopado, Imbone, Uíte), but also, to this day, on the beaches of Canero and Eticoga, although in small numbers. It is possible that the species is present on other beaches of the National Park, namely on the islands of Canogo and on the east coast of Orangozinho.

Limited surveys in 2008 and 2009 suggest that the nesting levels recorded in

1992-94 may still hold these days, despite the mortality that has been caused by fisheries and by harvest of females on the nesting beaches (*e.g.* Silva 2009). However, the available data is scarce and not sufficient to infer population trends or detect modest changes in numbers. It is also important to mention that the island of Adonga has been suffering from an important erosion process in recent years (after having benefited from a sedimentation process in the preceding decades) and that the main nesting area has been affected by those events.

## Ecology – data from Guinea-Bissau

### Habitat

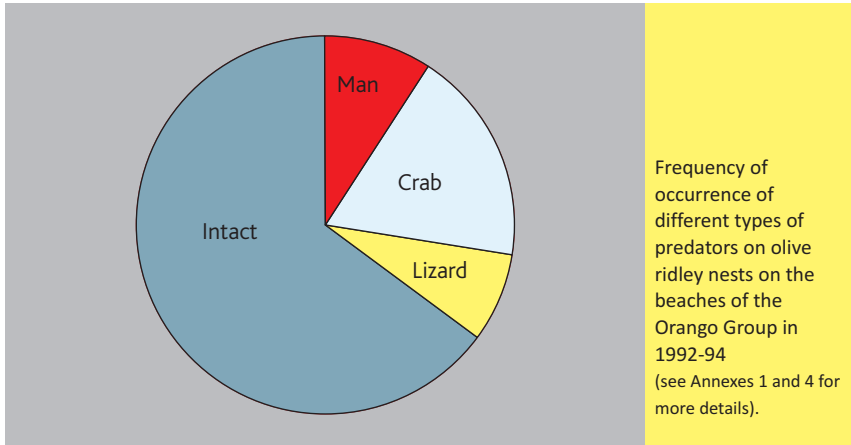
Adonga is a barrier island facing the open ocean, a favourite type of habitat for olive ridley turtles in many regions. On this island, nests can be dug on the open beach or under low bushes. Acapa-Orango, which is probably the second most important site at the national level, has a similar barrier structure and broad sand dunes. However, not all nesting sites are like this. Near Eticoga, for example, the beach is narrow, backed by bushes and trees, and the sea is shallow and with little wave action. This last area, however, is used by very few turtles.

It is interesting to mention that there is absolutely no data on the distribution of olive ridley turtles outside the nesting periods on Guinea-Bissau or in neighbouring countries. In fact, it is not known whether these turtles have a pelagic behaviour, as is the case with some populations, or if, on the contrary, they prefer to forage over shelf areas. This issue deserves a dedicated research program.

### Nesting and biometry

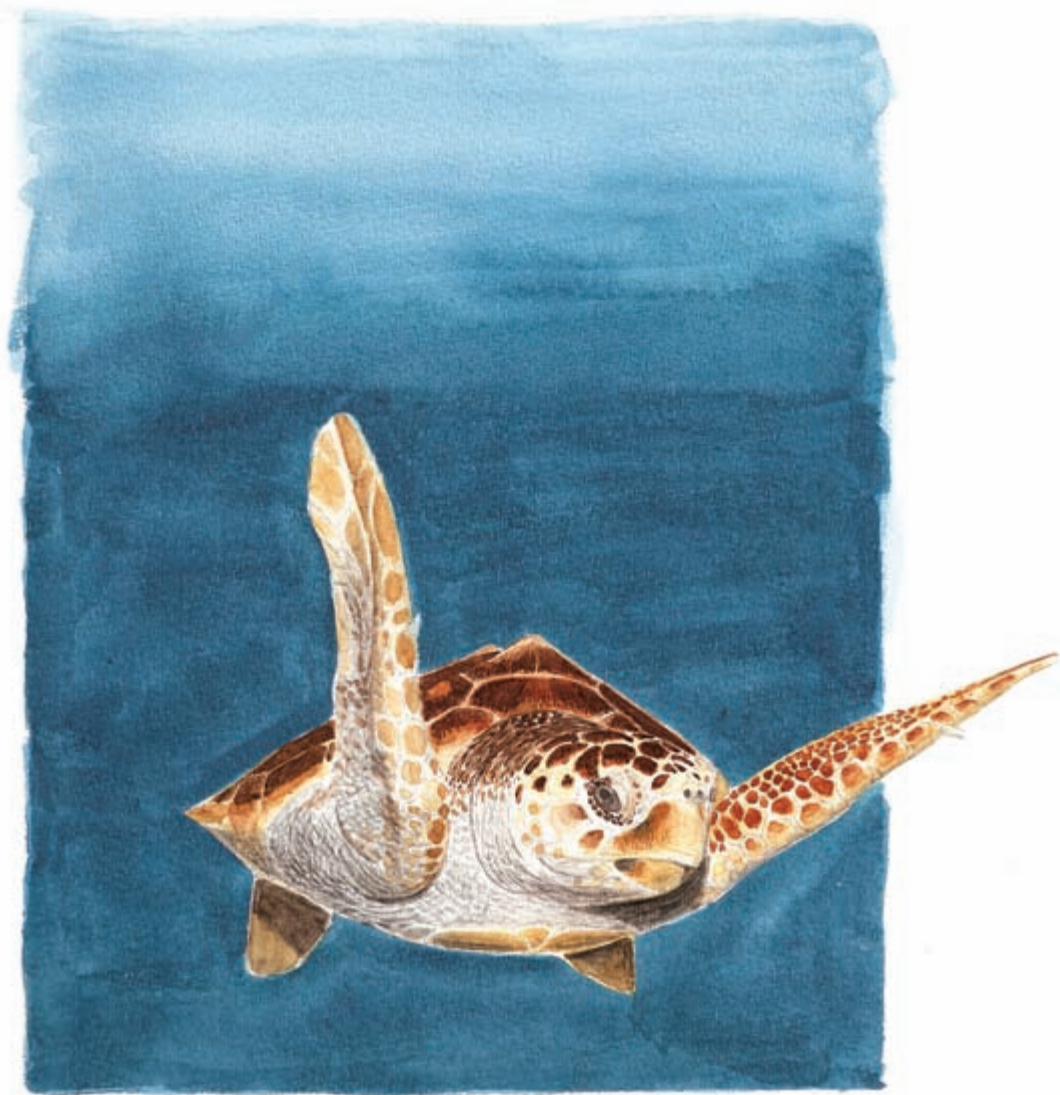
In Guinea-Bissau this is a sea turtle species that comes ashore mostly during the dry season (in this respect, its habits contrast markedly with the ones displayed by green and hawksbill turtles). There are records of nesting olive ridley turtles from October till July, but some of the reports from the rainy season (particularly those in July and October) may have resulted from misidentified tracks made by hawksbills. Nevertheless, there are confirmed records from each month, from December till May. Peak nesting takes place in January and February.

In 1993 and 1994, 24 olive ridley turtles were measured while laying on Adonga. The mean ( $\pm$  SD) curved carapace length was  $73.2 \pm 6.1$  cm (range 51-84 cm) and the width was  $71.3 \pm 6.6$  cm (47-84 cm). The number of eggs per clutch in seven study nests was 118, 130, 150, 109, 145, 128, 132, mean  $130.3 \pm 14.2$ .



### Predators

At least on Adonga, the main egg (and possibly also hatchling) predator seems to be the ghost crab *Ocypode cursor*, although monitor lizards can also inflict some losses. In 1992-94, from 142 recent clutches (between 24 hours and a few days old) on the Orango Group of islands, 13 (9%) had been harvested by humans, 26 (18%) predated by crabs, 11 (8%) by monitor lizards, and the remaining 92 (65%) were untouched on the day they were found by the monitoring teams. It must be stressed that some nests would still have suffered from predation after this date, particularly around hatching time, when the smell originating from the opening eggshells can attract predators with good olfactory capabilities, such as monitor lizards. It is also worth noting the low levels of human predation, which may have resulted from the efforts to raise awareness among local populations, which had some of their members involved in the monitoring efforts (each nearby village had one person directly involved in the surveys). As with green turtles, predation levels of hatchlings after entering the sea must be very high, but there is no actual data on this particular aspect.



## Loggerhead turtle *Caretta caretta*

Portuguese: tartaruga-cabeçuda, tartaruga-comum

### Description and identification

This is a medium sized turtle, carrying a large and heavy triangular shaped head. The weight of adults is very variable, differing (mainly) from one population to another, with most turtles weighing between 80 and 180 kg. The number of lateral scutes is five on each side, which distinguishes loggerheads from practically all other turtles. The general colour is a reddish brown with virtually no markings.

The female tracks made on the nesting beaches have a width of 70-90 cm and are well marked but not deep, as would be expected from a medium sized turtle. The prints from the forelimbs are asymmetrical and the tail usually does not leave any traces.

### General ecology

Adult loggerhead turtles are relatively sedentary animals during most of the year, remaining attached to a well defined sector of any particular continental shelf. These feeding areas may be used for years, with gaps resulting from the absence of the turtles when they migrate to the nesting beaches. Besides those site-faithful individuals, some loggerheads seem to have a different lifestyle, preferring to keep their juvenile pelagic habits, wandering around in the deep ocean while they look for food between nesting attempts. Other loggerheads have their foraging grounds in temperate areas, where the cold winter temperatures force them to move south, to warmer wintering grounds, from where they return in the following spring.

Young loggerheads feed on pelagic organisms, namely jellyfish, salps, crabs, isopods, amphipods, barnacles, molluscs, algae and even terrestrial insects that fall in the ocean after being transported over long distances by the wind. Adults are equipped with powerful jaws that are able to crush armoured prey such as crabs, clams or other molluscs from the sea floor, taking also anemones, corals, jellyfish, marine worms, fish (mostly from the seahorse family) and vegetable matter.

## ■ Global status

The loggerhead is globally classified as *Endangered* (IUCN 2008). As with most sea turtle species, it has a wide distribution over the three main oceans. More than any other species of the Cheloniidae family, this turtle ventures into subtropical areas, and it often is more numerous near the Tropic of Cancer or the Tropic of Capricorn than near the Equator. In West Africa, it nests in large numbers in the Cape Verde archipelago. The seas of this region are also visited by numerous immature individuals originating from the nesting areas of North America.

Some loggerhead turtle populations are declining rapidly and under serious threat (particularly those of the Pacific Ocean, with severe declines in Japan and Australia), while others have been recovering, for example in Florida and Carolina (United States of America).

## ■ Status in Guinea-Bissau

Even though the national status of this species is unclear, there can be no doubts that the loggerhead is, at best, a very rare breeder in Guinea-Bissau. During the 1980s, a carapace originating from the Bijagós was positively identified (Limoges 1989, see also Boesl 1995), but it is unclear whether this individual was nesting in the area or merely passing through or foraging. In 2003, during more detailed enquiries in Unhocomozinho, reports were obtained on the occasional nesting of loggerheads at this site. Local people described how they had recently noticed the nesting of a rare type of turtle and, when shown printed images, they identified the loggerhead as being the type they had seen. These people know several types of marine turtles well and claimed that this particular species had not been seen on Unhocomozinho for several years, even though they could remember it from a more distant past (Indjai *et al.* 2003b). According to the informants, there were at least 6 clutches laid between February and May 2003 (on 28 and 29 February and on 6 and 7 March, on the beach of Acante, and on 9 March and 9 May on Amubade and Etipem (Indjai *et al.* 2003a, b).

It must also be mentioned that research involving satellite tracking of loggerhead turtles nesting on the Cape Verde islands revealed that some individuals migrate past the coast of Guinea-Bissau, sometimes moving inside national waters (see Hawkes *et al.* 2006). Even though it has not yet been confirmed, it is not unlikely that some Cape Verde turtles have their main foraging areas over the Guinea-Bissau shelf, as happens off the coast of Guinea-Conakry and Sierra Leone (Hawkes *et al.* 2006).



Loggerhead turtle on a nesting beach of Cape Verde. Some turtles nesting in that region migrate through Guinea-Bissau waters on their way to foraging grounds along the African coast.  
*D. Cejudo*

### **Ecology – data from Guinea-Bissau**

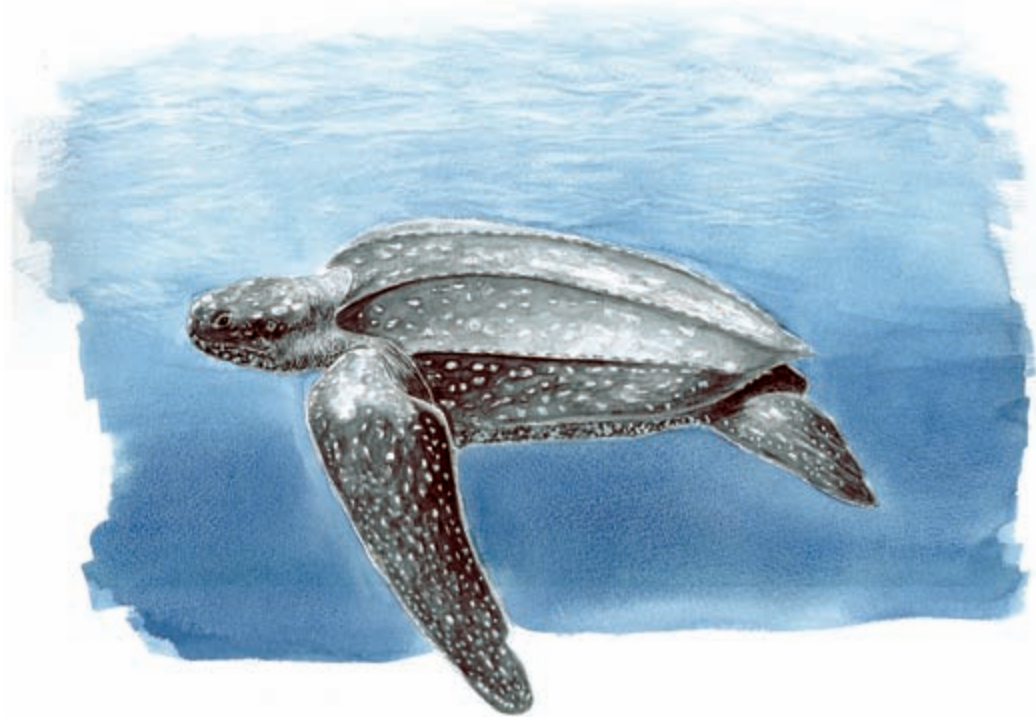
Assuming the verbal accounts from Unhocomozinho are accurate, it is possible that loggerheads on Guinea-Bissau preferably nest in the dry season. No other information is available on the ecology of this species in the country.

## Leatherback turtle *Dermochelys coriacea*

Bijagó: Djummeme

Creole: Tartaruga-gigante

Portuguese: Tartaruga-de-couro



### Description and identification

An adult leatherback turtle cannot be mistaken for any other animal. It is a true giant of the oceans. The largest individuals may weigh over 750 kg, with a carapace length of 180 cm. Even individuals of an average size usually weigh over 400 kg and have an overall length exceeding 2 meters.

It is not only its size, but also its particular morphology that make this species

easy to identify. The carapace does not display any scutes, but is covered by a leathery skin (which gave rise to the species name) with seven longitudinal ridges. It has a dark colour, almost black, with a variable number of paler spots on the head and neck, which may acquire a pinkish tone during laying. Most of these features are obvious in hatchlings too.

The tracks left by this species while ashore are very wide (150 to 230 cm) and deeply cut into the sand. The forelimbs are marked symmetrically and it is usually possible to see a central line that results from the tail dragging on the beach surface.

### **General ecology**

Leatherbacks are quite unusual not only regarding their looks, but also in their habits and ecology. When they are not nesting, all leatherbacks are fully pelagic in their habits, irrespective of their origin, age and maturation. The growth of these animals is relatively rapid, in comparison to other sea turtles. Adults nest on wide tropical beaches, facing the open ocean, usually in areas exposed to considerable wave action. Another unusual trait for a sea turtle shown by most females is the low fidelity to nesting areas, which may result in fast and considerable fluctuations in nesting numbers at a particular site as a response to environmental change (beach erosion, etc.).

Thanks to the development of satellite tracking technologies and the monitoring of movements of post-nesting females, there is a reasonable amount of knowledge on the migratory and foraging behaviour of adult leatherbacks. Both in the Atlantic and the Pacific, leatherbacks make migrations of thousands of kilometres that take them across ocean basins, and from tropical seas to the edge of Arctic regions, near Iceland for example. Their large body size allows them to keep a core temperature far above that of the surrounding water, even if they cannot be classified as truly homoeothermic animals. The diet of this species is mostly made up of pelagic gelatinous prey, such as jellyfish and comb jellies that are ingested in enormous quantities.

Despite the fact that leatherbacks turtles spend almost all the time travelling, feeding and resting on the ocean surface (generally not going beyond 100m depth), they occasionally make deep dives which can be as deep as 1000m below the sea surface (with maximum recorded values around 1250m). Such deep dives take the turtles to a chilling and dark world, where they presumably make assessments of the abundance of potential prey in a certain region, given that many gelatinous animals keep to deep waters during the day and only come to the surface under the cover of darkness.

## Global status

The leatherback turtle is classified as globally *Critically Endangered* (IUCN 2008). However, the populations from the Pacific and Atlantic oceans are suffering from quite different fates. While the first group has gone through a catastrophic decline over the last few decades and faces a truly imminent danger of extinction, the Atlantic leatherbacks seem to be in a much better situation, with some important nesting populations showing an apparent stability in numbers. The main threat to this species is linked to accidental mortality in fishing gear, particularly in longlines.

On the Atlantic coast of Africa, leatherback turtles have a wide distribution, with nesting records reported along the entire coast from Mauritania to Angola. However, the centre of its nesting distribution in West Africa is in Ghana and Ivory Coast (Turtle Expert Working Group 2007), with nesting beaches on Guinea-Bissau and neighbouring countries being clearly rather minor. The main nesting sites in Africa are located further south, in Equatorial Guinea and Gabon.

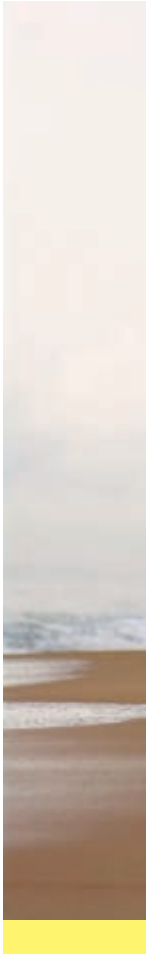
## Status in Guinea-Bissau

Being easy to identify and, by its size, a most impressive animal, the leatherback turtle is easily recognized by local people and fishermen, which tend to recall any individuals seen (or their tracks) and report them when enquired about such events. In fact, a sighting of a leatherback turtle is often the subject of conversation. As such, it is not difficult to obtain isolated records of these turtles, with reports coming from all over the coastal zone. This does not mean, however, that the species is common.

There have been records of nesting leatherbacks on Varela (northern mainland coast) and on the islands of Unhocomo, Orango Grande, Adonga, Orangozinho, Canhabaque and João Vieira (*e.g.* Limoges & Robilard 1991c, Barbosa *et al.* 1998, Dontaine *et al.* 2001, Schwarz 2002, Catry *et al.* 2009). It is highly likely that the species occurs on other islands where there have been fewer surveys and enquiries.

According to local people, on the beach of Copecabo (Unhocomo) one or two clutches are laid per year (Indjai *et al.* 2003b). In the Orango National Park, nesting occurs annually too, with a larger number of nests on the beaches of Adonga, Uíte and An-ôr. During the surveys carried out in 1992-94, ten sets of tracks and associated nests were seen on the Orango Group (five of which were from the previous night). From these observations, it was estimated that there could have been 31 nests in the first study year and 47 in the second, most of which were on Adonga (Catry *et al.* 2009). In more recent years there were no systematic surveys, but it is clear that the species still nests in the area (*e.g.* Indjai 2008).

Considering the above mentioned reports and sources, plus occasional enquiries made on several areas of the coastal zone, we can guess-estimate that





Leatherback turtle. *G. Feuillet / Kwata NGO*

nesting numbers in Guinea-Bissau must be of the order of some 25 to 75 nests per year.

### **Ecology – data from Guinea-Bissau**

The few data obtained for this species in Guinea-Bissau indicate that leatherbacks choose mostly to nest on long and wide sandy beaches facing open waters with considerable wave action. This agrees well with what is known from other regions of the planet. It is interesting to note the absence of this species from Poilão, an islet that has been the object of intensive surveys throughout several years and where leatherbacks could not go unnoticed if they nested

there. It seems reasonable to conclude that the reefs that surround Poilão, plus the reduced size of its sandy beaches, are enough to discourage any potential nesting females.

The systematic surveys of 1992-94 on the Orango Group indicate that this species nests from November to February. Reports from the local population point to a nesting season from February to April on Unhocomo (Indjai *et al.* 2003b). There is also a record from June, in the Varela region. Combining all the available information, we may provisionally conclude that, in Guinea-Bissau, this species is seen ashore mostly during the dry season, possibly with a peak at the season's height, in January.

## Use of turtles by local human communities

All around the globe, humans have used marine turtles over the past several millennia, and West Africa is definitely no exception. Where there are accessible nesting places, the meat and eggs of turtles are easy to gather, even by people who have no specialized tools and who are not in command of particular harvesting techniques. Since the first visits, in the 15<sup>th</sup> Century, navigators and chroniclers (such as Cadamosto or Valentim Fernandes) described the harvest and consumption of turtles in West Africa, which was regularly undertaken both by local populations and by the European visitors (Ferronha *et al.* 1993, Diallo & Soumaré 2007).

Even the most remote islets of the Bijagós have been visited by humans in the distant past and turtles must have surely been consumed in those days. The islands of the João Vieira Marine National Park, for example, were already mentioned by André Alvares de Almada (*in* Lima 1947) in 1594, with João Vieira, Meio, Cavalos and Palão (Poilão) being specifically mentioned. In 1664, Friar André de Faro anchored at Meio and reported that the site was generally uninhabited but that, periodically, Bijagós people went there to harvest palm wine and nuts (Lima 1947). According to Lima, such practices were still common in the mid 20<sup>th</sup> Century (as indeed they are today). It can only be deduced that, during those regular visits, the abundant turtles nesting there would be used as



Traditional canoe used in the Bijagós.

*L. G. d'Escrienne*

food, as there are no known taboos or other factors that would make this implausible. Without proving anything, the above mentioned facts and reports suggest that the Bijagós people must have exploited marine turtle resources since remote times and throughout the entire archipelago.

Nowadays, the consumption of turtle meat and eggs is common practice amongst coastal communities with direct access to this resource. In general, there are no taboos or codes of conduct that may prevent such habits. Nevertheless, in the Varela region, we have heard testimonies that the ingestion of leatherback turtle meat or eggs is forbidden amongst the members of the Felupe ethnic group and also amongst some Balantas (such prohibition might extend to green turtles). Despite this, human predation over nesting females and eggs is frequent on the north coast, as happens in most places of Guinea-Bissau.

Enquiries about the habits and rules governing sea turtle use in the Bijagós resulted in many contradictory testimonies. Despite the fact that there are some records of turtles occupying an important position in the mystical and ritual universe of the Bijagós (*e.g.* Bernatets 2005) the truth is that sea turtles do not seem to have an importance comparable to other animals in the imagination of the islands' peoples. Even on Canhabaque, where the social structure and the traditions of the Bijagós are particularly well preserved (*e.g.* Henry 1994) sea turtles can be taken and consumed in a free and independent fashion by any member of the community. Unlike other animals, such as hippopotamuses, ox, sawfishes or hammer sharks, often featuring on traditional masks or wall paintings (*e.g.* Duquette 1983), turtles do not seem to play a role in the art or symbolic representations of these people.

In the Bijagós, sea turtles are often used in religious and social ceremonies (Bernatets 2005). During visits to Poilão, for example, a few turtles are always ritually sacrificed. On other islands, young men search and capture turtles to the same end. Still, despite the role played by the turtles in those ceremonies, they are not sacred or protected by traditional rules. The possible exception are the leatherbacks, for which testimonies have been obtained (in the Orango group and in Canhabaque, for example) that indicate that these turtles can only be captured by those, or in circumstances, that fulfill a certain number of prerequisites. For example, on Orango leatherbacks can only be captured by men who have already gone through the “fanado” (initiation ritual) and, after the killing takes place, it is advisable to engage in a ritual ceremony that will dissipate any potential negative consequences. According to the opinion of other Orango residents, the capture of leatherbacks is strictly forbidden by traditional laws and anyone breaking this rule should be punished (*e.g.* Limoges & Robillard 1991c).

The consumption of sea turtles in the Bijagós is deeply linked with the annual agricultural and harvest cycle. During the rains, when rice is planted, the harvest



The Bijagós people maintain several ancient traditions and marine turtles are sometimes used in ceremonies of important religious or social significance. *P. Campredon*

from the previous year often has been fully used and consequently there is a period of hunger. This period coincides with the peak green turtle nesting season, which means that turtles and their eggs are regularly sought after.

Turtles are also used in the practices of “paga-grandessa”, in which youngsters make gifts to the elder ones. These gifts play a central role in the social conventions and setup of the islanders.

Turtle clutches are searched for by following the tracks of females and using the “canhaco” (Bijagó spear) to prospect the nesting area. The eggs are boiled and the yellow is eaten, while the white is often thrown away (Limoges & Robillard 1993c). All local species of marine turtle can be consumed, even hawksbills. In other regions of the world, the meat of this last species often contains toxic compounds, but apparently not in Guinea-Bissau. Such variation may result from differences in diet composition in various parts of the range of hawksbills.

The Bijagós people are not known to have a tradition of hunting turtles at sea. Usually, the turtles they consume are captured ashore, during laying. In the old days, turtles (as well as manatees) were sometimes captured in fish traps called “gamboas”, which consisted of semi-circular stone walls built in the intertidal area (Limoges & Robillard 1991c). More recently, with the availability of nylon monofilament nets, it is easy to block creeks in the mangrove or to surround rocky reef heads to capture fish and, occasionally, also turtles. However, the only

fishery that we know off specifically targeting turtles takes place on the remote Unhocomo and Unhocomozinho islands.

In several West African countries, various ethnic groups believe that different parts of a marine turtle's body have curative properties or can be used for medicinal purposes (Fretey *et al.* 2007). There is little evidence that this type of use is frequent or widespread in Guinea-Bissau, even though we have collected some interesting reports. On Orango Grande, for example, we have been told that the consumption of fresh turtle blood will alleviate coughing, even if this treatment is not often used. Bernatets (2005) collected information on various uses of turtle body parts for medicinal purposes on Canhabaque: the penis may be consumed, after being specially prepared, to cure impotence or infertility; substances can be extracted from the slender bones of the posterior flipper which can help improve the walking ability of children; the shell can be used as a splint to help in healing a sprain or a fracture; it is also believed that if eaten in large quantities, turtle meat or eggs can have a purifying action (laxative). This does not mean, however, that such uses are common, as we found Canhabaque residents who largely ignored such potential uses for turtle parts and products. The uses of turtle parts are not restricted to the medicinal realm. On Orango Grande, for example, if someone owns a plot of agricultural land (such as a plantation of cashew trees) with low productivity, he can resort to the magic powers of turtles, perform a small ceremony and hang some turtle bones on the area in question, which reportedly results in increased yields.

The shells of green and hawksbill turtles are often used as containers for the most varied purposes, namely for the processing of palm-oil. It is possible to find carapaces in virtually any Bijagós village, as well as in many settlements along the mainland coast, as happens, for example, around Varela. Even if they can be useful, many shells are just left to rot on the beach after the turtle has been stripped, which means that they are not much sought after. The shells of hawksbills (tortoiseshell) are greatly used around the globe for the manufacture of jewels, combs or other objects. In Guinea-Bissau, this type of use seems to occur only sporadically.

# Threats and conservation

In the past few centuries, it is estimated that marine turtle populations all over the planet suffered from a massive decline (King 1995, Spotila 2004, Jackson *et al.* 2001) and in many cases important populations may have been reduced to a tiny percentage (<5%) of their initial numbers (*e.g.* Jackson *et al.* 2001). Many populations, maybe the majority, are still declining, even if there are encouraging trends for some species at some sites (Hays 2004, Broderick *et al.* 2006 Chaloupka *et al.* 2008).

In Guinea-Bissau, the data collected to date are, as yet, insufficient to allow us to infer anything precise on population trends. Monitoring studies are quite recent and their implementation has not been without oversights. Furthermore, nesting numbers (which is the only population variable being monitored) present a high inter-annual variability at any site (Broderick *et al.* 2001), which means that long-term monitoring is required until one can show a statistically significant demographic trend. Despite the paucity of hard data, the testimony of local people of the Bijagós archipelago is quite clear. Everyone agrees that there have been important declines in turtle numbers during a period equivalent to one or two human generations. Elderly people, or even middle-aged ones, can recall times when turtles were more abundant. Frequent reports concern beaches where nesting turtles used to be common and where today they are very rare, virtually absent. Other informants have told us how declines have mostly affected certain turtle species (particularly olive ridleys). Reports such as these can be obtained all over the Bijagós, in places as diverse as Canhabaque, Bubaque, Orango or Unhocomo. In some cases, the locals recognize that the frequent capture of nesting females and the harvest of eggs may have contributed to the general population decline (for example, in the Unhocomo group, Indjai 2003). However, in most situations it is the development of commercial fisheries that is blamed. In any case, no one could reasonably question the fact that there has been a (maybe pronounced) reduction in turtle numbers in the Bijagós in the past few decades. The exception to this general trend may be the nesting population at Poilão.

In the present chapter, we start by providing an overview of threats to marine turtles, at a global and at a national Guinea-Bissau level, and then discuss

conservation initiatives already implemented in this country, as well as the most pressing needs for future action.

## ■ Main threats to marine turtles

### Harvest of eggs and poaching of laying females

Historically, the harvest of eggs and of laying females has represented the most important driver of the collapse of sea turtle populations around the world, and probably still ranks as one of the most important threats in some regions. There are several known cases where nesting beaches that used to see thousands of turtles nesting each year ended up empty due to the systematic capture of nesting females. The same has happened at sites where only eggs were taken (*e.g.* Tomillo *et al.* 2008), even if this type of use is known to cause a slower population decline than the harvesting of females. On most sites, harvest takes place with the aim of eating or selling the eggs and meat, but there are regions where turtles (mostly hawksbills) are killed with the primary aim of taking the carapace for the manufacture of jewels or other handicrafts.

In Guinea-Bissau, the harvest of eggs and adults during laying takes place virtually everywhere and it is plausible that a significant part of all the turtles that attempt to nest in any particular year end up being killed. Given the general difficulty, for most coastal people, of incorporating animal protein in their diet, and the weak enforcement of national laws protecting sea turtles, it is likely that most turtles met with are taken. Of course, remote beaches are usually not intensively patrolled during the night by would-be poachers, which allows many turtles to escape unharmed at the end of a nesting season.

In the year 2007, for example, at the southern part of the Orango National Park (mostly in the area of the village of Ancopado), at least 374 green turtle carapaces were detected on beaches, temporary camps and permanent settlements (from Indjai 2008 and Silva 2008). Almost all these turtles had been killed recently. Such high harvest rates resulted from a combination of two main factors: (1) many people had gathered for agricultural work in this area during the peak nesting season and (2) 2007 saw exceptional numbers of green turtles nesting in Guinea-Bissau, which is part of the natural inter-annual variation in nesting numbers displayed by this species. Even though we do not have a precise idea of the number of turtles present in this park, it is likely that many of the turtles that attempted to nest near Ancopado in that year were actually killed, given that the number of green turtles nesting annually on Orango (in normal years) is believed to be just a few hundred (Barbosa *et al.* 1998). All the available information suggests that such level of exploitation is unsustainable.

The harvest levels of adult females (numbers taken in relation to the number





Young Bijagó man stripping a sea turtle on the island of Meio, João Vieira  
– Poilão Marine National Park. *H. Monteiro*

attempting to lay each year) in other parts of the country are likely to be as high as on Orango, which represents a daunting reality. Nevertheless, it is possible that turtles that nest in the dry season (particularly olive-ridley turtles) suffer from less persecution, because they come ashore at a time of the year when rice is plenty, which contrasts with the situation in August and September, when most greens lay.

To the above-mentioned source of mortality, one needs to add the poaching of eggs, which locally may represent another significant pressure on the

populations. In 1993-94, from a total of 446 turtle nests located in the main nesting beaches of the Orango group (these nests were more than 24 hours old but less than a few days old), 15% had been predated by people (compared to 16% for crabs and 11% for monitor lizards). This level of exploitation is not particularly intense, which probably results from the fact that most Orango nesting beaches are remote and little used by humans. It should be noted, however, that this predation is for rather fresh nests and some nests could still have been taken a few days later. In other Guinea-Bissau beaches, with more frequent human presence, the removal of eggs is likely to be more important.

The exception to the general picture of a relatively intense harvest of turtles may be found on a few uninhabited islets, where human presence is sporadic, resulting in greater safety for nesting turtles. This is, of course, the case of Poilão, and to a lesser extent it also applies to Cabras, Meio or Cavalos. Adonga, which after Poilão is the most important known sea turtle nesting site in the country, is not as safe as it used to be. The islet has no permanent settlements, but the fact that it lies close to other larger islands allows frequent visits, such as the ones made by the people from Uíte (Orangozinho). In recent years, Adonga has even started to be used for rice cultivation and cashew nut tree plantations, which implies a greater presence of people and increased risks for the turtles. This is all the more worrying because this is the main site for olive ridleys in the country.

The meat and eggs of harvested turtles are, as far as we know, only meant for local consumption. Unlike what often happens in other West African countries, turtle products hardly ever seem to reach the markets. This is certainly the case for Bubaque or Bissau, for example, but a more detailed study should be conducted at other markets. We have heard vague rumours about people from Sierra Leone coming to Poilão and taking turtles to sell in their home country, but this lacks confirmation (see also, on the issue of harvest and transport of turtles to sell abroad, the section on artisanal fisheries).

In summary, even if it is a traditional activity of almost exclusively poor local people trying to bring some further animal protein into their diet, the harvest of sea turtles represents a significant threat to the conservation of these species. In Guinea-Bissau, the impact of this harvest is worsening, as other threats make turtle populations more fragile and as human density (of both locals and migrant fishermen) increases. The simple observation that, nowadays, marine turtles only nest in good numbers on remote beaches is strong evidence that they cannot cope with the human-related predation pressure that takes place in other areas. Testimonies of significant local declines near settled areas are further circumstantial evidence. Sea turtles are strongly philopatric, which means that local losses are hardly ever compensated through immigration from other sites.



Semi-permanent settlement of foreign fishermen in the Bijagós archipelago. In present days, most of the fishing effort in the coastal waters of Guinea-Bissau is accomplished by fishermen originating from neighbouring countries. *J.F. Hellio & N. Van Ingen*

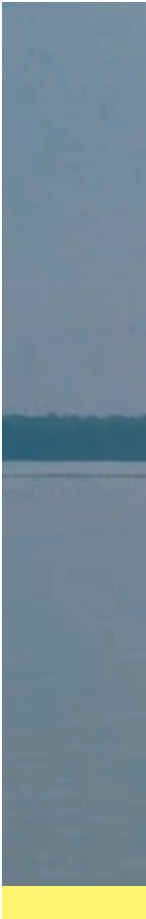
### Captures by artisanal fisheries

The capture of marine turtles in artisanal fisheries is a global phenomenon, but there are virtually no estimates of its impact on turtle populations. In some regions and in certain periods, fishermen can even direct their fishing effort towards these marine reptiles. This is a particularly serious scenario, when fishermen convert themselves into turtle hunters. Fortunately, in Guinea-Bissau there seems to be little directed catch effort (see more below).'

In national waters, sea turtles are regularly captured in large nylon nets deployed in inshore waters with the view to catch predatory fish such as sharks, rays, barracudas, jacks, snappers, etc. In Guinea-Bissau, this type of fishing is mostly carried out by foreign fishermen (mostly from Senegal, but also from Guinea-Conakry, Sierra Leone, etc.) but also, although on a smaller scale, by nationals, often in association with foreigners. The turtles may drown while entangled in the nets or, if captured alive, may either be killed and eaten or mutilated before being released. There are no quantitative data on the importance of this type of mortality, but it is almost certainly very important. In fact, talking to fishermen one learns that the capture of turtles is not unusual and that a large canoe may catch several turtles per day in certain periods and locations.

People from villages situated near important nesting grounds in the Orango National Park reported that, over the past couple of decades, many turtles were captured by foreign fishermen with a consequent decline in nesting numbers (particularly of olive ridleys, and maybe also hawksbills, which went from abundant to scarce). According to the same testimonies, green turtles are less often captured in nets and their populations did not decline so markedly, despite frequent capture of nesting individuals. Unlike the harvest on the nesting beaches, which only affects adult females, captures in nets also involve adult males and sub-adults of both sexes.

The only confirmed regular turtle harvest taking place at sea in Guinea-Bissau occurs around the islands of Unhocomo and Unhocomozinho. Here, fishermen use a recently developed local technique that enables them to efficiently capture young green turtles in feeding areas (see the chapter dedicated to this species). The fishery uses nylon nets and small canoes. The harvest level is unknown, but knowing that the turtles are easily captured and that people from these islands suffer from a great shortage of resources, it is likely that considerable numbers are taken. In 2002, for example, 59 carapaces were seen in the village of Equinar (Unhocomozinho) and 51 in the villages of Anaburo and Egara (Unhocomo). Fortunately, this type of fishing seems to be rare or entirely absent from other areas of the Bijagós as, should it be more widespread, it might have a serious impact.





Fishing canoe in a channel between islands of the Bijagós archipelago. *L. G. d'Escrienne*

Reports have been obtained of turtles being exported by foreign fishermen. In 2002, for example, girls from Unhocomo told us that they saw 15 live juvenile turtles on a Nhominca (Senegalese) fishermen canoe that were meant to be sold in Senegal (at Cap Skrin) (Indjai *et al.* 2003a). In Southern Senegal (at Joal-Fadiouth, in the Saloum delta), fishermen told us that when fishing is poor they target sea turtles that they sell to their fellow countrymen. It is plausible that some of these fishermen engage in turtle hunting on the Guinea-Bissau side of the border, given the almost absent control by national authorities of fishing activities.

In summary, it is very difficult to evaluate the seriousness of the threat posed by marine turtle captures by artisanal fishermen, but there is a strong suggestion

that the impact may be significant upon species such as olive ridleys, possibly for others too. Furthermore, the pressure exerted by traditional fisheries probably became more severe in recent years, given that the number of national and foreign fishermen working in Guinea-Bissau waters has been visibly increasing.

### **Bycatch by the industrial fishing fleet**

Industrial fishing vessels, including trawlers and longliners, pose a significant threat to marine turtles all over their global distribution, maybe representing the single most significant threat for several species and populations (*e.g.* Hays *et al.* 2003, Lewison & Crowder 2007). Longlines may be the main mortality factor for leatherback turtles, for example, a species that is in critical danger of extinction in the Pacific Ocean (Spotila *et al.* 2000).

In the offshore waters under Guinea-Bissau's jurisdiction, many trawlers operate, coming from countries as diverse as China, Spain, France, Italy and Portugal. There are no national regulations concerning the obligatory use of mitigation measures, such as turtle excluder devices (TEDs) and, in any case, many vessels operate illegally and would not obey any wildlife conservation regulations. In a preliminary study (R. Shutton, unpubl. data) it was suggested that between 500 and 1000 marine turtles could be accidentally caught annually in Guinea-Bissau by the trawling fishing fleet (Limoges & Robillard 1991), but we have no information on the methods used or on the confidence levels that are associated to this estimate. A later tentative evaluation, based on no more than a dozen questionnaires to fisheries observers in Bissau (combined with official data on the number of fishing licenses), pointed to an annual capture of the order of 300 turtles, of which some could still be released alive (Broderick & Catry 1998).

Needless to say, Guinea-Bissau turtles are still at risk when they move beyond national waters. They can fall victim to fisheries in international waters or in national waters of neighbouring countries where these types of threats are as important and pervasive as in Guinea-Bissau. Offshore Mauritania, for example, industrial trawling targeting small pelagic fish results in a bycatch of some dozens of marine turtles (greens, hawksbills and leatherbacks) per year (Zeeberg *et al.* 2006).

To conclude, the actual impact of industrial fisheries, nationally and abroad, for Guinea-Bissau turtles is very hard to evaluate, even in simple qualitative terms.

### **Pollution and disease**

Marine turtles may be affected by various different types of pollutants. Pollution by oil products is a known problem. Tar pellets may be swallowed by young turtles during their pelagic stage and end up blocking the digestive system or causing severe intoxication. Oil may also be ingested or may completely cover any individual that happens to be touched by a black tide. Nesting beaches may



Nets and other plastic material left or thrown in the sea represent a form of pollution that may impact turtles of all ages and sizes. In this case, the little hatchling was saved by personnel working in the João Vieira – Poilão Marine National Park. *G. Rosa*

also be severely affected by this type of problem.

Pollution by plastic bags, nets and a huge variety of other synthetic materials is also problematic, as turtles may ingest such material or become accidentally entangled, without being able to free themselves. Mortality levels caused by these pollutants are unknown, but they are most likely important.

Even if pollution levels in Guinea-Bissau waters are low, turtles originating from national beaches will surely meet some of the above-mentioned threats during their wandering pelagic lives in international waters.

As discussed in the section regarding the green turtle, fibropapilloma is a disease that has markedly expanded and increased its prevalence in the last few decades. Turtles with this disease develop external and internal tumours that may lead to their demise. In some populations, a large percentage of the adult turtles may suffer from this disease and it is feared that this may have a severe impact on the dynamics of the most affected populations. The recent increase of this condition and other evidence suggest that fibropapilloma affects mostly turtles that live in polluted environments. Fortunately, marine pollution is not, as yet, a serious problem in Guinea-Bissau or elsewhere in West Africa (particularly

Mauritania) where turtles migrate to. Despite the existence of known cases of turtles showing obvious fibropapilloma symptoms in Guinea-Bissau, the prevalence of the disease in the country seems to be extremely low.

### **Disturbance and deterioration of nesting beaches**

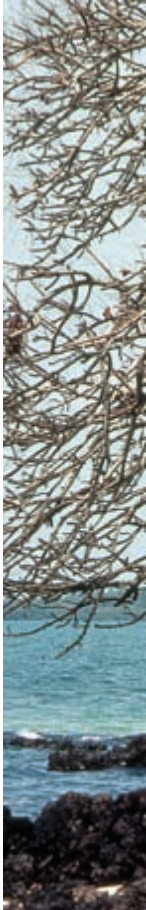
Across the global distribution of marine turtles, there are several factors that affect the quality of beaches as sites where nesting can successfully take place. In some regions, disturbance of nesting beaches through the presence of people or by public illumination may cause disorientation and death of hatchlings and, occasionally, even adult females. The main problem is the attraction of hatchlings to light, which often drives the little turtles away from the sea, leaving them susceptible to predators, exhaustion or other dangers. Presently, there are no identified sites in Guinea-Bissau where these type of problems may have any significant impact on nesting turtles.

At other sites and regions, there are threats resulting from sand extraction for building (for example, in Cape Verde some beaches were almost completely destroyed by this type of exploitation) or other works such as beach nourishing with different types of sand that may have less favourable properties for digging and for incubation or from the destruction of the vegetation that backs the beaches and that normally may provide shade for incubating clutches. This last aspect is important, as overheating may compromise clutch viability or result in an excess production of female hatchlings (see section dealing with climate change).

In Guinea-Bissau, the above-mentioned factors are, for the time being, almost irrelevant. The only significant habitat destruction results from the natural erosion of beaches due to currents and wave action. The important islet of Adonga, for example, went through a period of growth resulting from the natural deposition of sediments during the second half of the 20<sup>th</sup> Century (Cuq 2001). More recently, however, it has been suffering from an opposite process, with a predominance of erosion trends that may result in a significant degradation of this nesting area. Natural erosion processes may soon become more prevalent as a result of global climate change and the predicted rise in sea level on the one hand, and increased storminess and frequency of extreme weather events on the other, with potentially serious impacts on major nesting sites.

### **Nest predation by domestic or introduced animals**

The predation of eggs and hatchlings by dogs, pigs or even by natural predators that may occur in artificially inflated numbers due to ecosystem disturbance linked to human activities may, in certain cases, present a serious menace for nesting turtle populations. Indeed, there are several regions across the globe where sea turtle conservation programs include activities linked to the





The vast majority of the beaches in Guinea-Bissau are still in a good state of conservation and the general lack of beach development means that turtles here do not suffer from threats found elsewhere, such as those resulting from the artificial illumination of nesting sites. *P. Campredon*

control of such predators or to the active protection (by physical or chemical methods) of the nests.

In Guinea-Bissau, there is virtually no evidence that these types of problems may represent any serious threat and most egg predation is directly carried out by humans, rather than by animals that benefit from their presence or activities. On some nesting islands, like Cavalos, João Vieira and Imbone, there are populations of feral pigs but, as mentioned elsewhere, we know of no confirmed reports of predation by pigs in this country. The impact of pigs and other predators should be the object of research, but in any case the percentage

of the national turtle populations that nest in those islands is rather small, which means that this is not amongst the most pressing issues to be tackled.

### **Climate change**

The temperature at the surface of the planet rose by 0.6°C over the past 100 years and the best currently available forecasts predict that future warming will be more rapid and pronounced than what has been seen so far (IPCC 2001). The impact of the limited warming of the most recent decades is notorious in a wide diversity of organisms, both terrestrial and marine (*e.g.* Forchhammer *et al.* 1998, Weimerskirch *et al.* 2003, Thomas *et al.* 2006).

Climate change will impact turtles through several different processes: (1) change in the general productivity of the oceans, affecting food availability; (2) rise of sea level and increased storminess, with consequences to beach erosion and changes in the quality and distribution of nesting sites; (3) rise in sand (and nest content) temperatures with effects at the level of incubation success and sex-ratio of populations. This last phenomenon may be particularly serious. As discussed in the chapter devoted to general biology of sea turtles, eggs that are incubated at high temperatures produce an excess of female offspring. Above a certain temperature threshold, no males are produced, which of course will compromise the very viability of the populations concerned. Even today, there are populations where there already is an excess of females being produced, although it is not clear what the sex ratio of hatchlings would be under “normal” circumstances (*e.g.* Broderick *et al.* 2000, Öz *et al.* 2004, Booth & Freeman 2006). There cannot be any doubts that, during their evolutionary history, marine turtles have faced several periods of climate change, even though those happened at a much slower pace than presently, which would have allowed an adjustment of their physiology and a shift in geographic distributions of the populations which, in current conditions, seems to be much more difficult to achieve. The extent to which current and predicted changes will influence the demography of sea turtles is still uncertain, as is uncertain the very degree of climate change that the planet will experience. Nevertheless, the potential impact is large and very real. Research is needed to better understand this issue and make predictions, at a national and global level, as well as to evaluate if there are management initiatives that could be envisaged to minimize impacts (such as, for example, providing shade to nests). Presently, there is an ongoing research project on this subject, a partnership between national and Portuguese scientists, which will no doubt provide some answers as well as give rise to new questions.

## Conservation in Guinea-Bissau

### Natural and traditional protection

By comparison with neighbouring countries, marine turtle populations in Guinea-Bissau are relatively well preserved (even if they are not secure). This results, without doubt, from several factors, amongst which the most important is probably the existence of a large and little-developed archipelago with many uninhabited and remote islets, where turtles can nest relatively undisturbed. To this it must be added that the Bijagó culture, which has kept some of its fundamental traits until the present, favoured the preservation of some of the islets that are important for wildlife. Poilão, for example, is a sacred island, which belongs to the village of Ambeno (situated on Canhabaque). According to traditional beliefs, the island is inhabited by powerful entities. It is not allowed to establish settlements there, or to perform any other activities (agriculture, harvest), with the exception of initiation ceremonies or rituals of important mystic and social meaning. During these rare events, one or two turtles may be sacrificed, which has no impact on the population. Sometimes, years may go by without any ceremonial visit taking place. These types of rules also apply to other islets, and without doubt have contributed to biodiversity conservation in different parts of the Bijagós.



Poilão is a sacred islet, traditionally only visited on special and infrequent occasions. This, and its remoteness, has probably helped to preserve it as an important marine turtle nesting site. *J.F. Hellio & N. Van Ingen*

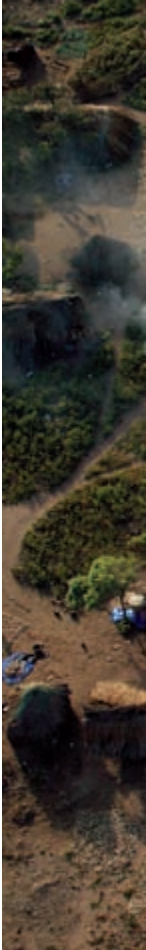
### Modern conservation efforts

As far as it is known, the old Portuguese colonial rule (until 1975) did not promote any efforts to conserve marine turtles or the natural values of the Bijagós. Since 1986, marine turtles have been fully protected by the state of Guinea-Bissau through the Law of Fisheries (article 17<sup>o</sup>). This was an isolated initiative, not part of a conservation strategy, but it may have limited any prospects for the development of any commercial use of turtles. This legislation was updated in 1994 and is still in place today.

From 1989 onwards, several research initiatives and participative processes were launched and developed, as part of a general effort for the planning and management of natural resources and biodiversity in Guinea-Bissau. Within this framework, a process leading to the creation of a network of protected areas was started. This was to fill an important gap, as the country was totally devoid of parks and nature reserves. Important areas for marine turtles were identified during a range of inventories that were organized to support the above-mentioned initiatives (detailed in the section devoted to the history of sea turtle research in Guinea-Bissau). As one of the most notable and important national biodiversity values, marine turtles were taken into consideration in coastal planning exercises (e.g. Limoges & Robillard 1991a, b, Catry *et al.* 2002). This explains the fortunate circumstance that the most important nesting areas, as well as the adjacent marine sectors, have been included in the central parts of two national parks.



The main sea turtle nesting beaches of Guinea-Bissau are, nowadays, part of two national parks. *P. Campredon*





The removal of temporary and permanent foreign fishermen camps from sensitive areas with important turtle nesting grounds was one of the measures with greatest positive impacts in the conservation of the biodiversity of the parks of Guinea-Bissau. *J.F. Hellio & N. Van Ingen*

In recognition of the natural and cultural values of the archipelago, as well as of the initiatives for its study, management and conservation, the Bijagós were classified as a Biosphere Reserve by UNESCO in 1996. This does not mean that all the islands became protected areas. The Orango National Park was created in 1997 (although only formalized in 2000) and protects, amongst other things, the important nesting beaches of Orango Grande and Adonga. The João Vieira Marine National Park was created in the year 2000 and it includes the islands of João Vieira, Cavalos, Meio, Cabras and, most importantly, Poilão. In 2001, the

park was declared by the state of Guinea-Bissau as a *Gift to the Earth*, as part of the world campaign promoted by the WWF. More recently, the Community Marine Protected Area of Formosa, Nago and Chediã (Urok Islands) was created. It should also be mentioned that, on the mainland coast, the Natural Park of the Mangroves of the River Cacheu (created in 1997) protects some beaches with nesting turtles too.

As often happens, particularly in less developed countries, the legal protection of a territory does not automatically translate into practical changes felt on the ground. The capture of turtles ashore and at sea is a reality to the present day. This is the result of basic deficiencies at the operational level, for example, the ability to effectively carry out surveillance missions, but also to a whole suit of factors that make it hard for significant progress to be made towards conservation objectives. Most of Guinea-Bissau's parks have resident human populations with great development needs. In this context, it is difficult to curb or eradicate certain illegal practices that locals themselves see as traditional and helpful in periods of shortage of resources, even if such practices are not sustainable in the long-term. Besides the shortage of equipment and other materials, park guards suffer from limited training and from lack of motivation to act upon transgressors who often are their family, neighbours or friends.

One of the most relevant changes, from a conservation point of view, brought about by the creation of protected areas was the removal, in 2004, of temporary and permanent foreign fishermen camps from sensitive areas, near important sea turtle nesting grounds. In the Orango group, 12 camps were removed, some of which were true villages with a large number of people and pirogues. The main camps were placed precisely in the most sensitive areas of the park, near Adonga, Imbone and Ancopado. These removals contributed to a reduction of the fishing activity, mangrove cutting and, probably, turtle harvesting, in those sectors. However, illegal fishing is still common practice in the area.

Temporary foreign fishermen camps also used to exist on Poilão, Meio and on other islands of the João Vieira group. These camps were small and short-lived. On Poilão also, military camps were once established, but this was discontinued many years ago. The potential impact of the permanence of fishermen and other people on these sites was very high. The creation of a marine park and the regular presence of guards, technicians and researchers on the ground prevented the establishment of camps and their associated harvesting activities. Despite this, fishing at sea still occurs even where and when it is not allowed, which sometimes results in limited sea turtle bycatch in the area.

Since the 1990s, many environmental education campaigns and messages have been broadcast through the local Bijagós community radio (radio Djan-djan-Bubaque). To this, one may add the production of leaflets, the distribution of



Turtle skulls on display at the *Casa do Ambiente e Cultura de Bubaque* (House of Culture and Environment of Bubaque). This centre for documentation, coordination and logistic support has played a major role in conservation and research initiatives in the Bijagós. *C. Barbosa*

printed shirts and the discussion in village meetings of many initiatives linked to conservation, sustainable development and the participatory management of the parks.

On Poilão, during the 2008 field season, some experiments for the practical direct management of turtles were carried out. When turtles were found laying on unsuitable spots, threatened by immediate sea erosion, clutches were translocated to a hatchery that was installed in a safe sector of the beach. These experiments followed recommendations published in the technical literature and met with great success, given that all the translocated clutches hatched after normal incubation periods (Barbosa 2009). Two of the nests that were rescued were of hawksbill turtles, which are, as mentioned above, relatively rare in Guinea-Bissau. These experiments should be replicated in other nesting areas where there are needs for a greater surveillance of incubating clutches (for example on João Vieira). The creation of hatcheries, if carefully carried out, may also play an interesting role in terms of environmental education and as a support for the exploitation of the “marine turtle resource” as a eco-tourism product. Finally, hatcheries are an important tool for research, namely in efforts to improve our understanding of the influence that the incubation environment exerts on the sex-ratio of offspring. Besides the manipulation of nests,

researchers working on Poilão have, on many occasions, helped turtle hatchlings to reach the sea, saving them from likely death by heat exposure or predation when stuck on the rocky reef in broad daylight.

The idea of using marine turtles as an environment-based tourism product has been around for many years (Agardy 1992, Catry 2000), but only since 2008 did some tourist operators start taking clients to Poilão on a more (even if still infrequent) regular basis. In the remaining areas, the presence of sea turtles is not predictable enough to allow adequate exploitation.

Finally, it should be mentioned that, over the past two decades, a major capacity building effort was made, with the training of guards, technicians and national researchers, and much research and monitoring was carried out.

### **Conservation priorities and future prospects**

The long-term conservation of marine turtles in Guinea-Bissau is far from being secured. As discussed above, current mortality levels, which result from various causes, may not be sustainable. Furthermore, in a longer time-frame, the challenges presented by climate change and sea level rise may be the most formidable and difficult to tackle.

In recent years, several action plans for the marine turtles were prepared and updated (Broderick & Catry 1998, Catry 2000, 2008). These plans were partially implemented, obviously constrained by the amount of financial and human resources that were possible to gather. The National Institute for Biodiversity and Protected Areas (Instituto da Biodiversidade e das Áreas Protegidas - IBAP), the state organism in charge of the management of parks and threatened species, is presently the main institution looking after turtles and their congregating sites. According to national law, the protected areas management is done in a participatory fashion, with the involvement of the parks' resident human populations and other stakeholders.

National priorities were identified and updated by IBAP in 2008 and summarize the main needs for the coming years (see box). Many of the problems we are facing are complex and beg for actions that in themselves are difficult to carry out. Desirable initiatives do not only respond to sea turtle conservation needs but are also of wider conservation interest. For example, there is a need for a code of conduct that minimizes the probability of pollution events linked to oil exploration in Guinea-Bissau waters. Amongst the top priorities, and with greatest likely positive impacts, are the ones that relate to the correct functioning of the protected areas in Guinea-Bissau, namely concerning their governance, the terrestrial and marine surveillance, the enforcement of regulations and the regular evaluation of the effectiveness of management.

Research and monitoring are also priorities (and made the present book



Researchers during fieldwork. The presence of scientists and students near the most important nesting sites is a deterrent towards activities that may threaten marine turtles.

*H. Monteiro*

possible). On the one hand, monitoring allows the evaluation of trends (demographic ones, but also of exploitation and of other threats) and, therefore, of the impact of conservation measures and threat-reduction initiatives. On the other hand, research allows the identification of new menaces, evaluates their relative importance and contributes to the search of new solutions. Finally, the benefits from the regular presence of researchers at important sites is well known: it increases local people's perception of the importance of biodiversity values and contributes to the surveillance and deterrence of illegal activities (*e.g.* Oates 2002, Wrangham & Ross 2008).



Green turtles just after leaving the nest. *J.F. Hellio & N. Van Ingen*

## ACTION PLAN FOR THE CONSERVATION OF MARINE TURTLES IN GUINEA-BISSAU

*(from Catry 2008 – Instituto da Biodiversidade e das Áreas Protegidas)*

### The Vision

Our goal consists in the long-term conservation of the common heritage represented by all marine turtle species that occur in Guinea-Bissau, for the benefit of local people and the national and international community. At the centre of this vision is the sustainable use of marine turtles as important resources for the promotion of ecotourism, as biological indicators of the state of marine ecosystems, as flagship species for environmental education and to gather support fundraising efforts directed at biodiversity conservation.

### Main objectives

In the path towards our ultimate goals, and considering past achievements, we believe that presently the most pressing needs are:

- ▶ *Keep an intensive surveillance on Poilão, to ensure that there is no poaching of eggs or adult females.*
- ▶ *Reduce the incidence of poaching of adults and eggs in the Orango National Park and in the Unhocomo Group, through a more effective enforcement of regulations and through the promotion of compensatory measures contributing to the sustainable development of local communities.*
- ▶ *Create partnerships for a better surveillance of important feeding and mating areas.*
- ▶ *Evaluate the present impact of bycatch in industrial fisheries and influence and promote the use of mitigation measures.*
- ▶ *Improve the scientific knowledge on the status, demographic trends and threats affecting sea turtles and promote the dissemination of existing information.*
- ▶ *Implement an environmental education campaign that targets several social levels and stakeholders.*
- ▶ *Promote a sustainable use of marine turtles.*
- ▶ *Develop a regional conservation strategy that takes into account the migrations of sea turtles between and across several African nations.*

## ■ Epilogue – We must keep our dreams

As recently as a few decades ago, even careful and informed observers thought that the enormous expanse of the Ocean meant that its resources were virtually infinite. Today, every oceanographer or naturalist realizes that there is an enormous crisis stemming from the catastrophic overexploitation of living marine resources. This crisis is worsened by other factors, such as pollution and, shortly, by that overwhelming threat posed by global climate change. The situation is of the utmost concern and needs to be faced with courage and determination, for the benefit of global biodiversity, but evidently, for the benefit of us all, since human kind may itself be under threat imposed by massive global changes which may affect the functioning of the whole Earth.



The conservation of marine turtles is not an easy mission. Only with a lot of will and coordination between different initiatives and partners will it be possible to save these marvellous creatures.

*J.F. Hellio & N. Van Ingen*

In this context, sea turtles may be relevant indicators. If our management of resources and ecosystems is wise, if we can keep climate change within reasonable limits, control pollution, introduce mitigation measures to fisheries, restore feeding and nesting habitats, then marine turtles will survive. Where we fail, the disappearance of turtles and other charismatic mega-fauna will function as an alarm-bell, which here and there (lets hope not) may come too late.

Leatherback turtles are amongst the largest and most striking living creatures of the world's oceans. In the largest of all, the Pacific, where they were once numerous, these beasts are in imminent danger of extinction, after a population collapse over the past few decades. Causes are varied and complex, and act in international waters as well as within the areas under the jurisdiction of several different nations. This situation may well be already irreversible. The unthinkable, the extinction of one of the planet's giants is about to happen before our eyes in the vastest of all oceans, despite all the efforts for study and conservation. If this and other similar realities may make one despair, it should not be forgotten that there are success conservation stories as well, and several important sea turtle populations have known remarkable recoveries as a result of conservation efforts and initiatives.

Turtles are more than just the “canary in the mine” that allows us to monitor our global environment. They are animals that inspire and make us aware of the beauty of life on this planet, as well as to the wonders and mysteries that remain hidden in the planet's oceans. Turtles are, given their eternal wandering in the vastness of the blue continent, special messengers for our dreams. Dreams of far away travel. Dreams of warm nights in the sand, listening to the soft noise of the distant surf. Dreams of deep and refreshing waters, of marvellous and colourful marine creatures. Dreams of oceans full of life, on whose shores our children and grand-children will be able to grow and live happy lives.

The war of conservation is not an easy one. In a country such as Guinea-Bissau, with so many needs and legitimate aspirations for development, this fight becomes even harder. But the path we have taken and progress already made gives hope, and there are plenty of us wanting to carry on. All those individual turtles we met laying on the beaches of the Bijagós faced impossible odds, many years ago, when they, for the first time, braved the wide ocean. Nevertheless, they are here to remind us of the miracles of life. Let's then take inspiration in the apparent courage of a young hatchling venturing into the dark waters of a tropical night. Let's imagine its journey offshore the Bijagós, into the deep sea, driven by currents and gales. Let's imagine that in twenty or thirty years time it will be back, to lay its precious clutch on the beach.

*We must keep our dreams.*



Female green turtle on Poilão. *G. Rosa*

# Acknowledgements

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# Annexes

10

## Annex 1- Methodological notes

In this section, we present in more detail some of the methods used when gathering the data presented in this book. More than a complete revision of the methods of study and monitoring adopted in Guinea-Bissau, we have tried to present elements that may help the reader to understand how we came to the estimates and conclusions that we present in the main text. More data on the used methodologies can be found in several published articles, particularly in Catry *et al.* 2002 and Catry *et al.* 2009.

### Sources

For the preparation of the present text, we consulted as many bibliographic sources and unpublished reports as we could (see global reference list). Of course, we are aware of the fact that not all unpublished reports could be found, but we believe to have been absolutely exhaustive in what concerns published materials.

The revision and use of data and written reports produced over the years present considerable difficulties. Most documents are unpublished internal reports from several institutions (INEP-CEATA, GPC, CIPA, IUCN, IBAP, NGOs) that have not been submitted to any specialized technical revision and with content that presents gaps in information that limit their interpretation and use. Furthermore, in most cases, original data sheets or notebooks have been lost. Important reports and databases disappeared during the 1998-99 war, while others were lost inside broken computers.

In order to avoid burdening the text with references, we have opted, in most cases, to only provide indication of the sources that support sentences when they refer specifically to sea turtles in Guinea-Bissau. The sections that concern general aspects of the biology, status and conservation of sea turtles generally do not contain references, even if the main sources used can be found in the bibliographic list at the end of the main text. On the other hand, we have made an

attempt to be as rigorous and complete as possible in what concerns the citation of work concerning Guinea-Bissau. Sentences concerning this country that are not supported by references result from the experience, observation and unpublished data of the authors.

### **Monitoring of the beaches of the Orango group in 1992-94**

From December 1992 to November 1994, regular surveys were carried out in the 6 main nesting beaches of the Orango group (presently the Orango National Park), including Acapa-Orango (ca 7.5 km), An-ôr (7 km) and Ancopado (6 km), on Orango Grande, and Imbone (6 km), Adonga (9 km) and Uíte (6 km; on Orangozinho). All the main sandy stretches facing the open sea were covered. Several small beaches, including many in the channels between islands, were not surveyed (such beaches are known to also have some nesting activity, but numbers involved are very small, probably insignificant relative to the totals of the general area). Work was coordinated by Bruno Paris, Honório Pereira and Castro Barbosa. Surveys were carried out by future technicians and guards of the Orango Park that, at the time, were under training, with further help from some locals recruited specifically for this purpose. All participants in the inventory received specialized training *in situ*, under the supervision of national and foreign biologists, who were also present during some of the survey sessions. The beaches were walked in the early morning, up to 5 times per month, with a coverage of all the months of the year (even if there were some gaps in individual beaches). In total, 320 surveys were carried out, with an average number of  $53.3 \pm 15.5$  surveys per beach (range: 26-71). In each survey, turtle tracks per species were counted, taking note of which were “fresh” (less than 24 hours) and “old”. Tracks were erased after counting, to avoid double counting on posterior dates. The condition of each nest was noted, recording whether it was intact or had suffered predation. In this last case, the presumed predator type (Human, crab *Ocypode cursor* or monitor lizard *Varanus* sp.) was identified from tracks left on the sand.

To obtain an approximate estimate of the total monthly number of clutches laid per beach, we multiplied the mean number of new nests per visit by the number of days of the relevant month. It should be noted that the existence of gaps (namely on a few moments with intense laying activity) and possibly insufficient training of some of the local collaborators, these data, despite their obvious interest, should be taken as merely indicative of orders of magnitude of nesting by each species in the Orango area in the late 20<sup>th</sup> century. It is also due to some technical shortcomings and the heterogeneity of the quality of data collected on different beaches that we opted not to present estimates for each individual beach. Nevertheless, some indication of the areas with greatest concentration of nesting is provided in the species accounts.

### Surveys on Poilão

Counting nests or tracks on Poilão presents considerable difficulties that go well beyond the simple, but very real, logistical problems posed by the remoteness of this study site and the fact that the long-term permanence on the ground is done by camping, often with limited boat or radio connections, and under the intense tropical rains of the wet season. In fact, turtles pose their own very special problems. The very high density of tracks on the sand makes their count problematic. This difficulty is particularly acute in years with more intensive nesting. Furthermore, some turtles “caught” by the low tide may crawl up and down the beach several times, while they wait for the incoming tide. Also, on some beaches the sand is quite coarse which makes the interpretation of the printed tracks unusually difficult.

As typical of nesting beach surveys, all Poilão beaches are walked early in the morning, recording all tracks seen. This information is complemented by two types of data. First, during the night, all main beaches of Poilão (with the exception of the Praia Militar, of difficult access) are walked one or two hours before the high tide time and all turtles seen are counted (often, other nesting data are also collected at this time). This count is not equivalent to the total number of nesting turtles, because many individuals come ashore after the night transect is completed. Secondly, in the morning, all turtles stuck in the rocks and pools and waiting for the incoming tide are also counted. Most of these turtles probably were not recorded during the night count (which takes place quite early in the tide cycle) and represent individuals that came ashore when the tide was already at its maximum value, or even after this point.

In a year with a very high nest density (2007), it was the case that the number of turtles seen during the night was as large, or even larger, than the number of tracks counted in the morning. This clearly indicates that, when track density is high, track numbers can be severely underestimated. In order to obtain a corrected estimate, complementary to the one resulting from simple track counts, we opted to calculate nest numbers in the following way: each time the number of turtles seen (nocturnal count + morning count) was greater than the number of tracks, we used the total number of individuals recorded, instead of track counts. These values suffered a correction by multiplying to “laying success” (the proportion of turtles coming ashore per night that successfully laid a clutch – see Catry *et al.* 2009). On the main text section we present estimates resulting from the simple count of tracks, as well as those that take into account the number of turtles seen.

Finally, it is important to mention that for the long-term monitoring of nesting numbers on Poilão, it would be important to always make a morning count of turtles stuck on the rocks. Such a count is much easier and replicable

(without large inter-observer variation) than the count of tracks or of individuals ashore during the night. Even if this count cannot easily translate into an absolute number of nesting turtles, it can be extremely useful to assess inter-annual variation and long-term population trends.

**Annex 2 - Number of green turtles tagged  
on Poilão from 1994 to 2007**

**Notes:** Tag loss has been very important in this study, which has resulted in very few recaptures, both away from Poilão or on Poilão itself on years subsequent to initial marking. In 2007, we ran out of tags half-way through the season, when very many turtles were still available for tagging.

Year	Number tagged
1994	314
1995	1651
2000	1404
2001	1035
2002	304
2003	35
2004	65
2005	40
2007	605

### Annex 3 - Summary of results of the Orango Group beach surveys in 1992-94

Total number of “new” nests recorded per beach

	<i>C. mydas</i>	<i>L. olivacea</i>	<i>E. imbricata</i>	<i>D. coriacea</i>
Acapa/Orango	22	6	1	0
An-ôr	2	1	0	0
Ancopado	35	3	0	0
Imbone	28	7	1	0
Adonga	21	30	3	4
Uite	18	3	2	1
Total	126	40	7	5

Estimates of nest numbers per species on the Orango Group in two years with regular surveys (see Annex 1 for methodology).

	<i>C. mydas</i>	<i>L. olivacea</i>	<i>E. imbricata</i>	<i>D. coriacea</i>
1992-93	751	620	50	31
1993-94	274	170	15	47
Annual mean	512	395	33	39

## Annex 4 - Predation on turtle nests as recorded in the Orango Group from December 1992 to November 1994

Only "old" nests are included.

### Predation on green turtle nests.

Beach	Human	Crab	Monitor lizard	Intact	Total
Acapa/Orango	22	6	17	57	102
An-ôr	2	3	0	2	7
Ancopado	6	3	0	56	65
Imbone	7	11	11	7	36
Adonga	6	22	8	33	69
Orangozinho	4	0	1	4	9
Total	47	45	37	159	288

### Predation on olive-ridley turtle nests.

Beach	Human	Crab	Monitor lizard	Intact	Total
Acapa/Orango	3	0	3	1	7
An-ôr	0	0	1	1	2
Ancopado	0	1	0	1	1
Imbone	3	25	1	5	10
Adonga	7	0	6	84	122
Orangozinho	0	26	0	0	0
Total	13		11	92	142

## Annex 5 - Measurements of green turtles captured on feeding areas in the Unhocomo Group

Date	Curved carapace length (cm.)	Curved carapace width (cm.)	Mass (kg)
May 2003	61	51	24,0
May 2003	60	54	33,5
May 2003	66	63	40,5
May 2003	46	41	10,5
May 2003	40	38	17,0
May 2003	50	47	15,5
May 2003	54	49	17,5
May 2003	59	56	23,0
September 2003	91	84	80,0
September 2003	51	41	19,0
September 2003	49	46	17,0
September 2003	40	34	9,5
September 2003	40	35	9,5
September 2003	59	54	28,5
September 2003	35	33	9,5
September 2003	45	41	14,0
September 2003	64	51	19,5
September 2003	44	40	14,0
September 2003	38	31	10,0



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