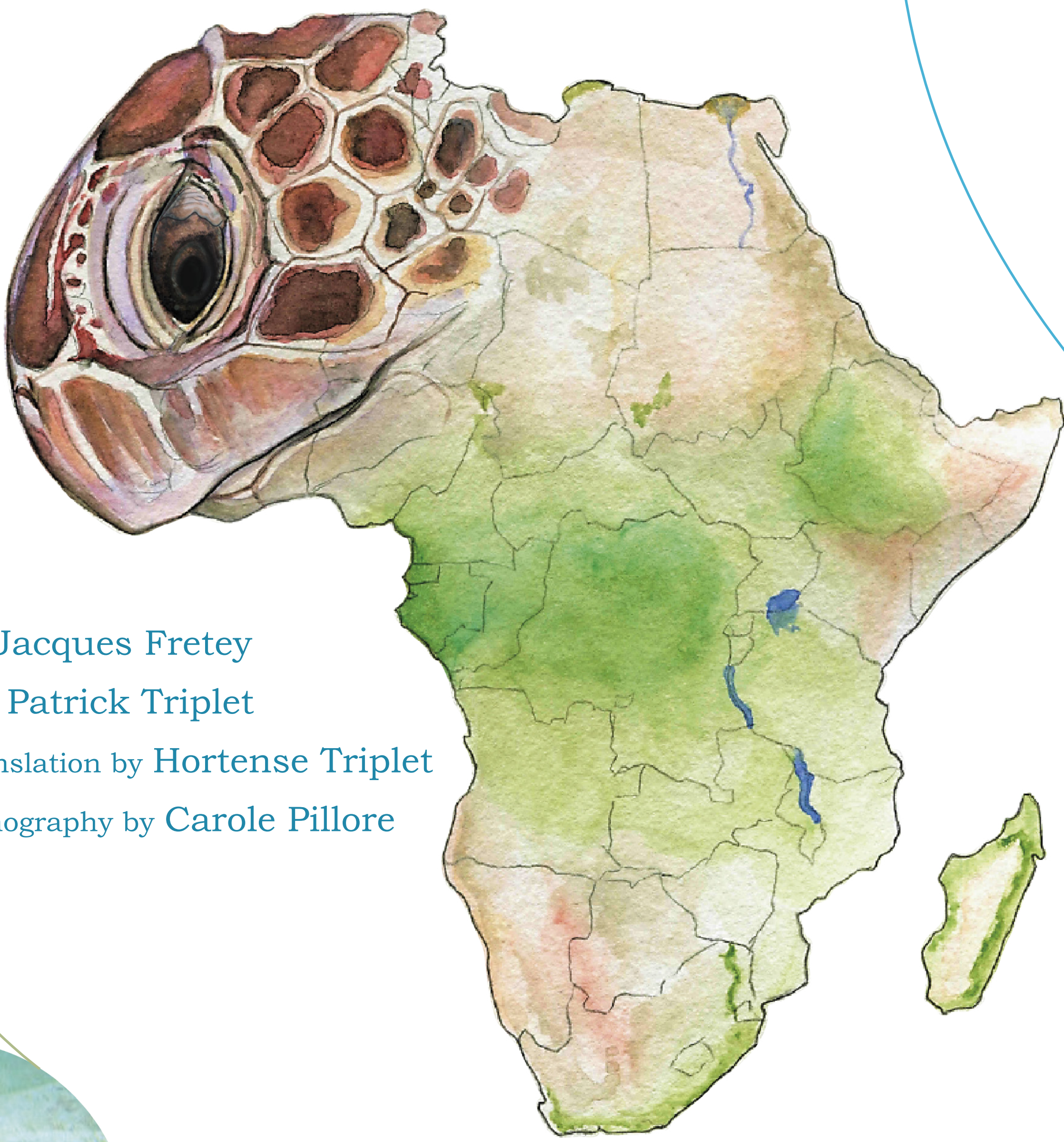
TRAINING MANUAL
for the conservation
OF MARINE TURTLES
IN West Africa



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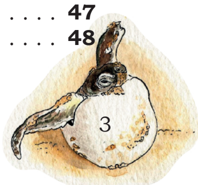


Chelonia mydas **immature (© J Fretey)**

I. Foreword

Inveterate migrants, marine turtles are widespread in all the world's oceans. Some of them travel tens of thousands of kilometers to feed, grow or reproduce. During their journey, marine turtles contribute to the 'health' of the oceans they travel through, but are also subject to a variety of threats. Among these, pollution, poaching and bycatch by fishing gears remain dramatic causes of the decline in all the populations, which are already in small numbers.

In West Africa, several Marine Protected Areas (MPAs) of the RAMPAO constitute resting, breeding, nesting and feeding sites for marine turtles. From the Banc d'Arguin National Park in Mauritania to the Loos Islands MPA in the Republic of Guinea, and from the Boa Vista MPA in Cabo Verde, the Joal-Fadiouth MPA in Senegal to the João Viera-Poilão Marine National Park in the Bijagos Archipelago in Guinea Bissau, most species of marine turtle nest on these protected sites in the RAMPAO network.

Since the creation of RAMPAO, efforts to raise awareness and to strengthen the capacity of managers and local communities have enabled some MPAs to meet the challenges of marine turtle preservation and conservation of their habitats. These achievements deserve to be capitalised on at the network level in order to contribute effectively to the preservation of marine turtles in West Africa.

This is the objective of this training manual for MPA managers and other conservation stakeholders.

Better still, it fills the gaps in terms of knowledge on marine turtle conservation, thanks to the needs expressed beforehand by the members of the RAMPAO network.

Result of a collaboration between the Association Chélonée and RAMPAO, this manual is inspired by local success stories (particularly endogenous knowledge). Better still, it fills the gaps in terms of knowledge on the preservation of sea turtles, thanks to the consideration of the needs, expressed beforehand by the members of the RAMPAO network.

Considering the strong interconnectivity and the complementarity that characterize the RAMPAO MPAs, the manual proposes principles and methods that can inspire and guide the actions of MPA managers and users in favour of marine turtles.

I wish all those who are passionate about and convinced of biodiversity conservation as much pleasure and interest as I have experienced in reading this Manual, which has helped me to remain convinced that the survival of marine turtles depends on each and every one of us!

Marie Suzanne TRAORÉ
Executive Secretary of RAMPAO

HOW TO RECOGNIZE,

STUDY THEM,

PROTECT THEM

II. The different species on the Western African coast

II.1. Taxonomic data

Six species can be seen on the Western African coasts, from two different families.

Family of Cheloniidae

Genus *Caretta* Rafinesque 1814
Caretta caretta (Linnaeus 1758), Loggerhead Turtle

Genus *Eretmochelys* Fitzinger 1843
Eretmochelys imbricata (Linnaeus 1766), Hawksbill Turtle

Genus *Lepidochelys* Fitzinger 1843
Lepidochelys kempii (Garman 1880), Kemp's Ridley Turtle
Lepidochelys olivacea (Eschscholtz 1829), Olive Ridley Turtle

Genus *Chelonia* Brongniart 1800
Chelonia mydas (Linnaeus 1758), Green Turtle, green turtle

Famille des Dermochelyidae

Genus *Dermochelys* Blainville 1816
Dermochelys coriacea (Vandelli 1761), Leatherback Turtle

II.2. Status of species in the RAMPAO area

Five species are noted in the MPAs of the network out of the six that can potentially be observed on the West African coast. The Kemp's ridley turtle, whose status is uncertain and whose identification is sometimes difficult for observers, is missing from this list. A questionnaire sent to the members of the network also aimed at defining the needs of the MPA agents in terms of knowledge on marine turtles. The need to provide them with determination key and an inventory of the study protocols for the different species emerged.

The complete report can be downloaded with this link :

https://www.dropbox.com/s/iac0x-7cafp7ly7g/Enqu%C3%AAte%20sur%20les%20besoins%20des%20aires%20marines%20prot%C3%A9g%C3%A9es.pdf?dl=0

These species, in particular the two most regular on the West African coasts, the Loggerhead and Green Turtle are under strong pressure, linked or not to the presence of humans near to their living areas.

II.3. Descriptive data on the different species in the RAMPA area

Each regular species or each species possibly noted in the RAMPAO zone is described. In a second time, an identification key is provided to validate the observations.

The Logerhead Turtle
Caretta caretta

Description

A heart-shaped carapace in its dorsal view characterizes the adult Loggerhead Turtle; its width is about 76 to 86% of its length. The head is large with strong jaws and comparatively thicker horny beaks than in other marine turtles. The flippers are relatively short and thick, each with two visible claws on the leading edge.

The carapace has five symmetrical pairs of costals, the first of which touches the nuchal plate. There are three large inframarginals on each of the bridges.

The carapace and legs are reddish brown; the plastron, the bridges, the underside of the throat and legs are yellow to creamy white. The cephalic scales are often edged with yellow. The hatchlings are dark brown dorsally, with pale brown legs on the edges and underside, and a generally much paler plastron.

Biometry

There are generally five possible stages of growth in this species :

- stage I : from the hatchling (45 mm) to a post-neonate size of 15 cm;
- stage II : exclusively oceanic juveniles, from 42 to 63 cm; estimates of the duration of this stage vary from 7 to 24 years;
- stage III : oceanic, neritic or benthic juveniles from 41 to 82 cm;
- stage IV : glarge benthic juveniles from 63 to
- 100cm;
- stage V : neritic or oceanic adults from 82 to 100 cm. The turtles are considered as adults when they reach 100 cm.

The overlap in size classes of the various developmental stages reflects the distribution of passage sizes at each stage.

In the Atlantic, nesting female Loggerheads average 94 cm in straight carapace length and 116 kg in weight. Maximum of 115 cm.

Habitats

The Loggerhead is found in temperate and tropical regions of the Atlantic. It occupies different marine habitats at different stages of its life cycle. Hatchlings take refuge in the neritic waters of the continental shelf. Then, they move to deeper oceanic waters and migrate long distances before reaching maturity size when they return to the coast.

They can be found hundreds of kilometers offshore, as well as in coastal areas such as bays, lagoons, creeks, channels and the mouths of large rivers.

Diet

The feeding behavior of the Loggerhead may change with age, but this species is carnivorous throughout its life. Hatchlings feed on small Jellyfish, Gastropods and Crustaceans.

In neritic areas, Loggerheads have a diet composed mainly of hard-shelled benthic invertebrates. In the oceanic stage, they appear to feed on Jellyfish, Crabs, Squids, Gastropods and pelagic Coelenterates.

Juveniles, subadults and adults look for a very large variety of preys, belonging mainly to the benthic fauna such as conchs, clams, crabs, sometimes shrimps, sea Urchins, Sponges, Squids, Octopuses, as well as fauna captured by man, hence by-catches in the trawls.

Breeding

The age of sexual maturity is estimated at 32-35 years. Sexual dimorphism becomes apparent when individuals reach a size of more than 67 cm; the most obvious difference is the length of the tail and a strong claw on the flippers in males.

The Loggerhead is the only species that can successfully nest outside of the tropics.

Nesting takes place mainly at night. Nests are usually dug between the highest tide line and the dune front. The Loggerheads are known to nest from 1 to 7 times (average 4.1 nests per season) during a nesting season at intervals of about 14 days. Return migration intervals of females to a site between nesting seasons average 2 to 3 years, but can vary from 1 to 7 years.

Presence in West Africa

The species nests sporadically in Mauritania (Tânît Bay, South of Nouakchott), Senegal, Guinea Bissau (...) and Sierra Leone. A significant number of females nest in the Cape Verde archipelago (López-Jurado *et al.*, 2000a), which represents more than 95% of Loggerhead nesting in the entire Western Atlantic (Fretey, 2001). Approximately 80-90% of all Cape Verdean nesting activity occurs on the island of Boa Vista, where abundance is currently estimated at over 10,000 annual nests (López-Jurado *et al.*, 2007). The islands of Maio, Sal and São Nicolau host an annual average of about 500 nests on each island (Lino *et al.*, 2010).

While a portion of the Cape Verdean flock of adult male and female Loggerheads after breeding migrate to feeding areas in the coastal waters of Guinea-Bissau and Senegal, a majority remains in the oceanic zone (Varo-Cruz et al., 2013).

Hawkes *et al.* (2006) and Eder *et al.* (2012) hypothesize that individuals smaller than 90 cm feed in a large area between the Cape Verde Archipelago and the African mainland coast, and that large females would feed along the coasts of Guinea and Sierra Leone.

Large concentrations of juveniles and subadults ranging in size about 20 to 60 cm are observed throughout the northern part of Macaronesia. Some of these immatures come from North American beaches and the Yucatan Peninsula via the Gulf Stream and the Canary System (Bolten *et al.*, 1998).

Juvenile Loggerheads from the Cape Verde Islands have been observed to share feeding grounds in the Canary Islands, Madeira, Azores, and the Southwestern Mediterranean with juveniles from other Atlantic and Mediterranean populations (Carreras *et al.*, 2011).

The Hawksbill Turtle
Eretmochelys imbricata

Description

Cordiform or elliptical carapace in adults, its width being about 74% of the total length.

Head rather small, with a long and narrow muzzle. Beaks not serrated, hooked. Two pairs of prefrontals.

Very thick scales of the shell, an adaptation to foraging in coral reefs and rock piles. The scales are most strongly imbricated in the mature state, but in older turtles, the imbricated character is often lost. Presence of five pairs of costals, the first not touching the nuchal. Each leg has two claws on the leading edge.

As with other species of marine turtles, males have stronger, more curved claws and longer tails than females.

This species is the most colorful of sea turtles. The pattern shows a wide range of variations, with very bright colors. The cephalic scales have creamy or yellow edges, more apparent on the sides or cheeks than on the frontal part. The scutes of the shell have an amber background color, with a variable amount and arrangement, in spots or bands of orange, yellow, green, blue and red. The spots and bands of color are usually arranged in a fan pattern. The ventral parts are amber colored. In juveniles, brown spots are noted in the rear portion of each scute.

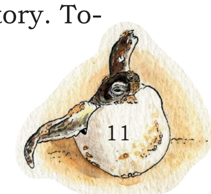
Biometry

The average straight carapace length of adult females ranges from 53 to 114 cm. The size at which females reach maturity varies between populations (66 cm in Sudan, 69 cm in Yemen, 73 cm in Oman, 84 cm in Mexico, 82 cm in Costa Rica, 76 cm in Puerto Rico,…). Males measure on average 77.8 cm (Nicaragua). Adult females weigh between 46 and 86 kg, males between 50 and 65 kg (Pritchard & Trebbau, 1984; Marquez, 1990) .

Immature female growth is faster than in males, with a growth rate of about 0.5 cm per year until declining as they approach sexual maturity.

Habitats

Hawksbill Turtles live in clear, nearshore waters of continental and insular shelves. This species was before considered relatively non-migratory. To-



day, some individual stay close to their breeding area, while others travel hundreds of kilometers between a nesting beach and a foraging habitat.

The area used for daily activities (foraging, resting...) is not entirely related to the availability of food, but is mostly influenced by factors such as refuge seeking and predator avoidance.

Unlike other marine turtles, Hawksbill Turtles are generally no deep divers, which can be explained by the shallow depth where their primary food is found.

Diet

The species is solitary but, frequently, individuals of several age classes are found together on the same feeding grounds. Another characteristic is that, until now, it has not been observed moving in « flotillas ». Migration studies have revealed rather short movements between nesting beaches and the nearest foraging habitat.

It is essentially carnivorous, which sneaks to hunt in crevices between rocks and corals, so its diet is often very variable. This mode of hunting explains its real body armor and the shape of its beaks.

The young feed on anemones, Cephalopods, Sponges, Sea Urchins, Shellfishs. When an individual become a regular inhabitant of hard substrates, its diet is mainly composed of soft corals, Tunicates, Invertebrates, algae and Sponges. Some populations can be very spongivorous, that is to say feeding almost exclusively on Sponges. Juveniles may feed on mangrove fruits, which involve nursery habitats in mangroves.

During the inter-nesting period, females tend to remain near from their nesting beaches in areas ranging from as little as 1 km2 to 43 km2. These relatively small core areas may permit females to conserve energy reserves throughout a breeding season when they are not feeding.

Breeding

Hawksbill Turtles usually reach sexual maturity after several decades. Depending on the population, the age of maturity has been estimated between 17 and 36 years for females, and around 38 years for males.

The Hawksbill turtle is considered as a solitary nesting species, but there are some beaches in the world where females arrive in groups. As with other marine turtles, the Hawksbill Turtle shows a certain fidelity to its nesting site, a characteristic that is more frequently observed in older individuals. However, subsequent nesting of females on other beaches than the original one is also possible.

Most female Hawksbill turtles come ashore at night, but many cases of diurnal nesting are reported.

This species has a nesting cycle of 2 to 5 years, with an average of about 2.6 years. A female is expected to nest during a dozen seasons in her lifetime. A female makes on average 2.3 nests per season, with a maximum of 5. The interval between two nests is usually two weeks.

Presence in West Africa

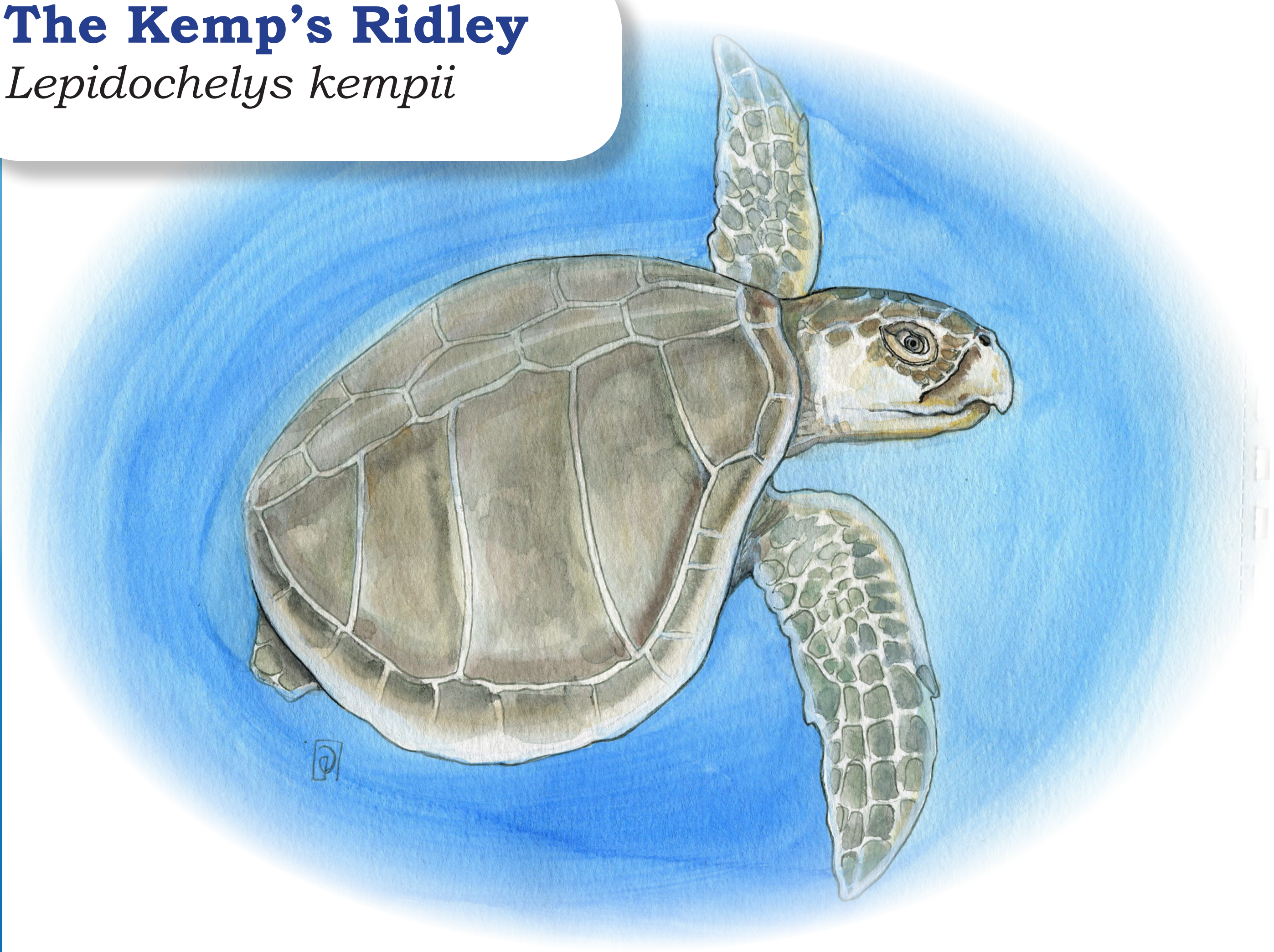
The species appears to be an occasional visitor to Micronesia. It is known from Mauritania only by a juvenile specimen naturalized in the collection of the Museum of the Monk seal at Cap Blanc and a jaw found in a fishermen's camp. Cadenat (1949) says it is strangely frequent in Senegal, and unconfirmed egg-laying has been reported around Kalissaye and Guéréo (Dupuy, 1986; Fretey, 2001). A turtle of 74 cm straight carapace length ringed with a Monel mark in the Biological Reserve of Atol das Rocas (Brazil) on 25 January 1990 was killed in Dakar on 25 July of the same year (Marcovaldi & Filippini, 1991). Maigret (1982) mentions the species at Cap Skirring in Casamance, as well as laying eggs west of Banjul, Gambia. There is no recent confirmation of nesting in Gambia.

A Hawksbill nest was observed in 2021 on the beach of João Barrosa (unpublished).

Limoges & Robillard (1991) reported nesting of 100-200 females per year in the Bijagos Archipelago, but Barbosa et al. (1998) believe there has been confusion of tracks between E. imbricata and L. olivacea. Carry *et al.* (2010) report 6 nests in the Orange Group from 1992 to 1994. Authors estimate a maximum number of 50 to 200 nests per year in the whole archipelago.

The Hawksbill Turtle nests in Katrack Island (Tristan Archipelago, Guinea) and in the Loos Islands, without knowing the importance of the nests.

The Kemp's Ridley
Lepidochelys kempii



Description

On the dorsal view, the carapace is almost round, with the width of the shell representing about 95% of its length. Presence of 5 pairs of symmetrical costals, the first ones in contact with the nuchal scute. Bridge with four inframarginals, each with a pore that is the opening of the gland of Rathke. This gland releases an odorous substance which probably plays a pheromonal role in a communication at sea of the females on nesting beaches.
The head is medium sized, typically subtriangular. Usually only one claw visible on the flippers.

Adult bodies uniformly olive grey in the dorsal parts and yellowish white in the ventral parts. Hatchlings are entirely blackish grey when wet. After about ten months, the plastron becomes almost white.

Biometry

Kemp's Ridley is the smallest of the sea turtles. The average size of the females varies from 61.4 to 65.7 cm (maximum: 74.8 cm), for a weight of 30 to 49 kg. The average weight of males is 34.6 kg.

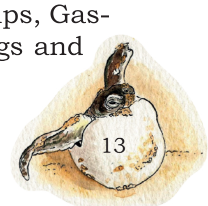
Habitats

In the Gulf of Mexico, *L. kempii* generally inhabits sandy and muddy bottoms, rich in crustaceans. Juveniles are frequently observed in bays, coastal lagoons and river mouths.

After leaving their birth beach, hatchlings swim towards the offshore currents, searching for a hiding place and food. During this pelagic period, some of them may become trapped in the currents that carry them out of the Gulf of Mexico. Juvenile and immature individuals are frequently encountered feeding in shallow waters, bays and lagoons of the U.S. East Coast. When these juveniles reach about 30 centimeters, they are strong enough to migrate. Some go to the North, others to European waters and the northwest coast of Africa.

Diet

The Kemp's Ridley is a strict carnivore throughout its life cycle. The diet of juveniles is not well known, but adults feed on a lot of Crabs, Shrimps, Gastropods, Sea Urchins, jellyfish, fish eggs and Squids.



Breeding

The minimum size of maturity in females could be 52.4 cm of straight length of the carapace. The age of sexual maturity can be reached earlier in this species than in the other marine turtles, around 10 to 12 years, sometimes before.

Presence in West Africa

The fact that the close species L. olivacea (see below) is morphologically very close to the taxon kempii et can occasionally present 5 pairs of costal scutes like it, has for a long time made the two forms confused (Carr, 1957).

The presence of individuals of Kemp's Ridley from the Gulf of Mexico is certain in the waters of the Azores and Madeira (Brongersma, 1981). But its reported sighting along the Western Sahara, a coastline not monitored for marine turtles, is not proven. Arvy et al. (1996) claimed to have found 3 small carapaces of *L. kempii* among fishermen in Nouakchott (Mauritania). But C. Arvy, after the 1996 publication, was no longer sure of the accuracy of his identification, and the species is not cited from Mauritania by Mint Hama *et al.* (2013).

Reported from Senegal, but absent from IFAN's herpetological collections, *L. kempii* is to be sought in that country. Thus, at present, nothing can be said about the possible presence or absence in west African waters of *L. kempii*, except that it does not breed there.

Some sympatry of Kemp's Ridley, or even hybridization, with *L. olivacea* is possible in Macaronesian and west African waters (Fretey, 2001).

The Olive Ridley
Lepidochelys olivacea

Description

Adult shell is very round, a little turned up at the marginals and flat on the top. The width of the shell represents 90% of its length.

The head is sub-triangular, of medium size.

The number of costals is rarely five on each side. They are usually of different number (up to nine) and mostly asymmetrical on each side of the vertebrae. Pores open on the four pairs of inframarginals, related to Rathke's glands.

One or two visible claws on leading edge of flippers with sometimes a very small claw on the distal part. Two claws on the hind legs.

Adults are solid olive grey above and creamy or whitish with pale grey edges below. Hatchlings are yellowish grey when dry and when wet become almost entirely black, sometimes with greenish sides.

Biometry

The average straight length of the shell of adults of both sexes varies from 51 to 79 cm (average: 67.6 cm). Individuals of 86 cm have been observed in the Gulf of Guinea. The mass is generally comprised between 32 to 49 kg, with an average of 38 kg.

Habitats

Outside their nesting areas, adults are most often neritic, traveling or resting in surface waters, but observations of turtles diving and feeding at 200 m depth have also been reported.

Olive Ridley turtles appear to frequent distinct habitat types: a foraging area near biologically rich bays and islands, and breeding areas near suitable sandy beaches.

This turtle usually migrates along continental shelves, and feeds in shallow waters.

Diet

The Olive Ridley is an opportunistic carnivore, which probably includes scavenging. It is able to feed for long periods on a single type of food. In other places, the diet can vary and be composed of fish, Crustaceans, Molluscs, Bryozoans, Gastropods, fish egg masses, Jellyfish…

Breeding

The age at the sexual maturity of the Olive Ridley arrives generally in the females at a size of approximately 62 cm, that is to say 7 to 9 years old.

Mating usually occurs on the surface of the water and seems to be polyandrous, with several males fertilizing the same female.

Only two nests per season. Intervals between nests: 17 to 30 days. Most females return to nest from one year to the next at the same place, some after 2 or 3 years.

Presence in West Africa

Carr (1957) reports an observation at Port Etienne (= Nouadhibou, Mauritania, 21°N), as the most northerly for the species. Mint Hama et al. (2013) report the recovery at PK 65 south of Nouakchott of three carapaces of *L. olivacea*, specimens whose meat was presumably eaten by fishermen. In Senegal, the specimens cited by Cadenat (1949, 1957) and Carr (1957) have not been found in the collections of IFAN in Dakar. Despite what Maigret (1977) wrote about a possible confusion between *C. caretta* and *L. olivacea*, the description made by Cadenat (large carapace, olive green coloration, 7/7 costals)… seems to show that it was *L. olivacea*. It is possible that the hatchling in collection at the Sea Museum of Gorée (Fretey, 2001) comes from Senegalese beach, but there is no proof of this. One egg laying has been reported on the Langue de Barbarie (Fretey et al, 2012). *L. olivacea* is not known from Gambia.

For the Cape Verde Islands, Fretey (2001) reports 6 records of dead or alive stranded individuals and shells, between 1998 and 2000. An inventory of 11 observations between August 1999 and March 2011 is made by Varo Cruz *et al.* (2011). Six nests would have been observed in 2020 and 8 in 2021 on the beach Joao Barrosa (5 km long). This remains to be confirmed.

According to Catry *et al.* (2010), the Olive Ridley is quantitatively the second most common nesting species in the Bijagos Archipelago, mainly in the Orango National Park. The authors estimated 790 nests deposited during the 1992-1994 monitoring period.

Olive Ridley nesting beaches in Guinea-Bissau (Catry *et al.*, 2010), Sierra Leone in Sherbro Island and satellite islets (Fretey & Malaussena, 1991) and Liberia (Stuart & Adams, 1990) are not far from the Cape Verde Islands. There could be neritic or oceanic feeding grounds in the waters of this region and diseased individuals could drift to Cape Verdean coastal waters (Varo Cruz *et al.*, 2011).

The Green Turtle
Chelonia mydas

Description

Oval carapace in dorsal view with the width of about 88% of the length. The head is relatively small with a typically rounded snout. A pair of elongated prefrontal scales between the orbits. Lower jaw with a sharp, strongly serrated edge that corresponds to strong ridges on the inner surface of the upper jaw. The scales of the shell are very thin, smooth and flexible when removed. Those of the shell include four pairs of costals, the first ones do not touch the nuchal.

On the upper side, among adults, the general color varies from pale greenish brown to very dark. In juveniles and subadults, bright combinations of yellow, reddish-brown and greenish tones are observed, forming striped patterns, or abundantly interspersed with dark spots recalling the hawksbill turtle's patterns (hence often confused). In juveniles, the cephalic scales and the upper surfaces of the legs are bordered by a narrow clear and yellowish margin, which disappears with age. The ventral side of the throat, legs and plastron is plain white, dirty white or yellowish white

Biometry

The average size of adults is 99 cm with a weight of 145 kg. The records for height and weight are 139.5 cm and 235 kg respectively.

Habitats

Chelonia mydas is a solitary turtle that occasionally forms feeding aggregations in shallow water areas where algae or seagrass are abundant. This species migrates from nesting beaches to feeding areas that are sometimes thousands of kilometers away. Almost all migrations are along the coast.

Diet

Adult Green Turtles feed during the day in seagrass growing in shallow waters. These foraging areas are apparently less used by other Vertebrates, except Sirenians (Manatees, Dugongs), but generally these marine Mammals and Green turtles have a small overlapping distribution. Among the main foods of adult Green Turtles are seagrasses of the genus *Zoostera, Syringodium, Thalassia*. With this vegetarian food, small amounts of Invertebrates living in these beds are ingested indirectly but they usually represent less than 2% of the adults' diet..

Breeding

Estimates for sexual maturity vary from 25 to 30 years, 58 years for some authors (Chaloupka *et al.*, 2004; Balazs & Chaloupka, 2004 ; Goshe, 2002), but of course, the size and age at which sexual maturity is reached vary between individuals in a population and according to the availability and quality of food (Bjorndal *et al.*, 2000).

Reproduction includes courting of females by males, copulation and nesting. A solitary female, usually near the shore, is courted by several males; copulation begins at the start of the breeding season and stops when nesting begins. It is assumed that fertilization of eggs laid during one nesting season occurs several years earlier, and the final « meeting » between males and females is probably to fertilize eggs for the next season. Fertilization occurs early in the season and excess sperm is probably stored in a spermatheca.

Females generally show fidelity to a nesting site, and they appear to be able to return to nest near the same beach location from which they emerged as hatchlings. The interval between successive seasonal nesting migrations depends on the population, the quality of the foraging area, and the distance. Usually, the nesting interval is 2 years, but females may breed in cycles of 1, 3, or 4 years, or switch between cycles due to aging or external influences (food, etc.). Successive nests during the same season are separated by intervals of about two weeks. The majority of the Green Turtles lay between 2 and 5 times, others nest only once or more than 5 times.

Presence in West Africa

West Africa is a region of global importance for *Chelonia mydas*, hosting one of the largest populations globally (Patrício *et al.*, 2019). The major breeding site (hotspot) of this population is Poilão Island, at the southeastern edge of the Bijagós Archipelago, Guinea-Bissau (Barbosa *et al.*, 2018).

According to Pasteur & Bons (1960), C. mydas would be incidental on the Moroccan coasts, but could nest towards Menastraou on the Western Sahara coasts. In about sixty years, no confirmation of nesting has been reported in Morocco. In Mauritania, sightings of nests are reported by fishermen all around M'hejratt, Jref, Rgueiba, El Khawi, but these nesting localities are not scientifically confirmed (Mint Hama *et al.*, 2013). The northernmost point confirmed by these authors is north of Nouakchott, before the military base, at 18°15'29.9»N / 16°02'16,2»W. The large meadow on the Banc d'Arguin is a globally important feeding habitat hosting adults of various populations. The species has a large nursery in and around the Banc d'Arguin for individuals of 25 to 40 cm in size. Nesting is known to be sporadic in Senegal on the beaches north of Dakar, in particular on the Langue de Barbarie. According to Maigret (1983), egg-laying was once more numerous. Immature and adult individuals frequent the coastal meadows near Joal and in the Saloum Delta. Regular nesting, yet to be confirmed, seems to exist on Ile des Oiseaux and on the beach of Fandiong (Diagne, 1999; Fretey, 2001). Nesting in Casamance and in Gambia (between Bakay and Karlung), the importance of which should be specified, and the presence of growing areas along this coast.

The Cape Verde Archipelago is a nursery for juveniles originating from the Bijagos (19%), Surinam (38%) and Ascension Island (12%) (Monzon-Argüello et al., 2010). Four nests of *C. mydas* were noted in 2020 on the beach of João Barrosa (unpublished).

In the Bijagos Archipelago (Guinea-Bissau), 6 main nesting beaches were identified in the Orango Group with nearly 1,000 nests per year, variable in number depending on the year.

In Poilão Island, at the southeastern edge of the archipelago, an average of 27,250 nests are dug per year (Barbosa *et al.*, 2018). From the end of June to November 1, 2007, 33,991 nests were counted on Poilão (Catry *et al.*, 2010) making this islet an Atlantic and global hotspot.

After nesting, females migrate from Poilão Island to Banc D'Arguin National Park (Mauritania) of more than 1,000 km in all cases through the coastal waters and close to the coasts of Gambia, Senegal and Mauritania. For these four individuals, part of the journey took place in oceanic waters (Godley et al., 2010).

Laying recorded in Sierra Leone on Yelp Islet (Fretey & Malaussena, 1991).

The Leatherback
Dermochelys coriacea

Description

Reduced external keratinous structures: the scales are temporary and disappear in the first months after hatching; the whole body is covered with a smooth skin (although traces of scales can remain on the eyelids, the neck and the caudal crest).
Lyre-shaped carapace composed of tiny osteoderms (mosaic of dermal ossicles) and a thick (oily dermal tissue) layer. Shell is presenting seven longitudinal denticulate crests and finished by a long supracaudal spur; plastron with six not very marked longitudinal keels.
The species has a large head with powerful jaws with thin, weak and horny beaks and large pharyngeal papillae.
The dorsal coloration is dark blue to black with white or pink spots. Adults have a pink spot on the chamfer. It is now known that this unique pink spot in each individual is associated with the pineal gland (epiphysis) responsible for biological rhythms in both sexes

Biometry

Because of the morphology of the carapace, many measurements taken on the breeding beaches are imprecise. The average length of the nesting females is 159 cm, with extremes of 130 to 182 cm. Exceptional measurement of 192 cm in French Guiana (J. Fretey, unpublished).

The usual weight of adult females is 320-390 kg. Note the exceptional weight of a male captured in Wales and weighing 916 kg (Eckert & Luginbuhl, 1998).

Habitats

The Leatherback occupies a unique oceanic and trophic niche. Its thermoregulatory system permits it to move from warm tropical waters (nesting areas) to feeding habitats in cold waters (more or less 4°C).

Diet

Leatherback Turtles travel extensively and forage over a wide ocean area where they have few competitors.

Foraging areas are generally far from nesting beaches, and primarily in temperate or cold latitudes. The Leatherback presents a specialized diet of Jellyfish and other gelatinous plankton (Siphonophores, Salps). As a pelagic species, it nevertheless moves closer to the coasts, following schools of Jellyfish.

The Sunfish (*Mola mola*) is another known medusivorous, and a competitive interaction between the Leatherback and the Sunfish has been suggested.

The size of the mouth suggests that species usually associated with Jellyfish or Tunicates, such as Amphipods, are swallowed along with the main prey.

Breeding

Sexual maturity of females reached at a length of the shell of 120-140 cm. The age of sexual maturity in the Leatherback is the subject of many controversies. Some researchers estimate it at 5-6 years, others at 13-15 years, others at 25-29 years (Girondot *et al.*, 2021).

The Leatherback presents « abnormalities » in its egg laying, with many eggs (up to 16% of the total) without yolk, infertile, oval, pear-shaped, elongated and dumbbell-shaped.

An average of six to seven clutches per season (maximum 12) with an interval of 9-10 days between each of them. The remigration interval represents the minimum time necessary for a female to acquire sufficient resources to make long and exhausting migrations of several thousand kilometers from its feeding habitats to its breeding area. According to health status of females, this time is variable; it is usually 2 to 3 years but can be longer.

Presence in West Africa

Numerous sightings at sea have been made since the 1970s in Mauritania (Maigret, 1983), and several corpses found stranded in the 2000s (Mint Hama *et al.*, 2013). If the regular or sporadic nesting in Baie du Lévrier indicated by J. Maigret were to be confirmed, this would truly be the northernmost point for the eastern Atlantic. However, there is no recent evidence of Mauritanian nesting of the species, but interviews with Imraguen fishermen claim to occasionally find nests with large eggs. An old fisherman from M'Hejratt claims to have already seen *D. coriacea* nesting in November 2010 on the beach between Lemcid and Tiwilit.

Females that have nested in northern South America (Trinidad, the Guianas) frequent Mauritanian waters (Eckert, 1998), perhaps to feed.

D. coriacea has been reported to nest sporadically in various places along the Senegalese coast, particularly at the Pointe de Sangomar and towards Ndoss (Fretey, 1991). The species could nest in Casamance, but could be very rare in Gambia. A more effective monitoring of the beaches in Mauritania and Senegal could show the reality, the frequency or the absence of egg-laying.

In Guinea-Bissau, nesting records are reported in the northeastern mainland at Varela, and on the islands of Unhocomo, Orango Grande, Orangozinho, Adonga, Canhabaque, João Vieira (Limoges & Robillard, 1991; Fontaine *et al.*, 2001; Catry *et al.*, 2009). On Adonga, the number of nests per season was estimated to be between 31 and 47 for the years 1991-1994.

No observations of the species come on mainland Sierra Leone, but small area of definite nesting on Sherbro Island (Fretey & Malaussena, 1991).

III. Some general data on the species

III.1. General morphology

Externally, marine turtles appear to be composed of a carapace, a head, a neck, four limbs and a tail.

In the marine species of the family Chelonidae (all the marine turtles, except the Leatherback Turtle), the carapace is the bony box protecting the turtle's organs.

The carapace **(Figure 1)** is composed of a more or less bulging dorsal part, **the shell**, connected to a ventral part, **the plastron**, through two bony bands, **the bridges**, joining these two parts on each side of the body.

The four legs are swimming tools that rotate around their longitudinal axis to efficiently take support in the water. The phalanges are long sticks enclosed in muscles and dermis without distinct fingers **(Figure 2)**.

The front legs have the shape of long **flippers** permitting the propulsion in water. The posterior legs are shorter, in the shape of **paddles**, with a role of rudder.

Among turtles with a shell, one or two pointed and curved nails are visible on the fingers I and/or II of the flippers and the paddles. They are named **claws**. The claw of finger I is generally more developed. In adult males, it becomes long and curved and takes the shape of a hook, permitting them to cling to the shoulders of females for the copulation. The Leatherback does not have a claw.

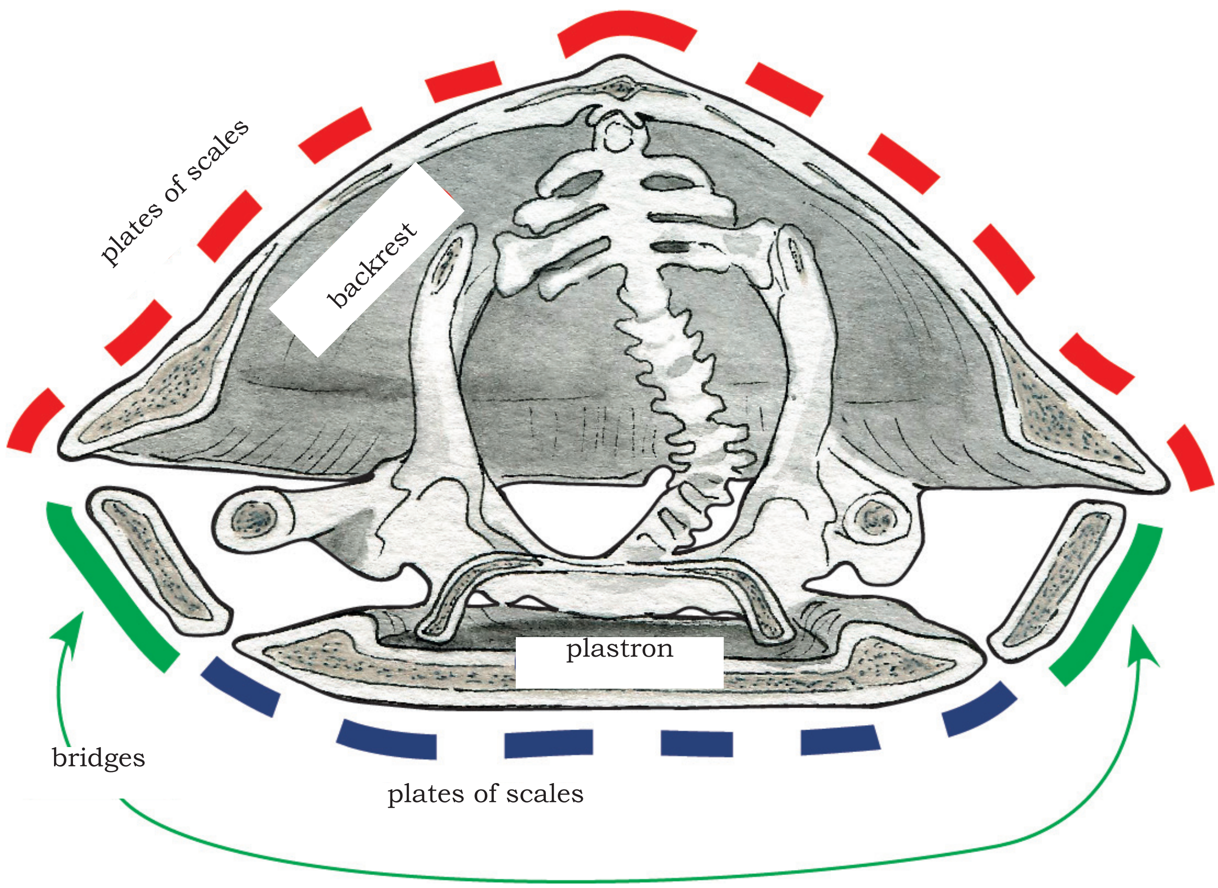


Figure 1 : The different parts of a shell (illustrated by C. Pillore)

As the carapace has a consequent volume, it creates resistances during aquatic movements. To counteract them, the carapace has evolved in marine forms towards a compromise between robustness and hydrodynamic properties, in order to move in water while keeping its protective property.

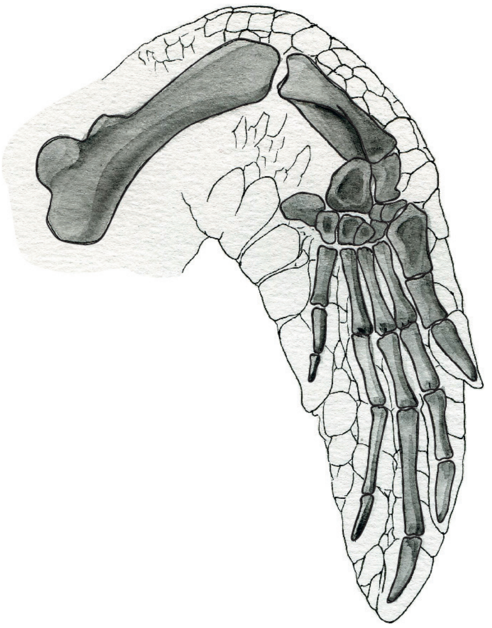


Figure 2 : Transformation of the phalanges into long rods trapped in the foreleg transformed into flippers used for propulsion. (Inspired by a Kemp's Turtle flipper dissection from the Association of Medical Illustrators, Toronto, 1998).

III.2. Some elements of anatomy

In the body cavity, the esophagus curves sharply to the left to join the stomach which leads to the small intestine with its digestive glands (liver and pancreas). The large intestine joins the distal small intestine and the digestive tract ends with the rectum **(Figure 3)**.

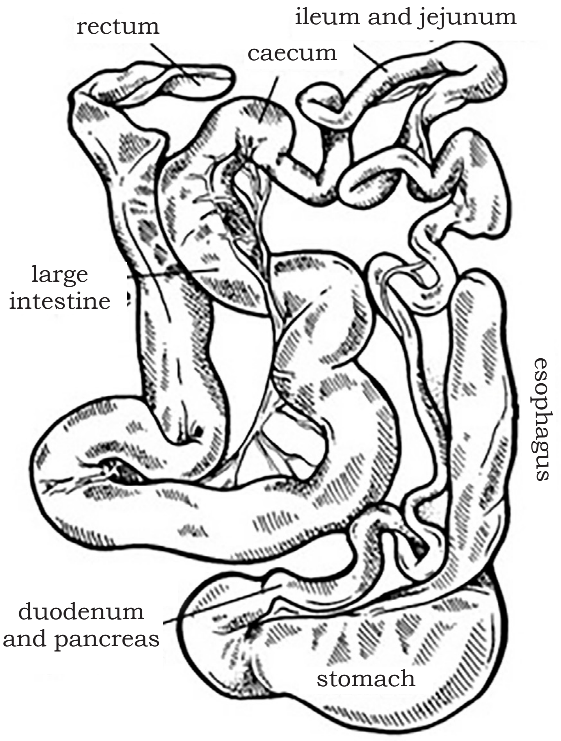


Figure 3. The digestive system of a sea turtle. (© J. Fretey)

The dense liver is composed of two lobes, with a variable size connection between both of them. The right lobe is generally larger and, on its posterior surface, houses of gallbladder, which is round. The gallbladder is usually dark green in color and may be full and convex or folded and concave when empty.

The large intestine (colon) ends in the muscular rectum that enters the cloaca, a chamber that receives urine, eggs or semen.
The urinary bladder is anatomically ventral to the rectum and hangs in the midline of the pelvis.

The pancreas is usually smooth, shiny (pink to peach colored), except in turtles that are decomposing. The green bile stain can identify the common bile duct of the gallbladder. The spleen is located near the distal end of the pancreas. It is almost round to oblong in shape, dark red, and highly vascularized.

In some species (*Lepidochelys kempii*, *L. olivacea* and *Caretta caretta*), lungs are more closely connected to the spine than in other species.
By following the trachea and then the two bronchi, the lungs are easily found. They extend over most of the length of the carapace. The gonads are found at the base of each lung.

The systemic circuit carries oxygenated blood from the heart to the head, trunk, and extremities, while the pulmonary circuit carries deoxygenated blood from the heart to the lungs. The lungs are in contact with the carapace **(Figures 4 et 5)**.

III.3. Tumors

The herpes virus associated with PF **(Figure 6)** may be transmitted by marine leeches that parasitize young turtles that are visiting a feeding habitat for the first time (figure 6). Each corpse and osteological remains should be removed from the stranding site. They should be silted up at the top of the beach.

III.4. Nomenclature of the scales

The carapace

In marine turtles, with the exception of the adult Leatherback, the body is covered with horny scutes or scales. In the newborn and juvenile Leatherback, there is a fractionation in pearly scales, not keratinized.

Each of the scutes has a name, on the head and on the carapace **(Figure 7)**. Their arrangement or number on the flippers can help in specific identification.

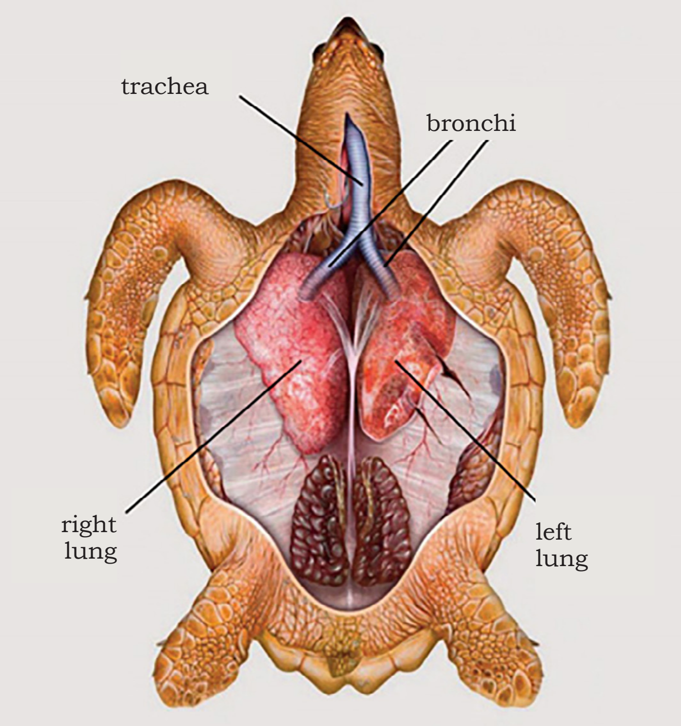


Figure 4. Respiratory system (© J. Fretey)

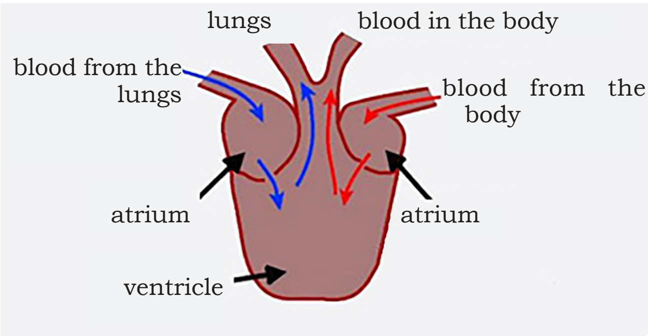


Figure 5. Marine turtles, like most reptiles, have a three-chambered heart: two atria and a ventricle with sinus venosus preceding the atria (© J. Fretey)

Figure 6. Fibropapillomatosis, commonly known as fibropapilloma or FP is a disease causing cauliflower-like tumors, often on the shoulders, on the soft parts towards the tail or on the head. These tumors can be benign or become numerous, huge and cause death. Green Turtles are the most severely affected (© J. Fretey)

The shell is covered anteriorly by a **nuchal** scute (sometimes absent or fused to neighboring scute in *Lepidochelys olivacea*), followed sagittally by **vertebrals** (generally referred to, as for rib plates, simply as vertebral, costal, ...) clamped by **costals**; the margins of the shell are covered by **marginals** extending on each side from the nuchal to the pair of **supracaudals**, at the posterior end of the shell.

On the anterior part, the plastron is lined with a first asymmetrical scute, the **intergular.** In some individuals, there is a second asymmetrical scute at the posterior end of the plastron: it is the **interanal** scute.

Posterior to the intergular and anterior to the interanal, Six pairs of large scutes synmetrical to its median line occupy the plastron: if we follow the plastron from its anterior part to its posterior part, there are the **gulars**, the **humerals**, the **pectorals**, the **abdominals**, the **femorals** and the **anals**.

Each bridge is lined in its most anterior part with a series of **axillary** scales making the junction between the large plastron scales and the ventral part of the marginal scales. Posterior to the axillary scale is a single row of large **inframarginals** that also form the junction between the large plastron scales and the ventral part of the marginal scales. In some species, pores open in the inframarginals.

The carapace of the Leatherback is provided with twelve longitudinal tuberculated ridges of which five on the back, five on the plastron and the two others on the left and right bridges **(Figure 8)**. On the shell, the vertebral ridge follows the median line and is bordered by two pairs of costal ridges: the internal costal ridge and the external costal ridge. The ridges running on the left and right bridges are the marginal ridges.

On the plastron, the umbilical ridge follows the median line and is bordered by two pairs of lateral ridges: the pectoro-abdominal ridges and the bridge ridges. The shoulder pads are the two points of the carapace delimiting the nuchal notch. The posterior end of the pseudo-shell is transformed into a more or less long and thick supracaudal spur which overhangs the tail.

The head

Head scutes are numerous and we will mention only the main ones appearing very differentiated **(Figure 9**). **Prefrontals** are usually arranged in pairs but sometimes one or more supernumerary scutes are added. They are located between the eyes, bordered anteriorly by the nostrils and, posteriorly, as their name implies, by the **frontale** (often crest-shaped) which is itself anterior to the large scute in the center of the head, the **frontoparietal**. The other scutes are not described in the text but are shown in the figures below representing a dorsal and a lateral view of the head.

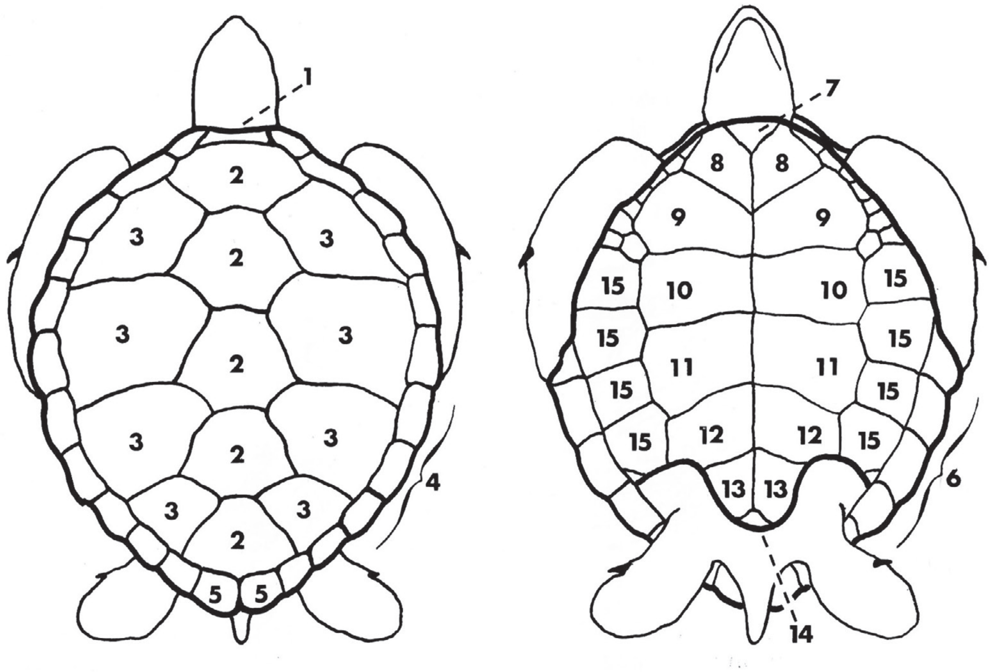


Figure 7. Names of the carapace scutes (© J. Fretey)
1: nuchal; 2: vertebrals; 3: costals; 4: upper marginals; 5: postvertebrals; 6: lower marginals; 7: intergular; 8: gulars; 9: humerals; 10: pectorals; 11: abdominals; 12: femorals; 13: anals; 14: interanal or postanal; 15: inframarginals; 16: axillaries.

The flippers

The anterior part of the base of the flippers (area of insertion of the flippers on the rest of the body) is lined by the **proximal scutes (Figure 10)**. The free end of the flippers is occupied by large **distal scutes**. Between the proximal scales and the distal scales, the anterior edge of the flipper is lined by the **leading edge scutes** while the posterior edge is lined in its proximal half by the **large posterior elbow scutes.**

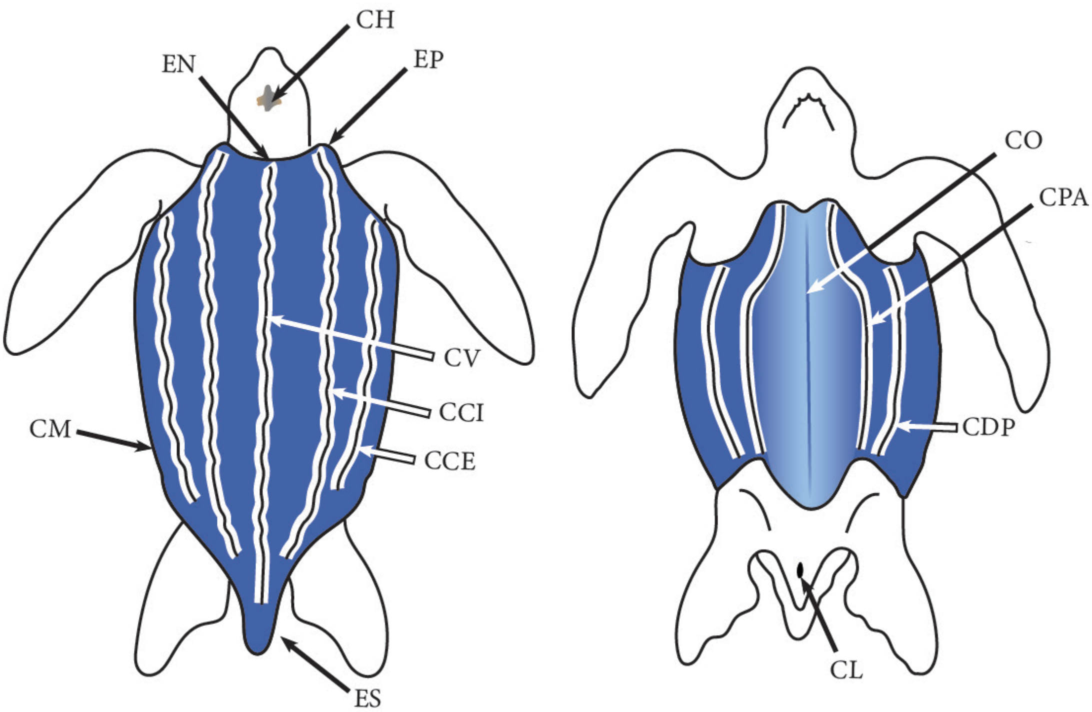
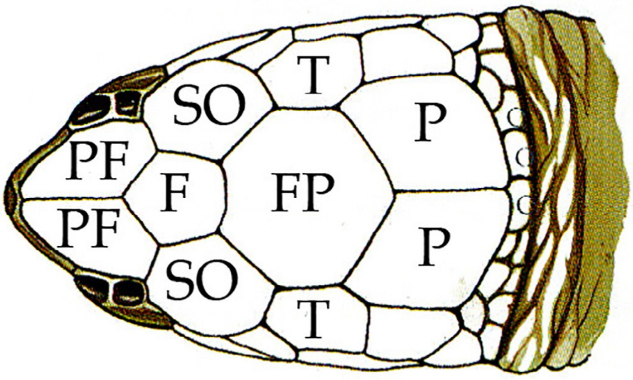


Figure 8. Nomenclature in the Leatherback Turtle (© J. Fretey) (illustrated by C. Pillore)
Back view (left): ECR: external costal ridge; ICR: internal costal ridge; BR: bridge ridge; CH: chamfer; CL: cloaca; MR: marginal ridge.
Ventral view (right): UR: umbilical ridge; PAR: pectoro-abdominal ridge; VR: vertebral ridge ; NE: nuchal notch; EP: epaulet; SR: supracaudal rostrum.



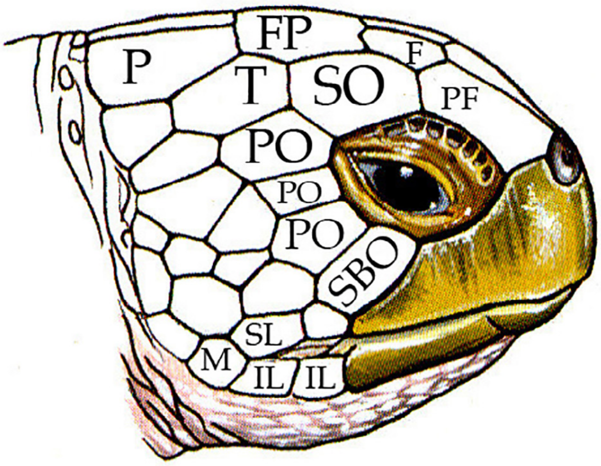


Figure 9. Nomenclature of the cephalic scales
(© J. Fretey)
F: frontal; FP: frontoparietal; Il: infralabial; M: mandibular; P: parietal; PF: prefrontal; PO: postocular; SBO: subocular; SO: supraocular; T: temporal.

III.5. The reproduction

Marine turtles spend most of their life at sea, but they are still attached to land for reproduction. At certain times of the year, adult females of all species come to the beaches to nest in a hole (the nest) that they dig in the substrate (from very fine sand to coarse gravel), at a greater or lesser distance from the sea and backshore vegetation. They come to lay eggs several times during a season **(Table I)**.

Natural nests: complex ecosystems

The nest of a marine turtle is a real ecosystem in itself **(Figure 11)**. Its depth varies according to the species and the size of the hind legs of the female, from 30 to approximately 80 cm. In species having created a pit as the Green Turtle, the angle of position of the female will determine the total depth. A strong tide can decrease this depth by eroding the sandy layer or, conversely, another female installed next to the nest can, by sweeping, bring sand on top. The incubation habitat in which the eggs develop must be relatively humid, but not too humid, with a low salinity and a well-ventilated environment.

The embryos are vulnerable to extreme environmental conditions in four areas: substrate moisture and salinity, gas exchange and temperature.

The characteristics of the sand (color, composition, compaction, etc.) surrounding the eggs are important. They determine the humidity level which, within the nest, during the two months or so of embryonic development, is essential to maintain the temperature, salt and gas exchange for the correct development of the embryos.

Within each egg, the embryo has a vital need to exchange respiratory gases with the outside. Since

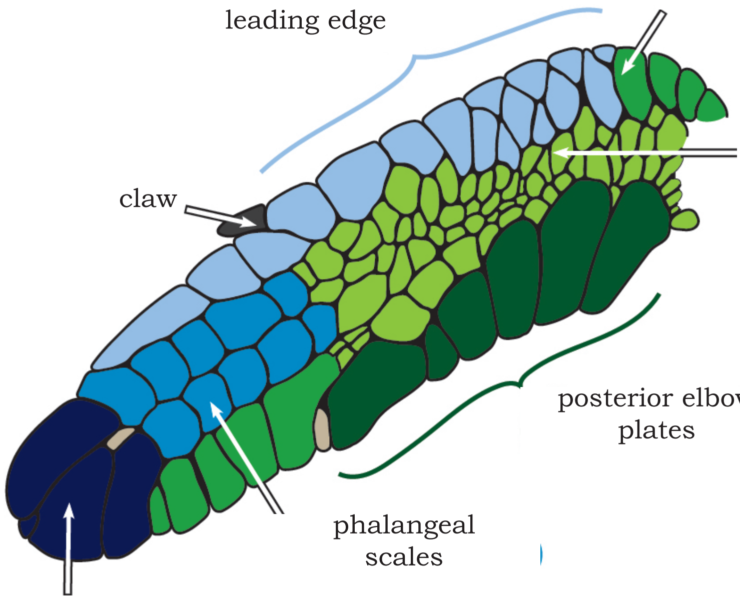


Figure 10. Nomenclature of flipper scutes (©Dawn illustration and Design) (illustrated by C. Pillore)

Table I : Typical number of clutches by species and season (© J. Fretey)

Species	*Loggerhead turtle*	*Hawksbill turtle*	*Olive Ridley*	*Green turtle*	*Leatherback turtle*
Number of clut-ches by season	7	5	2	5	7 (maxi : 12)

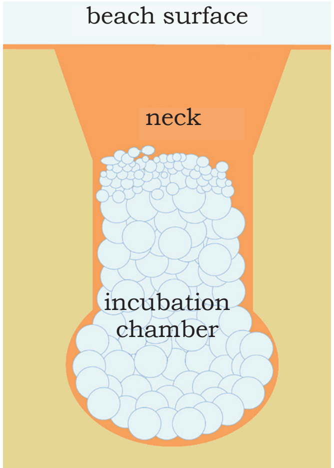


Figure 11. Different parts of a nest (©Study.com)

the eggs will be surrounded on all sides by sand grains, the gases that would normally diffuse in and out of the eggs can be prevented by a too compact sand barrier, so the grain size of the sand is an important environmental factor.

These different factors, as well as the location of the nest in relation to the sea and the vegetation, and the position of each egg inside the chamber, influence the ambient temperature, which, during a short thermosensitive period, determines the sex.

The nest is then filled in and the females return to the sea. This event is called nesting. It is composed of a sequence of successive stages lasting, on average, all species combined, between 45 minutes and 3 hours. It is a therefore a privileged moment to approach the females and to collect a whole series of information of great interest for a marine protected area. Depending on the species and the temperature of the substrate, the incubation time will be slightly shorter or longer than 2 months (theoretically between 45 and 78 days, but exceptionally up to 90 days, **Table II**).

The definition of a clutch. Real egg and false egg

We called « clutch » all the eggs evacuated by a female turtle during a single nesting **(Tableau III)**.

The mature, unfertilized female sex cell or gamete produced by the ovary is called an oocyte. The oocyte does not contain a yolk. The yolk is the part of the egg that serves as a source of food and energy for the development of the embryo. The yolk and the germinal disc form a single cell.
The egg is theoretically the fertilized state of an oocyte with the genetic material of a male gamete. But in its usual sense, the egg is the product of the laying whether it is fertilized or not, and whether it contains an embryo or not. In a marine turtle clutch, there can be unfertilized eggs (clear eggs), without yolk, that will not give any embryo development. In the Leatherback, the clutch contains a number of infertile eggs sometimes equal to a third of the total number of eggs; they are usually laid last, even when the female goes back to the sea.

Analysis of the content of a nest after emergence

A nest after emergence of neonates contains **(Figure 12)** :

1) Empty membranes composed of two more or less separated but whole shells;
2) Fragments of membranes;
3) Clear eggs without embryo development; these eggs are white, more or less spotted, swollen into spheres;
4) Rotten eggs swollen into spheres, dry and shriveled or deliquescent;
5) Rotten eggs penetrated by roots;
6) Rotten eggs with small holes indicating invertebrate predator attack;
7) White cracked eggs with a small turtle ready to emerge, alive or dead;
8) Unbroken, often wilted, yellowish eggs with a full-term embryo (stage 31), alive or dead;
9) Wilted eggs with a small turtle at hatching (head and one or two front legs out), alive or dead;
10) An ascending hatchling, alive or dead;
11) Spherical or wilted, yellowish eggs with a dead embryo inside (various stages);
12) Dead neonates due to predation within the nest, often emptied of their internal contents.

Table II : Incubation time values for the different species nesting on West African beaches (© J. Fretey)

Species	Average incubation time (in days)	Minimum and maximum extreme incubation times (in days)
Loggerhead	58	49-67
Hawksbill turtle	56	45-75
Olive Ridley	54	45-65
Green turtle	58	48-88
Leatherback turtle	60	50-78

Table III : Characteristics of clutches and eggs in species from the Rampao area (© J. Fretey)

Species	Average number of eggs	Limit values of eggs	Average diameter of an egg (cm)	Average weight of an egg (g)
Loggerhead turtle	112	40-190	40,9	32,7
Hawksbill turtle	130	50-250	37,8	26,6
Olive Ridley	110	90-182	39,3	35,7
Green turtle	113	38-195	44,9	46,1
Leatherback turtle	81	10-160	53,4	75,9

Full-term embryos use a small, hard growth at the tip of the upper beak (« egg tooth » or oviruptor) to pierce the various membranes. After the hatchlings emerge, as the extra-embryonic fluids drain into the substrate and the empty membranes are dragged to the bottom of the incubation chamber by emergence actions, the nest contents have greatly diminished in volume. New-born turtles gather in columns, embraced the ones in the others. They sleep and if one of them moves, a wave spreads from a turtle to another one and all are agitated. The ones on top scratch the sand and the ones on the bottom, moving, compact it. The column thus rises towards the surface. Usually a drop in temperature (daylight, rain) causes the emergence from the nest. We will see in Chapter V that all the eggs are not fertile and that all the hatchlings do not arrive at the surface.

A fairly good estimate of the sex ratio of turtles emerging from a nest can be obtained by looking at the average temperature value in the middle of the eggs during the second third of incubation. The pivotal temperature above which the feminization of the embryos is 100% is known for each species **(Table IV)**.

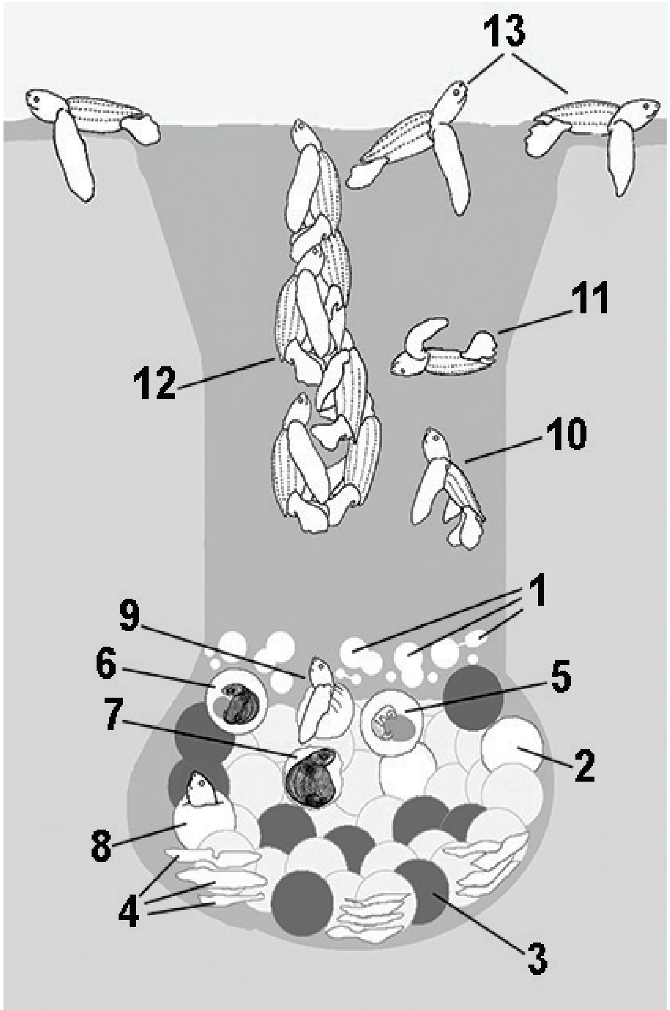


Figure 12. Diagram of a leatherback nest during the ascent of hatchlings (© J. Fretey)

1.Infertile eggs; 2. Clear egg without development; 3. Rotten egg; 4. Empty membranes; 5. Embryo dead at stage 28; 6. Embryo dead at stage 29; 7. Embryo dead at stage 30 just before hatching; 8. Neonate dead at hatching; 9. Hatchling alive at hatching; 10. Live neonate not joining the column and destined to die; 11. Hatchling isolated from the column and dead; 12. Ascending neonate column; 13. Emerging.

Determination of hatching success

The rotting of an egg or the brutal mortality of an embryo can have various causes: cooling, excess of humidity, lethal temperature,...

We can distinguish an emergence success from an incubation success.
The success of emergence takes into account only the new-born turtles gone out of the nest by themselves. The incubation success counts the emerging hatchlings, the hatchlings found alive or dead in the nest pit, the hatchlings alive or dead. The calculation is done with the total number of eggs (to be specified if infertile eggs are counted or not) and results in a percentage.
Therefore, it is necessary to remember:

Emergence success:
(Number of emerging hatchlings/total number of eggs) x 100.

Success of incubation:
(Number of hatched eggs/total number of eggs) x 100.

Table IV : Pivotal temperature for each species of turtle nesting on the West African coast (© J. Fretey)

Species	Pivot temperature
Loggerhead	28,74°C
Hawksbill	29,32°C
Olive Ridley	29,13°C
Green Turtle	28,26°C
Leatherback	29,50°C

III.6. Natural predators and predatory pets

The natural threats that can cause the destruction of a nest of marine turtles are numerous. This destruction can easily reach 100%, by rotting, with a nest invaded by roots, or with a nest completely uncovered by the erosion related to the waves.

When the terrestrial fauna of a protected area is rich, it is natural to observe interactions between species, predators and prey. In West Africa, the main cause of predation on eggs and emerging hatchlings is often the Ghost Crab (*Ocypode cursor*). The predation rate can reach more than 50% on some nesting sites with high crab population density.

Studies (Fretey, 1976; Fowler, 1979) in South and Central America have shown that a Ghost crab gallery to a nest, before closing by collapsing sand, attracts flies because of the odors of the nests, pierced by the crabs. After the flies, these odors will attract mammals, which will dig and often completely destroy a turtle nest, while the Ghost crabs had destroyed only 2 or 3 eggs.

The eggs can also be attacked by ants, mites,...

During their race towards the sea, the hatchlings, sometimes slowed down by obstacles, are easy preys for Ghost crabs. The secondary predators are most of the time crows (Pied Crow, Brown-necked Raven...). And where present, the Jackal is a formidable nest digger.

In terms of conservation, there are no nice hatchlings being eaten by nasty predators. This predation is a natural threat so humans, especially in a protected area, should not intervene but the reality is that the Ghost crab is a common species, while all marine turtles are in decline on a global scale.

When a marine protected area has a village nearby, many threats can arise to nests and emerging newborn turtles: stray dogs and cats, pigs, etc. Poorly managed village garbage on the backshore can lead to a thriving rat population that will be formidable predators.

IV. The different habitats

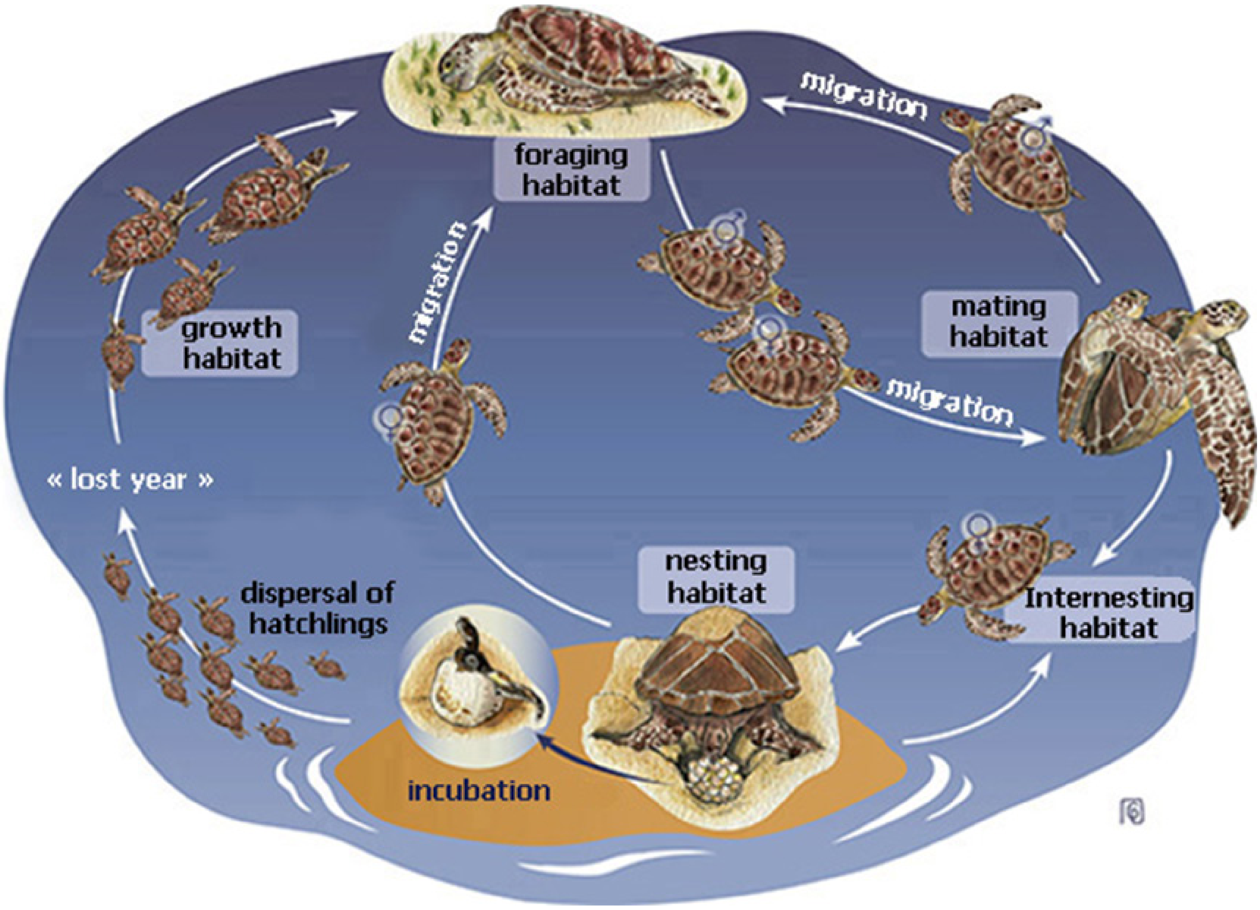


Figure 13. Schematic life cycle of marine turtles (adapted from Lanyon *et al.*, 1989 by C. Pillore)

Marine turtles have a complex life cycle including, according to the age classes, more or less long stays in different biocenosis, sometimes neritic, sometimes benthic and for the adult females and the first reproductive stages (eggs, embryos, hatchlings) terrestrial areas, sandy or not. During its life, an individual, according to its species and its population, will occupy very different habitats, coastal or in open sea **(Figures 13 and 14)**.

A turtle will change of habitat during its life cycle, but sometimes also during the nycthemeral rhythm.

IV.1. Coastal habitats

Breeding habitat

At the beginning of the breeding season, the behavior of adult males is social and active, while that of adult females is mainly solitary and inactive. In breeding habitats, close to the coast or not, in deep water or not, several males can compete for the same female. The male accepted by the female clings on it with his long-curved claws. The couple can be carried away at rising tide by waves and run around on a beach.

Except for the Leatherback Turtle, species mate along a migratory corridor or in a foraging habitat, most often very close to the coast and a nesting beach.

Internesting habitat

A female nests several times per season. Between landings, females are generally resident in the vicinity of the site(s) where they nest. This internesting habitat may be close to the coast, less than 20 km away, and may require, for a marine protected area, to maintain its integrity, especially if it is close to a commercial port with dangerous ship traffic, or of an urban area or a polluting industry.
Between two nesting seasons, females return to their foraging habitat to which they are generally faithful. They reconstitute their fat energy reserves there before leaving again 1,

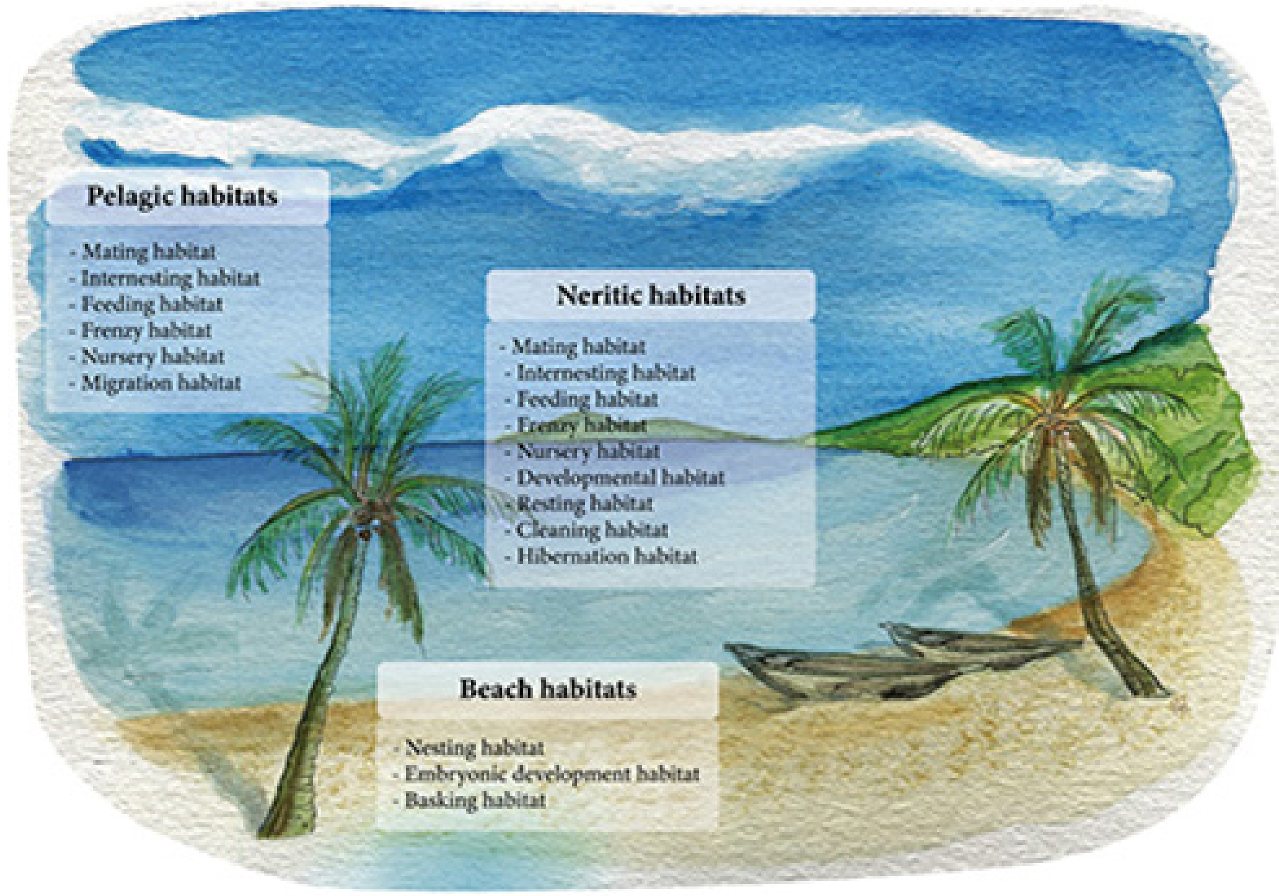


Figure 14. Figure 14. Different habitats of marine turtles from the coast to the pelagic environment (© J. Fretey et P. Triplet, 2020) (illustated by C. Pillore)

2, 3 or 4 years later towards their nesting habitat at a few hundred kilometers but sometimes over much longer distances, which is often the case for the Leatherback and the Green Turtle

Frenzy habitats and nurseries

After racing out to sea from the nesting hole and leaving the birth beach (nesting habitat) and after their often violent entry into the waves, hatchlings will swim rapidly offshore during a « *frenzy period* », against the current, for about 24 hours. This is a period during which a hatchling Green Turtle, for example, moves at an average speed of 1.58 km/h.

After this time of agitation, the young turtles make minimal movements, usually residing in a nursery habitat in deep oceanic waters where they remain for several years.

The « passive pelagic migration » is still not well known in most species where the young turtles would drift with the currents for a period of time called *lost years*.

Growing or developmental habitat

This is a habitat or series of habitats where young turtles and subadults pass through and stay as they grow to adult size. Growth is slow for some species, so residence in a developmental habitat can sometimes last for decades.

It seems that, during their first months of life, most young turtles do not always disperse with the ocean currents and do not drift passively, but they swim very actively towards favorable habitats.

These habitats of development, more or less coastal, rarely correspond, for the same species, to a feeding area of the adults.

Once they reach a certain size, except for the Leatherback and the Loggerhead which remain pelagic, young turtles have enough swimming power to break free from the currents and reach a coastal habitat for a benthic stage of development

.

Foraging habitat

Each type of feeding specific to each species determines the presence of turtles in different residential habitats.

Foraging habitat consists of coastal or offshore areas where sexually immature or mature sea turtles feed, sometimes in a gregarious manner. Tropical seagrass, coral reefs, and sedimentary estuaries are often feeding areas. Adult turtles spend most of their lives in adult-only feeding habitat, rarely with immatures.

The food choices of species, and hence their habitats, influence their growth rate and age of maturity. Demographic differences are attributable to variability in diet, quality and quantity of resources ingested.

Marine resting habitat

Near the coast, sea turtles, between periods of activity, may rest on the bottom, sometimes with part of their body in a rocky cavity, and remain there between two ascents to the surface to breathe and then search for food at various depths.

Hibernation or wintering habitat

This is a winter lethargy and not a true wintering. The dormancy of a turtle, usually on a sandy or muddy bottom, happens during a significant decrease of the sea water temperature. A temperature threshold for going dormant is assumed to be just below 15°C. Dormant turtles are often buried in sediments, covered with mud. In a state of light anaerobic dormancy, they must however come up (at night it seems) to breathe, demonstrating it is not a deep hibernation.

Cleaning station

Some species (*Chelonia mydas*, *Caretta caretta*...) may have a preferred location, free of predators and turbulent water movements, where they can intentionally rest and be cleaned by fishes or crustaceans. Scientists do not know how such symbiotic associations and cleaning stations are established, and how turtles identify them.

IV.2. Terrestrial habitats

Nesting habitat

Any coastal land area where at least one female of any species has nest in historical times is considered as nesting habitat for marine turtles.

Although it is not entirely clear why some beaches are used by sea turtles to nest and others are not (which to us, humans, seem more « beautiful » and attractive), nesting habitats must meet a number of factors and requirements. The site must be easily accessible from the ocean; this criterion will be different for a female Leatherback and a female Hawksbill, for example. The first one will avoid rocks or any other abrasive obstacle likely to cause injuries to its body devoid of scales and horny scutes. Conversely, the second one, in an armor, will not hesitate to pass sharp *beach-rocks*[1]. Theoretically, the nest must be able to be dug in a non-floodable place at high tides, and the substrate must have cohesion of grains permitting the solid construction of a well and an incubation chamber. The substrate, most often fine sand, must be such as to facilitate the diffusion of gases, not to retain too much moisture and to have temperatures favorable to a good embryonic development.

One of the most remarkable and mysterious elements of sea turtle biology is the ability of some adult females to return to nest in the geographic area where they were born, often after traveling thousands of miles. English speakers call this phenomenon natal homing, which could be translated as « return to the fold ». This philopatry is not systematic, neither to all species, not to all populations within a species.

It is often assumed that most nesting females show some degree of fidelity to a nesting habitat, returning cyclically to the same beach to nest at intervals of one or more years.

Research have introduced the idea that a magnetic impregnation of the future geographic nesting area occurs in hatchlings during the phase of departure towards the open sea and away from the natal beach.

This terrestrial nesting habitat includes the three littoral stages of the emerged part, more or less long, of the beaches: infra littoral zone, intertidal or mediolittoral zone (foreshore), supralittoral zone.

After ascending the generally slope of a beach, the female stops at the point where she will dig the nest. The Leatherback, like the Loggerhead turtle, nests in a very wide-open area, but the space of the first one goes flush with the waves to the limit of the shrubby vegetation, and she can dig in grassy or creeping Ipomoea areas. The Green Turtle nests either in open areas or under the first branches of shrubs at the top of the beach. Olive Ridley turtles commonly use narrow beaches on the edge of lagoons or estuaries. The Hawksbill turtle can easily cross rocks and coral debris to reach a beach of coarse substrate; this species goes the farthest inland, making its way through low shrub vegetation at the supra-littoral level, and even beyond towards houses and roads **(Figure 15)**.

Embryonic development habitat

Once the site is chosen, the female digs a cylindrical pit with alternating work of the hind legs. The bottom is enlarged to form a chamber where the eggs pile up.

The embryos are vulnerable to four extreme environmental conditions: substrate moisture and salinity, gas exchange and temperature.

The characteristics of the sand (color, composition, compaction, etc.) that surrounds the eggs are important in determining moisture levels during the two months or so of embryonic development. Moisture levels within the nest may be critical to maintaining the temperature, salinity and gas exchange necessary for proper embryo development.

Another consideration in optimizing the nesting environment is the grain size of the sand. In each egg, the embryo has the vital need to exchange respiratory gases with the outside, because eggs will be surrounded on all sides by sand grains, gases that would normally diffuse in and out of eggs can be inhibited by a too compact sand barrier

1 Rocky slabs resulting from a cementing of the sand, and spreading out parallel to the shore

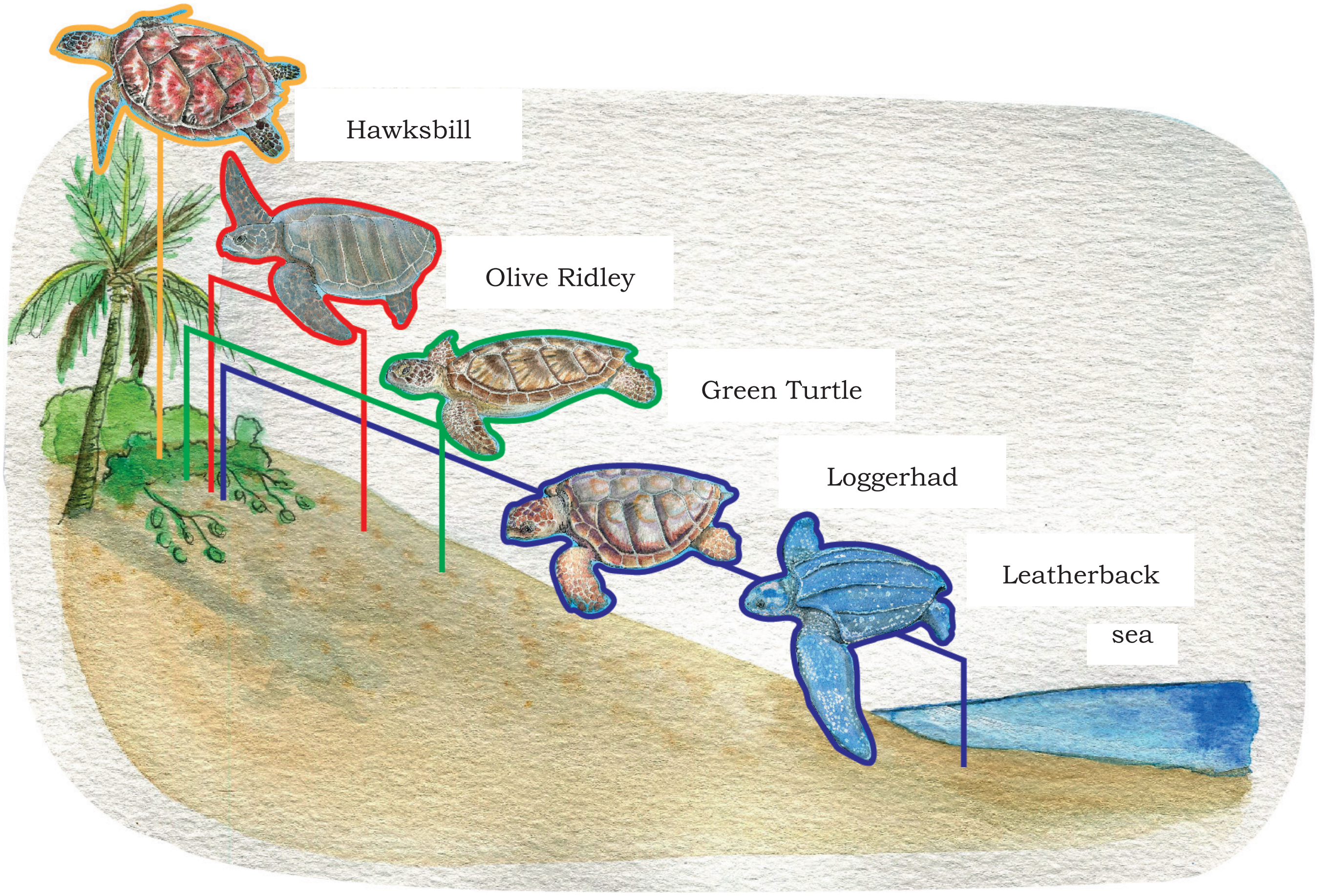


Figure 15. Spatial distribution of species in nesting habitat (inspire de ONF-Guadeloupe) (illustrated by C. Pillore)

V. Identification of species found in West Africa

V.1. Adultes and large immatures

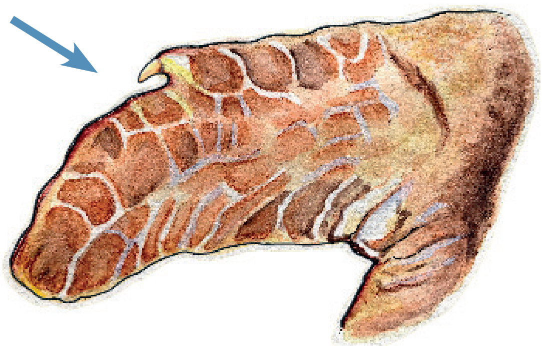
Identification key for adults and large immatures marine turtle species on West African coasts

This key is theoretical. It can not take into account aberrations of scutes nor hybrid individuals. Contrary to the usual keys, we have deliberately multiplied the characters.
To identify a turtle in front of you, look at each drawing below and choose the one that seems to fit you.
Each drawing leads to a species or to other characters. Let you guide...

A turtle to identify has...

1

A bony carapace covered with well differentiated scutes. Size of the carapace lower than 1.30 m. General coloration from grey-green to brown red.

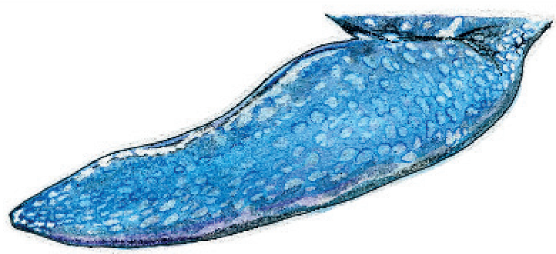


Flippers covered with a skin with scutes.
Presence of 1 or 2 claws

→ See **3.1** and **3.2**

2

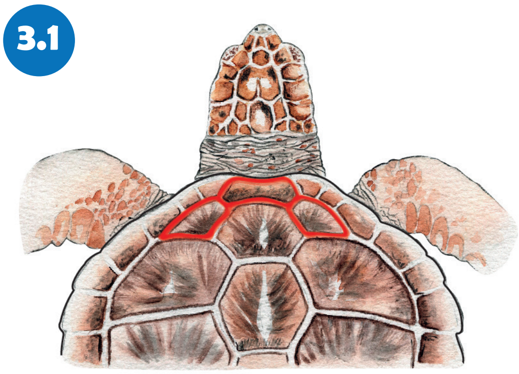
A pseudo-carapace made up of a thick layer of fat where are included hundred small ossified nodules covered with a fine smooth, brilliant, of blue cobalt, blue midnight to blue steel skin. Size of the carapace higher than 1,30 m.



Flippers without scute or claws

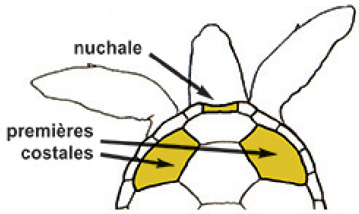
It is a
Leatherback turtle
(Dermochelys coriacea)

3.1

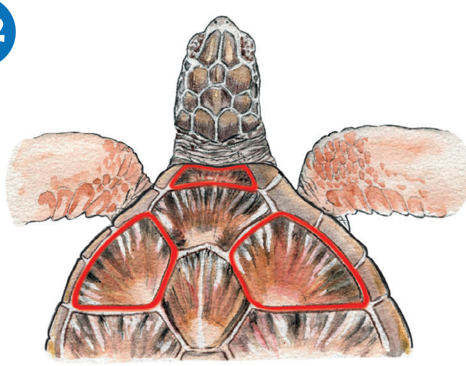


The nuchal is in contact with the first costals

See **4**

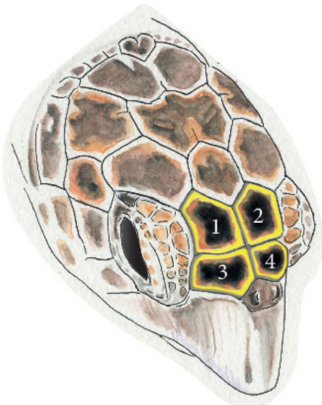


3.2



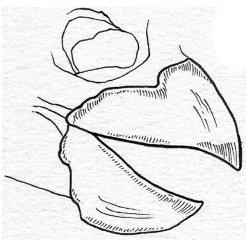
The nuchal is not in contact with the first costals

Scutes of carapace imbricated



Presence of 4 prefrontals

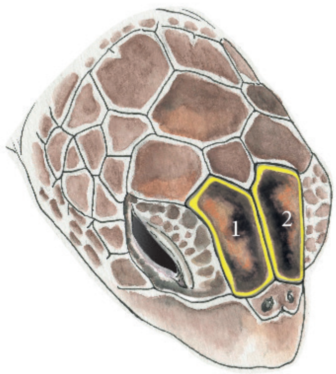
Elongated snouth with a long and hooked upper beak



Strong beaks with non-denticulated edges

It is a Hawksbill turtle
(Eretmochelys imbricata)

Scutes of the carapace always juxtaposed



Présence de 2 prefrontals

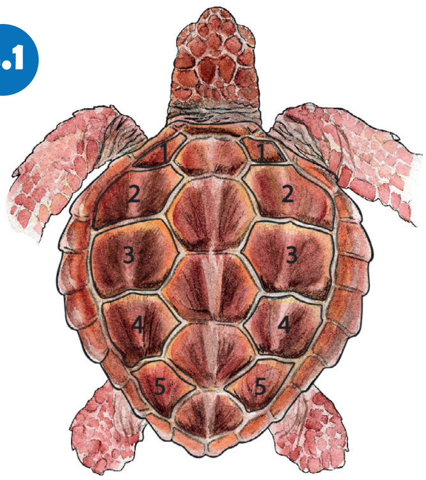
Short and rounded snout

Weak beaks with denticulated edges

It is a Green turtle
(Chelonia mydas)

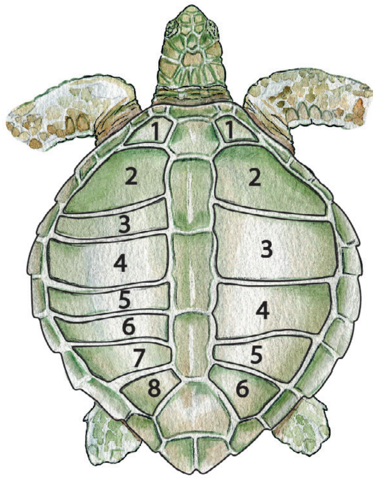
4

4.1



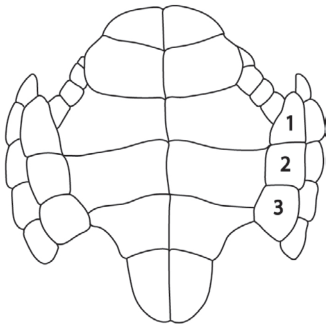
Usually 5 pairs of symmetrical costals

4.2



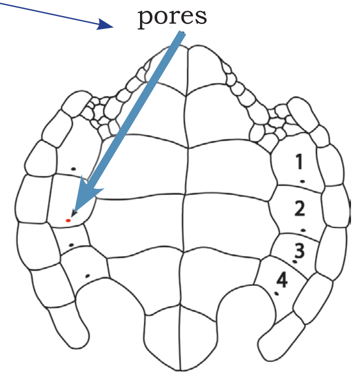
Usually more than 5 pairs of asymmetric costals

no pores

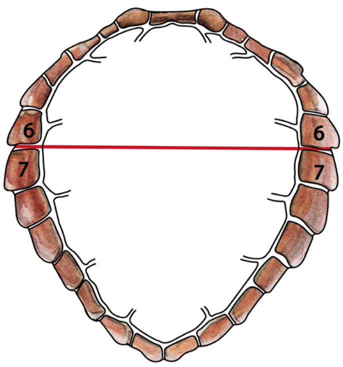


3 pairs of inframarginals without pores

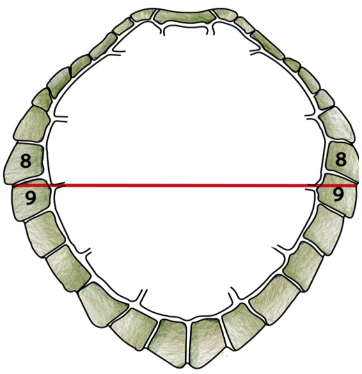
pores



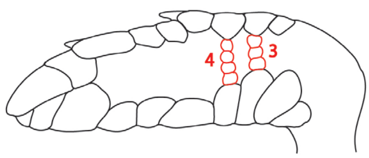
4 pairs of inframarginals with pores



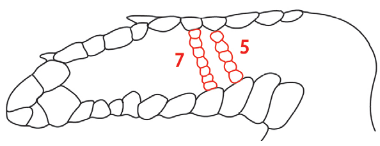
Largest width of the carapace at marginal level 6 and 7



Greater width on the carapace at marginals 8 and 9



3 or 4 small intermediate scutes on the flippers between the large scutes

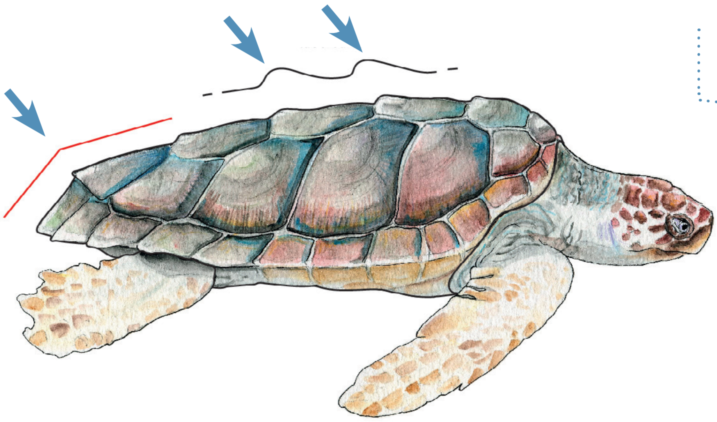


5 or 7 (rarely 4) small intermediate scutes on the flippers between the large scutes

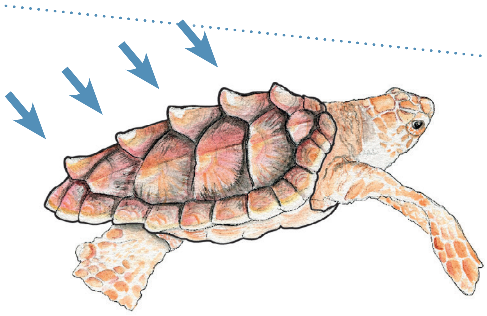
It is a Lepidochelyd

See 5

Continuation of the identification key next page



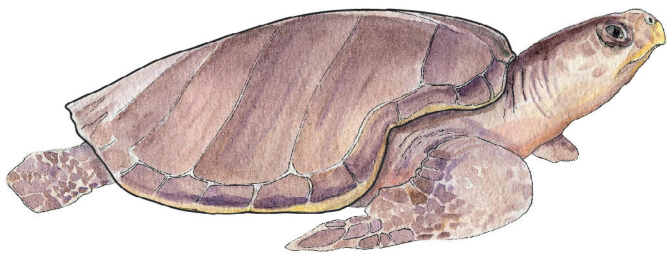
In adults, the profile oh the carapace has blunt tubercles and a typical posterior break



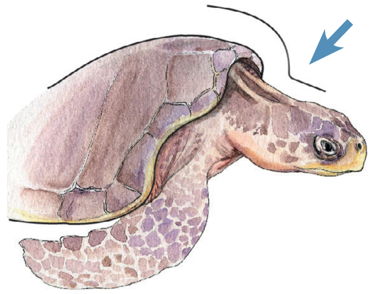
juvenile

It is a Loggerhead
(Caretta caretta)

5

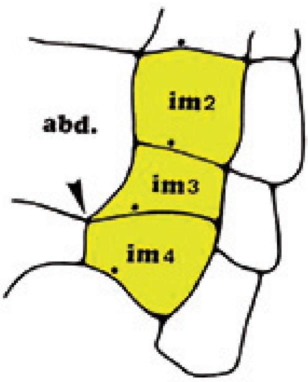


Smooth and without tubercles on adult carapace

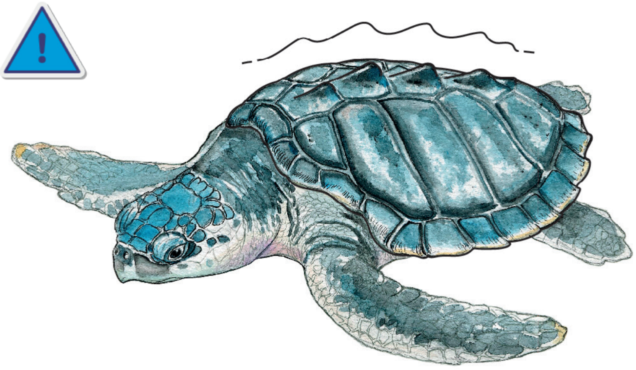


hunchbacked appearance

5.1



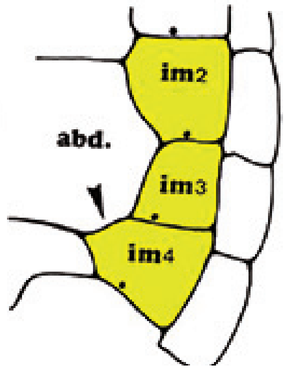
Absence of abdominal suture



Immatures which can present vertebral tubercles like the young Loggerhead

It is a
Kemp's Ridley
(Lepidochelys kempii)

5.2



Large abdominal suture separating in part the inframarginals 3 and 4

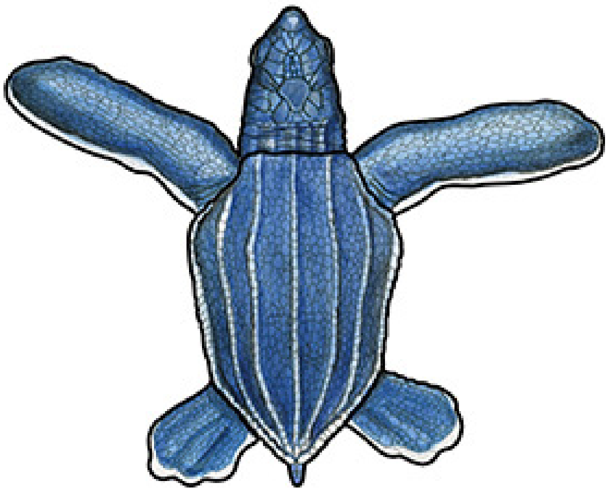
It is a
Olive Ridley
(Lepidochelys olivacea)

V.2. Hatchlings and juveniles

1a

Top of carapace covered with small beaded and polygonal scales; presence of 7 longitudinal ridges (including those on the edges). Flippers as long as the carapace. General coloration black with white marks. Size of 55-60 mm.

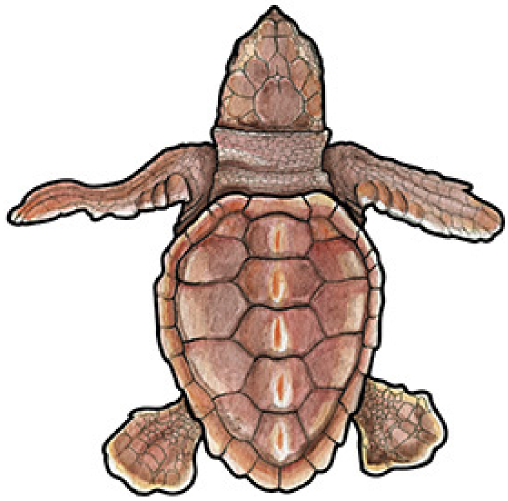
It is a
Leatherback Turtle
(Dermochelys coriacea)



1b

1b. Top of carapace covered with geometrically shaped horny scutes; presence of at most 3 longitudinal ridges; flippers shorter than the carapace; general earthy grey, dark blue-grey to reddish-brown coloration, with no real contrast. Size less than 60 mm.

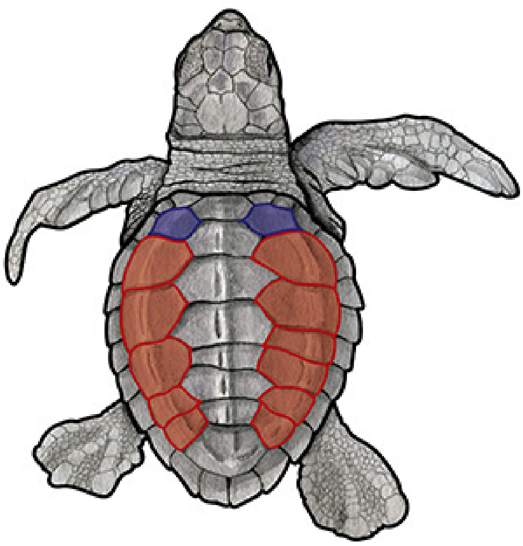
→ See **2a** and **2b**



2a

Five or more pairs of costal scutes, the first ones touching the nuchal scute. First costal (in blue) half as high as the following ones.

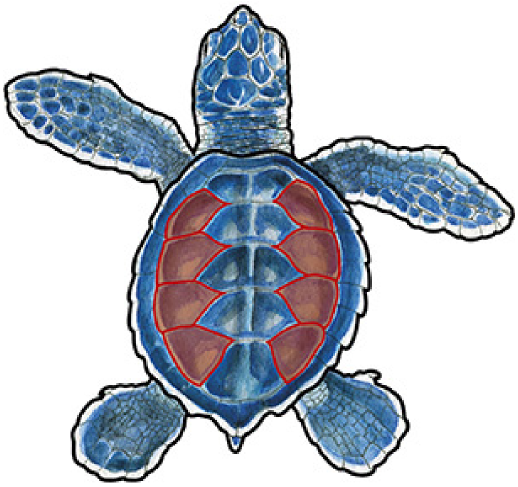
→ Voir **3a** et **3b**



2b

Four pairs of costal scutes of equivalent size, the first ones not touching the nuchal scute.

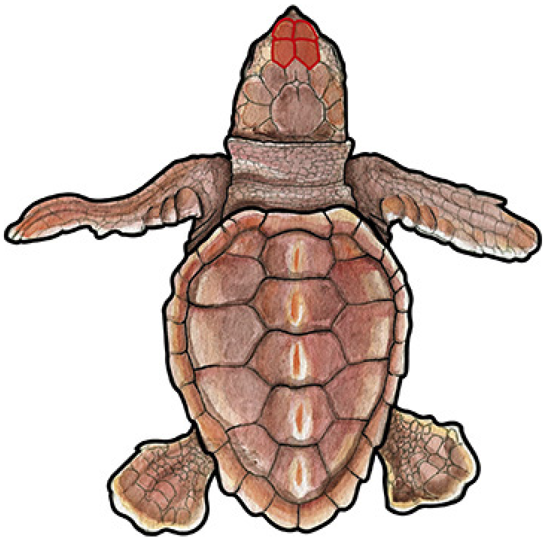
→ See **4a** and **4b**



3a

Five pairs of costal and five vertebrals. Pre-frontals divided into more than 4 scales. Golden brown to reddish-brown shell.

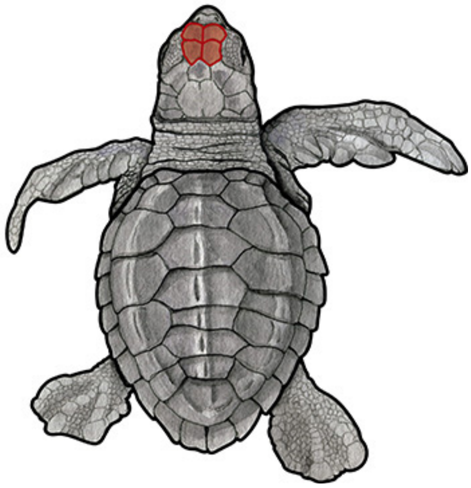
It is a
Loggerhead
(Caretta caretta)



3b

Usually more than five pairs of costals, often asymmetrical, and more than five vertebrals. Two pairs of prefrontals. Ashy grey, khaki green, olive green or ochre-brown shell .

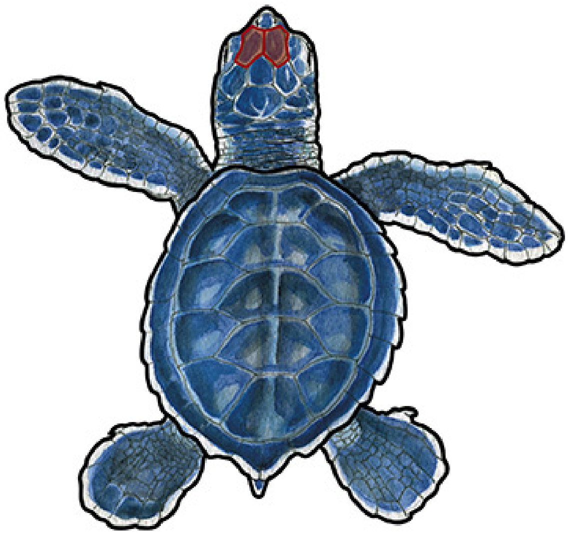
It is a
Olive Ridley
(Lepidochelys olivacea))



4a

Only one pair of prefrontals. Blue-back shell with white marginalia. Plastron and throat creamy white; head scales blackish with a pale border.

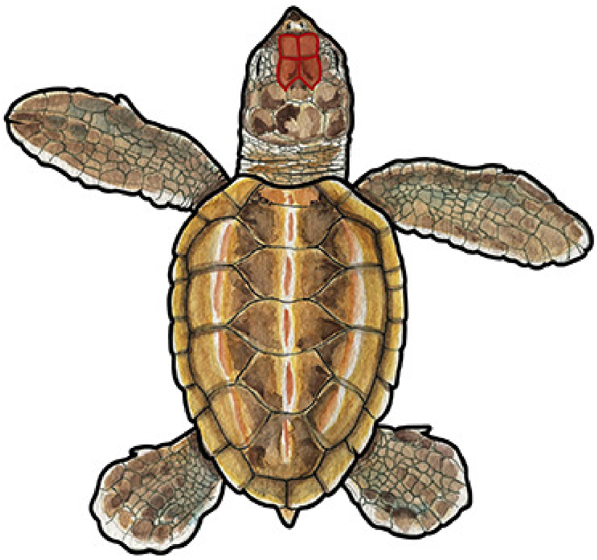
It is a
Green turtle
(Chelonia mydas)



4b

Two pairs of prefrontals. Golden brown to chocolate back and marginals; top of the head golden with brown mottling; plastron and throat dark color.

It is a
Hawksbill Turtle
(Eretmochelys imbricata)



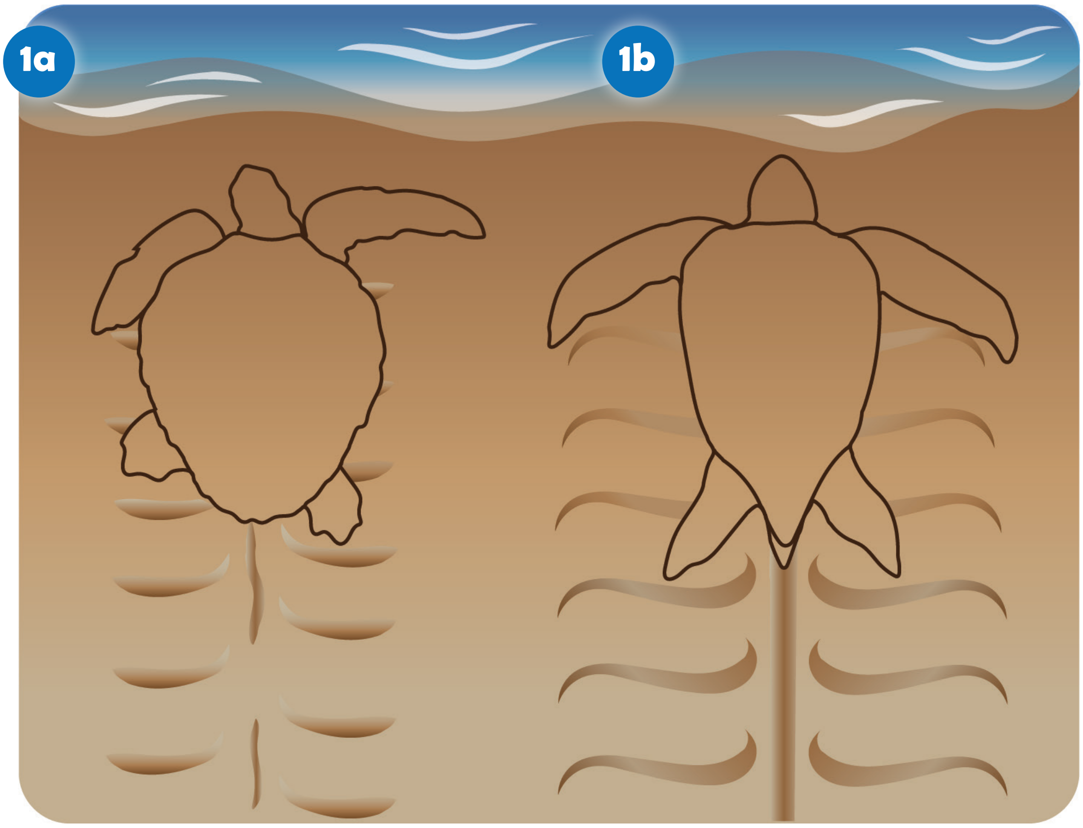
V.3. How to distinguish tracks and identify species?

During their stay on a beach, the flippers, the back legs and sometimes the tip of the tail of the female leave tracks of their locomotion, more or less deeply in the sand. They form, according to the species, zigzags either symmetrical, or alternated, on a more or less important width.

1

In marine turtles, there are two types of terrestrial locomotion: the simultaneous type where the four limbs are carried forward at the same time (Leatherback and Green Turtle) by tilting the whole body forward, and the alternating type where a front limb and the rear limb of the opposite side are carried forward at the same time (Loggerhead, Olive Ridley, Hawksbill). These two types of locomotion are at the origin of two different groups of tracks: symmetrical tracks (simultaneous type) and non-symmetrical tracks (alternating type).

It is difficult to determine a key for the tracks of the different species because their visibility greatly depends of the granulometry of the substrate and of their age. However, we propose here some useful indications for their identification. We advise to take photos« vertically » of the suspicious tracks in order to be able to return later on their identification.



Asymmetrical trace in commas

Symmetrical chevron traces

See 2

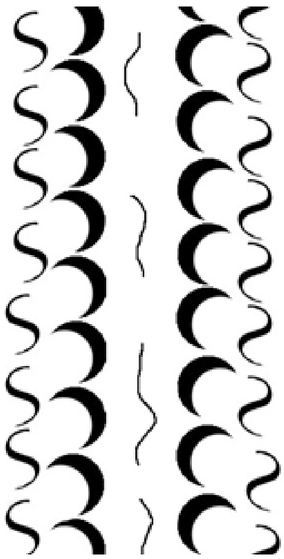
See 3

2

The two halves of the trace do not appear like an image and its reflection in a mirror, but are offset from each other, with comma-shaped marks.

In the Loggerhead, the track is made up of rather marked alternating prints left by the flippers; this track is moreover deprived of a caudal furrow. Its width is between 70 and 130 cm. The Hawksbill track is similar but there is usually a sinuous caudal groove in the center of the track. The track measures 70 to 85 cm broad. The track of an Olive Ridley Turtle measures 70 to 80 cm thus can be confused with the track of the Hawksbill, but the caudal furrow is only very seldom visible. The tracks of the Hawksbill turtle and the Olive Ridley Turtle are therefore quite difficult to differentiate even if the prints of the Hawksbill turtle's limbs are deeper than those of the Olive Ridley. In fact, it is necessary to keep in mind that both species do not use the same type of habitat for their nesting: the Olive Ridley prefers open areas and will therefore settle more readily on the sandy bank, whereas the Hawksbill will rather seek to hide in grassy or shrubby vegetation, after making a long journey in search of the preferred site. The tracks of the Hawksbill can thus appear very discreet, in particular when the female crossed an area covered with pebbles or with a dense creeping vegetation. The presence of low broken branches in the shrubby thickets will sometimes mark its passage to the observer.

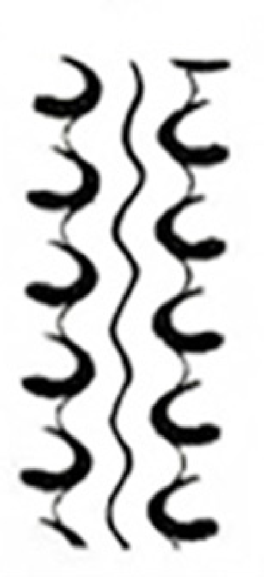
2a



Center of the wavy track leading to a nest in a free beach area. Width between 70 and 130 cm. Generally, absence or intermittence of a caudal furrow but without well-defined line; no regular marks of the flippers...

It is a track of a Loggerhead
(Caretta caretta)

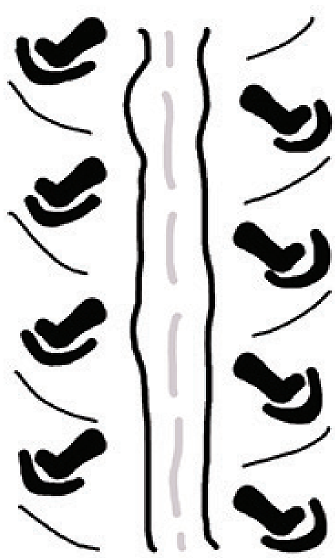
2b



Track leading to a nest under the vegetation. Width between 70 and 85 cm. Presence of a well-marked caudal furrow. Deep impressions...

It is a track of a Hawksbill
(Eretmochelys imbricata)

2c



Track leading to a nest in a free zone of beach. Width between 70 and 80 cm. Caudal furrow not or little visible. Shallow footprints in the form of a hook with print of the posterior legs...

It is a track of a Olive Ridley
(Lepidochelys olivacea)

3

Track composed of two identical parts (like an image and its reflection in a mirror) and symmetrical on both sides of a central furrow indicating the tail drag and a small regular hole during stops to breath, with chevrons directed forward.

In Leatherback and Green Turtle, tracks consist of a continuous or discontinuous central mark left by the tail, with diagonal herringbone grooves on each side left by the forelimbs and small mounds of sand formed by the thrust of the hind legs. Distinction is mainly done by the width of the track measured between the distal ends of the diagonal grooves. If the width is greater than 150 cm, it is a Leatherback track. The median furrow left by the long tail is usually deep, with a small hole left by the tail tip at each stop. If the width is less, and usually less than 130 cm, then it is a Green Turtle track. The tail track is a broken or continuous line. It should also be noted that the tracks on the ground of a female Leatherback often show many convolutions.

3a

Trace of a width higher than 1.50 m with many convolutions due to the marks of the flippers; rectilinear, continuous and fine caudal furrow…

It is a track of a
Leatherback
(Dermochelys coriacea)

3b

Simple trace of a width lower than 1.30 m; regular marks made by the flippers; interrupted caudal furrow formed by a line and a small hole…

It is a track of a
Green turtle
(Chelonia mydas)

VI. Monitoring of nesting

VI.1. Is it better to count females coming ashore to nest, tracks left on the sand or nests?

Experiences at many nesting sites have shown that counting females requires a heavy investment of time, people and energy. Follow-ups based on counting tracks and/or nests require less investment, and permit to cover many kilometers of beaches.
For each site, a protocol must determine the information to be collected and the frequency of patrols.

For a given site, the most important thing to know is which species come to nest, what is the nesting success and what is the incubation success. So, we are not going to count tracks or nests for the simple pleasure of counting tracks or nests as if we were doing it everywhere else, but to know the qualitative and quantitative interest of our site, and to engage ourselves in an efficient conservation process

It is useful, if not essential, to divide the targeted beach into segments of approximately equal length. These segments could be coded (e.g., AB, BC, CD, etc.), which will permit the team leader to indicate to the patrollers the sectors to be monitored or to report an event (e.g., a poached nest) without using a GPS. In the case of very large beaches, it is recommended that the patrol distance not exceed 1.5 km. The goal is not to tire out a patroller but to have an efficient monitoring with an actor who is vigilant and attentive to everything that happens in his zone. The better the prospector knows his zone, the more efficient he will be in his search and discoveries.

VI.2. Counting the tracks

The track count consists of walking along a beach or a well-defined and marked section of beach to count the number of tracks and, if possible, to identify the species from which the track come from, and to determine if the female has actually nested (track with nesting) or if she left without nesting (track without nesting). It is also an opportunity to identify evidence of nest predation by animals, egg collection by humans, or sea erosion of nests.

Trace counts make it possible to monitor the status of marine turtle populations and to check the effectiveness of the conservation strategies implemented. Coupled with the monitoring of nesting females and the monitoring of nest incubation, they permit to conclude for a site:
1) The annual number of nests;
2) The annual number of nesting females;
3) The annual nest productivity.

Ascent and descent

The arrival of a female turtle on a beach is indicated by 3 types of tracks **(Figure 16)** : 1 track of locomotion of ascent, a zone of nesting (stirred sand, body pit), a track of locomotion of return to the sea.

Each ascent of female is composed of two parts, the ascending track which corresponds to the arrival on the sand and the ascent of the beach until the future site of nesting, and the descending track which corresponds to the return of the turtle towards the sea.

The nesting area can be more or less high on the beach, and sometimes be hidden in the backshore vegetation.

Depending on the time of high tide in relation to the time the female is on land, one or both tracks may be erased by the waves. This erasure can be a good indicator of the time of ascent, in order to adjust the patrol schedules the following nigh.

It is not uncommon, especially for the Green Turtle, that an emerging female, digs and leaves without nesting, disturbed or not by humans or by any obstacle during the digging. The location of the nest without eggs is then called « false nest ». In such a case, the female can go back up a little later in the evening or the next day.
Taking fear during the ascent of the beach (moving silhouette worrying the turtle, artificial light,...), a turtle can quickly turn around. Will be left then on the sand a trace forming a backwards U.

To distinguish between the ascending and descending tracks, it is necessary to observe the track, keeping in mind that during its forward progression, the turtle pushes the sand backwards, at each movement of the

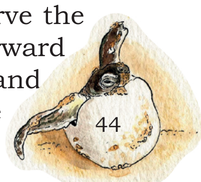


Figure 16 : A normal land track of a female turtle always includes an ascent track, an area of stirred sand, and a return track to the sea (© Schroeder et Murphy, 1999).

Figure 17 : Trace of ascent and departure without nesting (© Schroeder et Murphy, 1999).

limbs (this is particularly visible at the level of the prints left by the flippers). These tracks of the flippers form chevrons directed towards the front. Moreover, if the two tracks have not the same length, the ascending track is always the shorter because it is erased by the tide. Finally, if the two tracks cross, the descending track is always above **(Figure 17)**.

Track with nesting

The observer begins by determining the freshness of the track, then identifies the ascending and descending tracks. The recognition of these two parts makes it possible to count correctly the traces of nesting, in particular on the sites where nesting is numerous and where the traces are superimposed the ones with the others. The species of turtle at the origin of the observed track is, if possible, identified, then the observer determines if the turtle has indeed nested (track with nesting) or has left without nesting (trace without nesting).

Only fresh tracks from the night before the morning of the census are counted and recorded on a collection form. Once the track has been recorded, in order to facilitate the work of the following days and to avoid counting the same track, the observer marks the upper part of the ascending track (not the area of stirred sand) by a line in the sand made with his foot or with a stick, or by crossing the track with the vehicle used for the count. In the case of non-daily counts, the area is walked over the day before the census in order to cross out the existing tracks and to avoid counting them as fresh tracks the next morning.

The distinction between fresh and old tracks is not always easy when counts are not daily and old tracks are not removed by any means.

There is no substitute for experience, but a few tips may prove beneficial:

a) the design of the new tracks is generally more marked than the older ones;

b) the substrate that has been freshly stirred up is still wet (hence the importance of doing the counting shortly after daybreak before the sun dries out);

c) the old tracks are generally more parasitized by animal prints (crabs, jackals, monitor lizards...) or human prints that are superimposed on them.

VI.3. Counting of nests

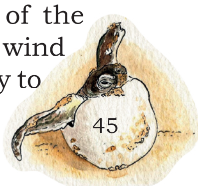
The team leader organizes the patrols so that each actor is in charge of a well-defined area to prospect.

When to do the count?

Track counts should not be conducted at night. The artificial light produced by torches or headlamps does not permit to see and to identify correctly the tracks. The relief is modified and deceives the observer. Moreover, the lighting of the site can disturb nesting females, and even provoke their movement towards the sea.

A good count must be done at daybreak, when the sun is still low on the horizon and casts shadows that amplify the relief of tracks. It is advisable to carry out the count about thirty minutes after sunrise, every day at the same time, which makes it possible to eliminate from the outset the great variation of the light factor that can affect the results.

It is necessary to look for tracks on the whole linear of the beach. Be careful, some of the tracks may have been erased by the sea, wind or rain. **Appendix 1** gives the opportunity to synthetize data.



A track does not equal a nest

If the site hosts Hawksbill Turtles and the substrate is composed of coarse sand or pebbles where tracks are not very visible, one should look evidence of nesting in the vegetation.
A track does not automatically mean a nest. A turtle sometimes emerges without nesting. If the track is continuous, i.e. if the ascending part and the descending part are not separated from an area of stirred up sand, then it is a track without nesting: the female left at sea without nesting. Even if the stirred-up substrate or the presence of a body pit between an ascending and a descending track can lead to the assumption that there is a nest, it is only a supposition. Unless you systematically search any disturbed area for nests, the presence of a nest will remain only an assumption.

The presence of an area where sand has been stirred up does not necessarily mean the presence of a nest. Indeed, in the case where there is an area of stirred sand, to affirm the absence or the presence of a nest, it is necessary to be able to determine if this area of stirred sand is the result of the activity of turtles during the phases of sweeping and/or digging (trace without nesting) or if it is the result of the activity of the turtle during the phase of scrambling which intervenes after the nesting and the filling of the nest (trace with nesting). The extent of the zone of stirred up sand can represent a good index. For the Leatherback Turtle, it is considered that when the surface of this zone is up to 4 m2, then the track is without nesting. In the Loggerhead Turtle, the presence of an escarpment and/or a body pit accompanied by sand thrown on the ascending track indicates the presence of a nest. When the Green Turtle has really nested, an escarpment and a deep body pit are present, as well as an amount of projected sand covering the ascending track for more than 2 m.

During the census, observers move along the beach at the last high tide line. On sections of beach up to 4 km, counting of tracks can be done on foot. Beyond that, the use of a vehicle (like a quad bike) or an all-field bicycle is essential. For a correct collection of information, when using a motorized vehicle, it is advisable to drive slowly, on the bottom of the beach (in order to avoid driving at the level of the zone of concentration of the nests), and to stop at the level of each nesting track to permit its identification.

Degraded nests

Patrollers will take advantage of the nesting track count to identify nests that may have been poached by humans, nests affected by animal predators and nests affected by erosion.

Animal tracks with scattered empty membranes will indicate predation. You should look for evidence of poachers digging in the sand. For example, there may be footprints that are intermingled and indicate heavy trampling in a limited area. The presence of small holes pointing in different directions is particularly indicative of human activity in locating the exact location of a nest; indeed, a long wooden stick or iron rod is used to probe the depth of the sand and locate the presence of nests by the tracks left on the end of the stick by the eggs that are pierced by the sounder when it enters the middle of a nesting. Often, after collecting eggs, the excavated nest is not filled in and a gaping hole surrounded by footprints remains at the site of the old nest.

Correct or incorrect legibility of the tracks

After nights of heavy rain and/or strong winds, it is recommended not to carry out track counts in order not to risk recording erroneous results. Apart from these climatic factors, the quality of the beach has a definite effect on the appearance of nest tracks and their persistence. In a coarse, medium or fine sand, the tracks will not be engraved in the same way. On shell sand, the prints of the legs will be very little marked. On dark (black) sand, the most discreet tracks will be much more difficult to distinguish than on light sand. A very steep slope of the sandy bank can also change the appearance of the tracks. In fact, it is important that the observer become accustomed to the specific characteristics of his or her beach through daily practice.

Ideally, it would be beneficial if the observers could observe the female as often as possible during the entire locomotion and nesting sequence. This observation will permit the patroller to assimilate the different movements of the limbs at the origin of the prints left in the sand, and to note the differences between the species.

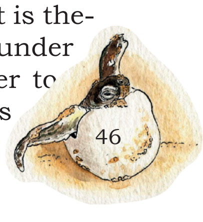
A paper form is used to record data collected in situ regarding nests found, as well as those that have been collected, predated and eroded **(Appendix 2)**.

VI.4. Patrols in search of females

In order to optimize the efficiency of patrols, they must be scheduled in such a way as to permit the teams to encounter a maximum number of females during their stay on the beach **(Figure 18)**. It is very rare to have enough teams to ensure complete coverage of the sites monitored throughout the night.

When to patrol on the beach?

On some sites near a river, female turtles arrive at high tide. It may also happen that Hawksbill Turtles come to nest during the day, but this phenomenon has never been reported in West Africa.
When patrols are set up on a new site, it is therefore advisable to test the conditions under which turtles come to this site in order to determine whether there are time slots



for optimal use, linked or not to the tidal regime, the bases of the moon, etc.

On your site, several species may nest in succession. The nesting season of each species can be out of synchrony with the others. For a good monitoring and not to lose data, it is thus imperative to know the nesting season.

For a first year of monitoring, it is often interesting to interview villagers close to the nesting site, or even to hire a poacher.

Patrol schedules

The patrols are therefore nocturnal, and begin at nightfall.

Patrols will begin at approximately 8:00 pm. The team leader, with experience, will adjust the start time of the monitoring. Depending on the number of patrollers and the length of the sites, patrols will end later than midnight.

In any case, the changes of encountering turtles must be optimized.

Knowing that a female turtle stays on land on average, depending on the species and the environmental conditions, from 45 minutes to 3 hours, the team leader will have to organize the patrols in such a way that if, during the inspection, a turtle arriving behind a walker without being seen, he will not miss it when returning to the base camp.

The ideal is to establish for each site an average chronogram for each species by noting without disturbance the timing of the 7 phases of the nesting protocol **(Appendix 3)** of a sampling of females. The next step will consist in determining for each night the time slot of presence of each species. The time slots of presence of each species are then represented graphically according to the days as well as the high and low tide times in order to determine the existence of an optimal time slot of partial linked or not to the tidal regime.

Patrol protocol

The patroller will have a headlamp with a red filter. He will light the beach in front of him by walking in the middle of the beach, with the lamp on, unless a full moon makes artificial lighting unnecessary.

Patrols conducted on foot will preferably be conducted by two-person teams to ensure more reliable data collection (double-checking) and safety.

The team of patrollers (preferably wearing dark clothing) will set out at a set time to walk to and from their assigned section of beach.

La marche est régulière et ne doit pas être trop rapide.

It is important to set your pace so that you can make the round trip in the allocated time. The patrollers move along the high tide line, carefully observing the ground for any tracks left by an emerging turtle.

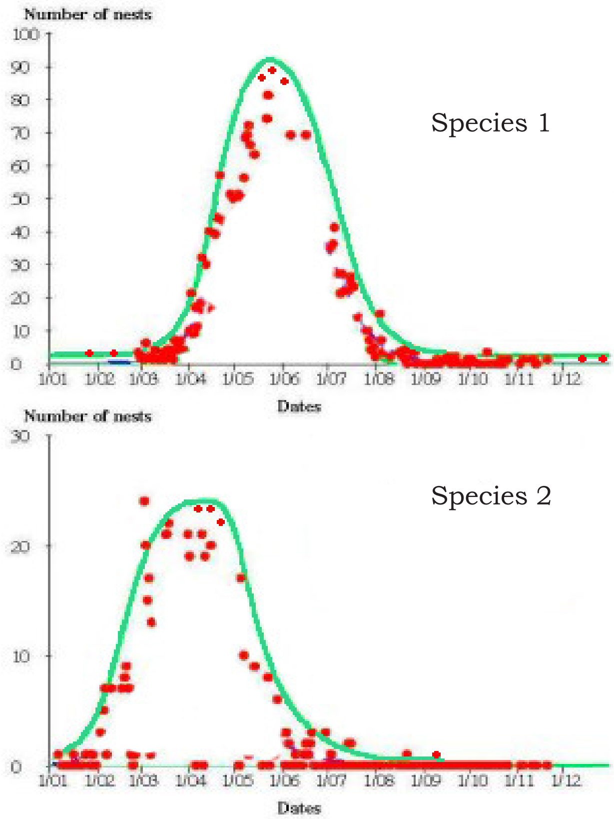


Figure 18. Summarizing data for a given season for a given species usually showing a bell-shaped pattern of sporadic female ascents, a peak in ascents, and then a descent to isolated ascents again.

Some tracks will be easily discerned (e.g. those of the Leatherback and the Green Turtle) but others, such as those of the Olive Ridley or the Hawksbill Turtle, may be more inconspicuous. It is thus necessary that the patrollers remain attentive during their whole progression on the beach.

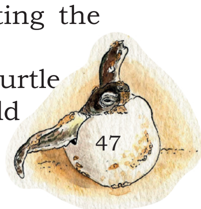
On small sites (15 minutes for example per trip), it is preferable to make a consequent break at the end of the beach sector in order to avoid too frequent passages on the beach with the lamps and new turtles will not have much time to come. On long sites (more than 30 min per trip), with obstacles (trunks, lagoons...) or on sites where there is a lot of nesting activity, it is preferable to make two patrols, each one starting at one end of the site and crossing each other.

When the lamp beam shows a female emerging from the waves or ascending from the beach, or a fresh track of ascent, the patroller stops and turns off his lamp.

When an ascending track is spotted, the patroller looks on the top of the sandy bank for the turtle at the origin of the track. If artificial lighting is necessary to locate the turtle, it should be turned off as soon as the animal is located.

The patrol will let the turtle settle and will determine what it does (sweeping, digging, nesting...) mainly by listening or by briefly lighting the headlamp.

In any case, if the team encounters a turtle as it lands on the beach, the lights should



be turned off immediately and the patrollers should crouch or sit down and wait for the female to settle. Intervention during the ascent would inevitably leads to the female returning to the sea.

When the turtle is no longer in danger of being disturbed, the patrollers approach, preferably from behind the animal, to determine the species and stage in the nesting sequence.

With practice it is possible to determine by sound what the turtle is doing. If it is not possible to use sounds to know where the turtle is, we can go to observe if it moves or not, without approaching too much and sifting the lamp with the hand. If after a few minutes, there is still no noise, it means that the turtle is nesting or will nest. A person with the help of a lamp sifted by his hand will see if the turtle has already started to nest. To do this, it is enough to look at the back and to observe in the nest.

We cannot generalize on the sensitivity of female turtles to disturbance. Some are very fearful, others not, and whatever the species. Leatherback turtles are generally less shy than other turtles. Anyway, if you need to measure the turtle coming to nest, to identify it by a marking, to take pictures or to make a skin sample for genetic analysis, it is during the end of the digging and the nesting the most favorable and the least disturbing moment.

As soon as the manipulations are over, the lights should be turned off to permit the animal to easily return to the ocean. The stray lights during the scrambling and departure phases can indeed disturb the females and cause their disorientation.

What to record and on what?

For practical reasons, it is often better to have a field notebook on which to record the observation, rather than on loose cards.

If loose cards are preferred, they should be protected in a clipboard holder. This type of binder has the advantage of having a rigid support to fill in the card next to a turtle. We recommend hanging the writing instrument (pencil or pen) with a string on the clipboard. This will avoid looking for a way to write in a night environment or an embarrassing loss of the pen in the sand.

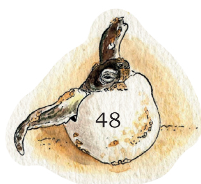
We propose **(Appendix 4)**, two models of cards, but each site can adapt them according to what is desired. One permits us to put on the same form all the observations of an evening patrol of a zone; the other one will be an individual form per observed female, very precise.

Several cases of what will or will not be possible to note:

1) The observed turtle has not yet nested; follow the previous instructions and wait until she finishes digging and nesting to make the manipulations and fill in the observation form;

2) The observed turtle is quiet (end of digging, nesting, nest filling). In order to know if this female is already ringed, without lighting the lamp, approach on your knees on both sides, at the level of the flippers and feel the posterior edge of the leg. If a band is present, briefly turn on the light without illuminating the turtle's head and note the ring references. If the patrollers are equipped with a magnetic transponder reader (PITs), proceed in the same way but pass the reader over the shoulders and the nape of the turtle's neck (see Chapter VII);

3) The observed turtle has already nest and is in the final stages of the nesting protocol. Do not disturb it. Note on the form the time of observation; specify that the turtle has nested.




Eretmochelys imbricata **(© Y Lanceau)**

VII. Protection of nests *in situ* and in hatcheries

VII.1. Marking nests

Introduction

The purpose of monitoring nests left in the wild may be to protect them as well as possible by leaving them in place, to take temperature measures or to be able to analyze them at the end of the incubation to estimate the success rate.
Marking a nest can be done in several ways. It can be with a brightly colored plastic ribbon or any other marker with a unique code that will associate a clutch with the data that will be related to it. Numbered stakes can be planted behind the nest, permitting for triangulation location (see below). After opening the nest, a piece of metal can also be placed on top of the eggs to permit location by a metal detector. The ideal is to mark the nest during the nest digging or the nesting in order to limit the thermal, hydric and gaseous disturbances, by the reopening of a closed nest. Be careful not to mark the nest with a material (plastic strap for example) that can cause a hydrous increase by the percolation of rainwater through it or the attraction of predators.
When the nest is opened after the hatchlings have emerged, the mark found in the nest should clearly link the analysis data to the nesting female and the nesting data.
The nest marker used should not be visible on the surface or very little, especially in areas frequented by poachers. Another advantage of placing the marker among the eggs is that other female turtles are not likely to disturb the marker (as they may do with surface stakes), unless they are digging on a pre-existing nest in an area of high density of nests..

General location of a nest

We advise, if the beach is not large, to mark it every 20 m (every 100 m for a very large beach). The marker will be a stick sunk at least 50 cm into the sand, topped by a sign with a painted code **(Figure 19)**. The markers are numbered from zero, and every 20 meters there is one with an even number. Add a zero to this number to get the distance of a nest in meters from the zero point. Example: the marker 24 means that we are 240 m from the zero point.

To locate a nest, the method can be to measure its position in relation to the nearest stick, specifying the environment (bare sand, Ipomae, under a tree...). Two months after the nesting, the location of a nest is generally not visible any more on the surface of sand and this method to locate a nest *in situ* will generally have to be accompanied by a location with GPS or by triangulation.

Location of a nest by triangulation

Triangulation **(Figure 20)** is a technique to determine the position of a point (here a nest) by measuring the angles (a and b) between this point and two references points (sticks).
The nest can be considered as the third vertex of a triangle of which we know two angles and the length of one side (A).

Figure 19. Locating nests in relation to zone signs (© J. Fretey).

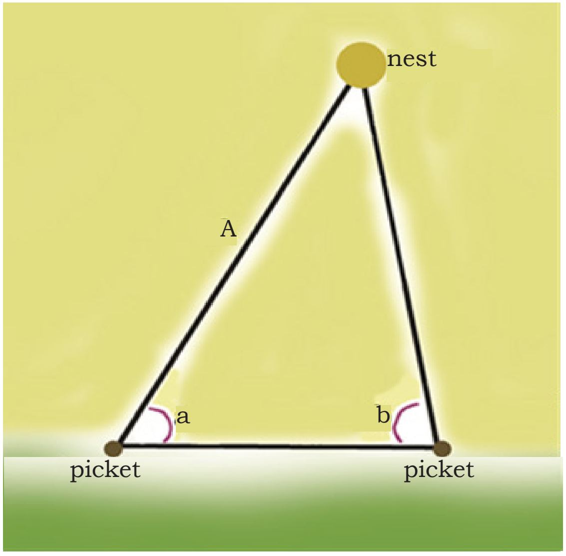


Figure 20. Scheme of triangulation to locate a nest (© J. Fretey).

VII.2. The implementation of temperature recorders (equipment and technique)

The evaluation of the effects of climate change on marine turtle populations is increasingly identified as a global priority in conservation projects for these species. The fact that the sex of the embryos depends on the egg incubation temperature may lead, in the medium or long term, to an increase in global average temperature of 2.8°C (+1.7°C to + 4.4°C) by the end of the century, to a complete feminization of the populations. It seems therefore essential that field projects wishing to maintain a sexual balance of hatchlings on nesting sites seek ways to reduce the effects of rising temperatures. To do this, it is necessary to have an idea of the substrate temperature and their possible increases.

Today, there are several companies offering recording thermometers with very high accuracy (0.01°C) that can withstand harsh conditions: Hobo, Tinytag, Vemco, Onset,…

The procedure is as follows **(Figure 21)**. Place the thermometers in 2 places, if possible during the same day:

1) In control sites not far from nests. The thermometers are placed at different depths in the sand, for example minus 60 cm, minus 30 cm and minus 10 cm.

2) In nests. In the middle of the eggs, at the same depths as in the control sites.

It is impossible to place the sondes correctly between the eggs during the nesting and to know the depth of their location relative to the surface. Therefore, we recommend letting a ribbon hanging among the eggs during their expulsion from the cloaca of the female. This ribbon, about 1m long, will be attached to a body that can be easily located (piece of polystyrene or small log, for example). It will be necessary to take care, at the time of the sweeping by the turtle, that this inert body remains visible. After the departure of the female, the nest will be reopened, the eggs taken out and their north pole indicated by a cross, the thermometers put in place, then the nest refilled.

To estimate the beach surface (level 0), a board will be placed on the sand across the nest pit, and selected depths will be measured from this clipboard.

The location of the sites where the thermal sondes have been placed is determined as precisely as possible with a GPS. To find the nest and recover the sondes, after emergence of the hatchlings, it will be sufficient to follow the ribbon. The recovery of the sondes will be an opportunity to make an analysis of the nest.

Thermometers placed at minus 10 cm and 30 cm will be subject to the nycthemeral variations[1] of the weather, depending on the differences in day and night temperatures, and whether it is raining, windy or sunny and burning the sand.

In sand, the closer to the surface, the more the substrate temperature will be subject to daily variations related mostly to air temperature and rainfall. Generally, little thermal variations are recorded at minus 60 cm regardless of outdoor temperatures.

A choice will be made for the temperature recording sequences: every 10 minutes, every 30 minutes, every hour…

[1] The nycthemeral rhythm is a 24-hour cycle, divided into a day and a night period.

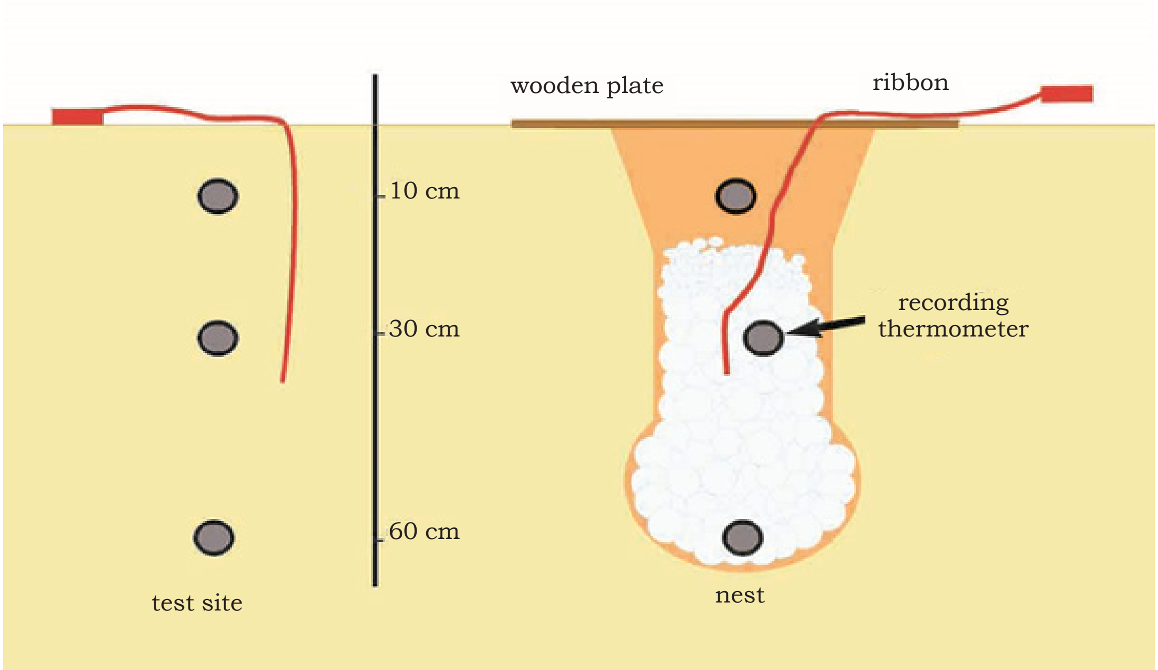


Figure 21. Installation of recording thermometers at different depths in a control site and among eggs (© J. Fretey).

VII.3. How prevent predators from attacking nests?

Protection of a nest from predators can be achieved by placing a mesh of rigid plastic wire just below the surface of the sand, or else placed in a cage-like pattern above the nest.
Three systems can be generally used:

Protection by net

From medium-sized mammals (e.g., dogs, Civets), a 1-square-meter net with 5 x 10 cm galvanized iron mesh, secured by stakes at the corners, should be placed over the nest as soon as possible after nesting. The stakes are made of steel bars 60-90 cm long and bent into hooks at the top to secure the protective net. For smaller mammals (Genets, Mongooses...), a smaller mesh net can be used, but it must be removed before emergence. In all cases, the net should be buried 8-10 cm below the surface to make it invisible to predators and curious walkers.

It is important to use mesh that is small enough to prevent predator access, but large enough to permit the passage of hatchlings to the surface

Protection by wire cage

Galvanized wire mesh cages can be round or square in shape. The square shape is often preferred because it permits the wire to be turned outward at the base on all four sides to prevent small predators from digging. We recommend having a cage made by an ironmonger that is 90 x 90 x 75 cm, with a mesh size of 5 x 10 cm; this cage includes a base that is turned outward 15 cm deep **(Figure 22)**.

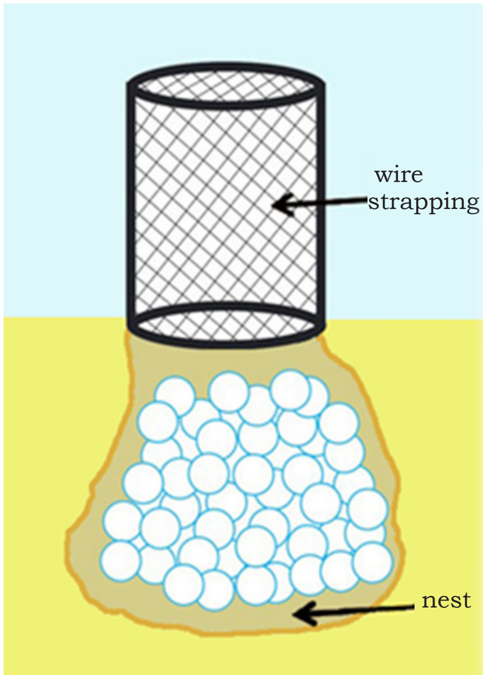


Figure 22. Positioning a wire hoop over a nest for protection against large predators (© J. Fretey).

It is preferable that the cages are buried at a depth of about 30 cm above the first eggs. This is accomplished by centering the cage over the nest and then, placing it on its side, digging a 90 x 90 cm trench to a depth of 30 cm around the nest.

Dry sand from the surface should be set aside before digging. Once the trench is complete, the cage is placed in the trench, which is then filled in leaving approximately 45 cm of cage height above the sand to prevent predators from digging into the nest. Cages are more effective than flat nets, although they are more visible.

Repellents against predators

The idea here is to condition predators (mainly mammals) to avoid destroying

nests (eggs and hatchlings) by using selective chemicals, which cause very unpleasant reactions when absorbed. Various researchers have used lithium chloride and various hormones in and on eggs, in the hope that predators, especially small mammals, will lose interest in consuming sea turtle eggs. The results with this technique do not seem to be effective.

Although nest predation is certainly opportunistic, the habit of nest robing is, at least for some species of predators, a clearly learned behavior. Predator control, in general, involves a variety of techniques. All are time-consuming, some are expensive, and few have shown significant results. Nevertheless, some methods should be used when predation is a serious threat; that is, a threat that clearly exceeds the natural cycles of the food web.

Perhaps the least complicated method of dealing with wild technophilic or domestic predatory mammals is to shoot in the air to scare them away. This method has been used to control stray dogs on some nesting beaches in Central America and the Southwestern United States, raccoons and wild pigs, as well as various « pests » elsewhere in the world.

Figure 23. Guyanese stray dog eating a hatchling
(© O. Grünewald – J. Fretey)

Figure 24. Laobe dogs or yellow dogs do not hesitate to enter the sea water to search for food
(© P. Triplet)

VII.4. Raising awareness about the impact of dogs on turtles and their eggs

Dogs can be predators of sea turtles (adults on land, eggs, emerging hatchlings) on nesting beaches **(Figures 23 et 24)**. This is a cause of human-induced mortality, in addition to the various anthropogenic causes of mortality that already affect hatchlings of the various species that come to breed on the West African coast. The situation is tricky to deal with because even if their owners leave most of the incriminated dogs free, dogs generally enjoy the benevolence and respect of villagers. The strategy for dealing with these dogs is to reduce their numbers over time. The best way to act is to sterilize as many of them as possible, with an effect that will only be visible several years later. In most cases, immediate action is to protect or relocate nests in areas where these dogs are active.

VII.5. Building a hatchery

Whenever possible, it is always better to leave the nests in place! But...

After numerous experiments in the 1980s and 1990s to obtain better incubation of marine turtle eggs using sometimes very sophisticated techniques, the consensus today is that the best solution is to let eggs in their natural nest. Relocation of eggs to an enclosure or other hatchery model should therefore be undertaken only as a last resort, and only in cases where in situ protection is not possible. Transplanting operations should only be undertaken for nests that are too close to the waves and at risk of obvious exposure, too close to villages where they would be poached, in an area subject to heavy erosion, or inhabited by numerous technophilic predators.

It is very difficult, for reasons of cost and logistics, to set up a system of useful transplantation of numerous nests for the conservation of a species over the long term. A transplantation of nests is also to set up a management of the nature and the conservation of a threatened animal species by creating a dependence to humans, which is not desirable.

If tourists heavily visit your marine protected area, it will be difficult to get them to see that no action is being taken to save nests threatened by erosion, stray dogs, or other predators. A well-managed and publicized enclosure, even if it does not save all threatened nests, will be seen by tourists and school children as a relevant and effective activity, and will be a great place to raise awareness.

Why an enclosure and how to manage it?

It appears that the technique of a simple screened enclosure to protect nests, **if really necessary**, is the best way to conserve eggs in West African marine protected areas.

The role of an enclosure is double. Its first vocation is to permit eggs, threatened in natural conditions (poaching, flood zone, erosion,...), to expect a good incubation success rate but the enclosure is also an excellent place to raise awareness for villagers, school children and tourists. This aspect should not be neglected but it is only valid if the enclosure is well maintained, aesthetic and educational and gives irreproachable results.

The operational efficiency of an enclosure depends largely on well-trained, meticulous and reliable staff. Contrary to what one might think, hatching success in enclosures is usually lower than in natural nests, even when conscientious staff manages these.

It is important to avoid, as much as possible, the perception by resident villagers that caring for an animal species requires structures or financial outlays far greater than those given to them. For this reason, involving a primary or junior high school in the management of a transplant enclosure, with community grants given to these schools, provides both acceptance of this activity by the villagers and an effective awareness-raising activity.

Enclosure site selection and construction

The choice of the site where the enclosure is located, often for reasons of convenience near a camp, can lead to a sex ratio of embryos different from that of the whole beach.

Enclosures and other transplant sites should be located as close as possible to the nesting site to minimize physical trauma to the eggs during transport and to reduce the time interval between collection.

It is also important to be careful and not to put the enclosure under a tree. This will create shade and the falling leaves will create harmful humus.

The new location of the eggs must provide satisfactory conditions of humidity, temperature and gas exchange to promote embryo development, and security from predatory animals and poachers. Experience, particularly in Suriname (where the first transplants were done in the early 1970s), has shown that the enclosure substrate works best when the sand is coarse and taken as low as possible on the beach (grain size for better gas exchange, absence of territorial bacteria).

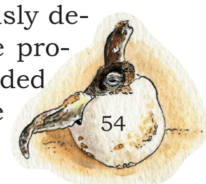
It is necessary, in the false nests, to provide the possibility for the embryos and the hatchlings to keep the print of the nesting beach, and to facilitate the release to the sea.

If possible at a site, multiple enclosures are preferable to a single enclosure to increase the diversity of conditions in which eggs are incubated and hatchlings released.

The location of the enclosures should be chosen to cover the range of microhabitats naturally used by the turtles, keeping in mind the need to include different representative sand temperature gradients (full sun, sheltered by vegetation, mid- and upper beach, etc.).

The sand surface of the enclosure should be located at least 1 meter vertically above the level of the highest equinox tide line to avoid subsurface flooding of the eggs. It is also important to avoid placing an enclosure where it can be easily flooded by runoff or pools of standing water that stay at the top of the beach during very high tides and heavy rains, near the mouths of rivers or outlets of lagoons.

The size of the enclosure will obviously depend on the number of nests that the project plans to transplant. It is recommended to start with a not too large enclosure



(e.g. 5 m x 4 m), in order to test the operation, and then to build a second larger one if the results of the first are encouraging (Figure 25).

VII.6. The transplantation protocol

First recommendations, the collection of the eggs to be transplanted

In order to minimize embryo mortality due to handling, all eggs should be placed in the hatchery within 2 hours of nesting.

Eggs are often recovered during a daytime patrol, a number of hours after they are laid, which is detrimental because the embryonic cells are already developing.

The easiest way is, when it is possible, to collect directly eggs during nesting. No need to light the turtle. When the turtle has finished digging, the manipulator 1 places the hand under the cloaca to collect the expelled eggs. Otherwise, if the oviposition has already begun since several minutes, he will take the eggs already accumulated at the bottom of the nest.

Although freshly laid eggs are not sensitive to careful movement, it is better for transplantation to take the eggs out without turning them. To do this, the north pole of the egg will be marked with a small, unstressed cross with a grease pencil, and then each egg will be placed and wedged into a bucket containing sand. So, each collected egg is entrusted to an assistant (manipulator 2) who will put a pencil cross on them and place them gently in a bucket. For the Leatherback Turtle, where the nest is very deep, and in order to avoid that eggs fallen at the bottom of the nest are difficult to reach, we recommend, at the end of the digging action, to bring a few handfuls of sand in the nest in order to decrease the depth.

Manipulator 2 places each egg in the bucket or insulated box, cross up, with a little sand between the eggs to prevent them from shifting during transport.

Handling and hygiene precautions

As a general rule, eggs should always be handled with care and all actors should be aware of their fragility. When the eggs have to be transported in a vehicle (quad, 4x4), they should be protected as much as possible from vibrations, by simply insulated them with sand.

Research has shown the presence of many human bacteria on the membrane of eggs handled with bare hands, which can be dangerous for embryos. Therefore, eggs must be handled with proper hygienic care. Hands should be washed to remove any bacterial contamination and chemical residues (such as sunscreen or mosquito repellent) or isolated in disposable gloves before handling the eggs.

Any hand manipulation of eggs (including counting, measuring and weighting) must be carried out within less than two hours after they are laid, otherwise eggs will have to remain in situ without handling for at least 25 days in order to reduce the impact of the movement that inevitably induces mortality among the embryos.

Transport the eggs to the enclosure as soon as possible after collection.

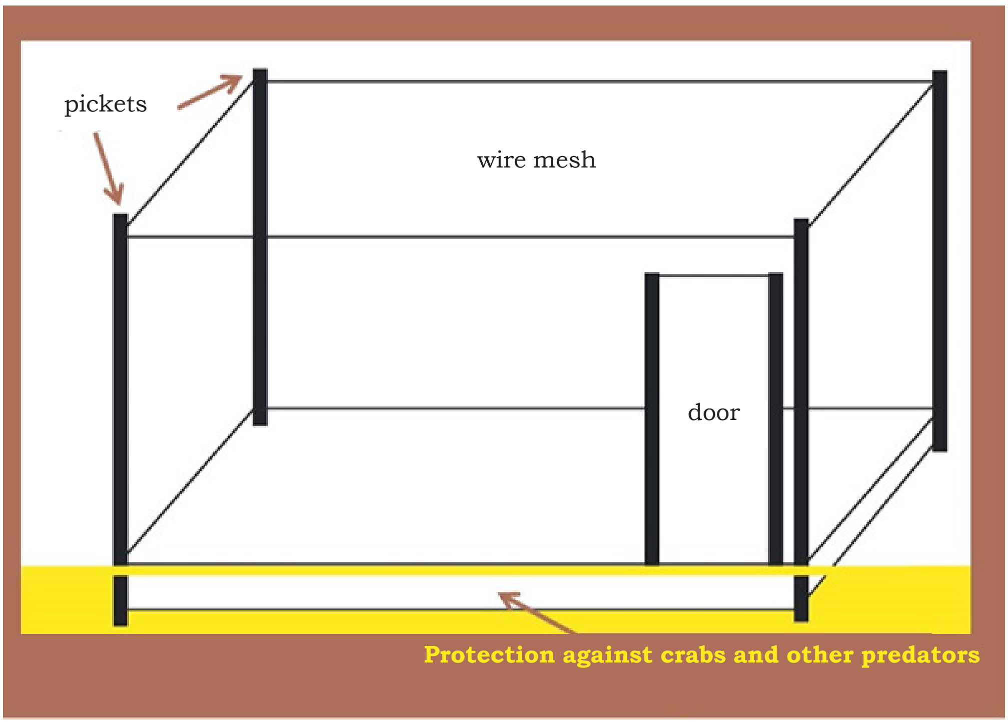


Figure 25. Schematic diagram of a nest transplant enclosure (© J. Fretey).

Burial of eggs in a false nest

Each transplanted clutch must be placed as quickly as possible in the false nest dug for this purpose in an enclosure, in a micro-habitat approximately the same as that of its original nest **(Figure 26)**.

Nests should be spaced about 1 meter apart, primarily to permit for easy movement within the enclosure. These false nests will be built in the shape of a gourd or boot flared wide at the base, and a straight neck (well) running from the incubation chamber to the surface.

While manipulator 1 digs the nest, manipulator 2 starts to fill in the form corresponding to this nesting. For a Leatherback, the infertile eggs can be kept or eliminated, depending on the choice made. If these eggs are kept, put them last in the false nest. Leatherback Turtle naturally lay these infertile eggs last. We believe that these are a strategy to limit predation by serving as decoys; it seems that they also provide the eggs below with some hydrography.

The average depth of a natural nest should be reproduced in an enclosure, depending on the considered species. When the excavation of the false nest collapses in very dry weather, it is necessary to pour a little fresh water in the hole, and then continue its excavation. Place the eggs in this false nest one by one respecting the cross. Under no circumstances should the eggs be « tipped » into the nest all at once. The wet sand removed during the digging of the artificial nest must be used to cover the eggs by compacting it. Do not hesitate to pack the sand when closing the pit. It is not advisable to put the dry sand in direct contact with the eggs; it should be used only in the final stage to cover the nest.

Each nest is identified at its periphery by a stake equipped with a plastic label with an individual code corresponding to a card number on which the data appear.

We recommend placing a cylindrical mesh enclosure over each nest. Wire mesh should be avoided, as hatchlings can be injured when the head and legs pass through. The net should be cut into pieces about 40 cm high and 195 cm long to form a cylinder 60 cm in diameter.

A metal frame can be used to support the net, form the cylinder, and secure it in the ground. The cylindrical device should be buried about 10 cm in the sand to prevent penetration by burrowers, such as crabs. Depending on the local predation rate, the top of the cylinder can be covered with plastic netting, mosquito netting or other suitable netting.

Embryonic development and incubation time

The enclosure should be monitored regularly. Seeds that sometimes germinate on the substrate must be removed to prevent roots from penetrating to the eggs.

In no case nests will be opened between the setting in incubation and the exit of hatchlings.

It is useless to expose the highest eggs placed in the false nest, the opaque membrane does not permit anyway to see the embryonic development. There is a great risk of disturbing the metabolism of the em-

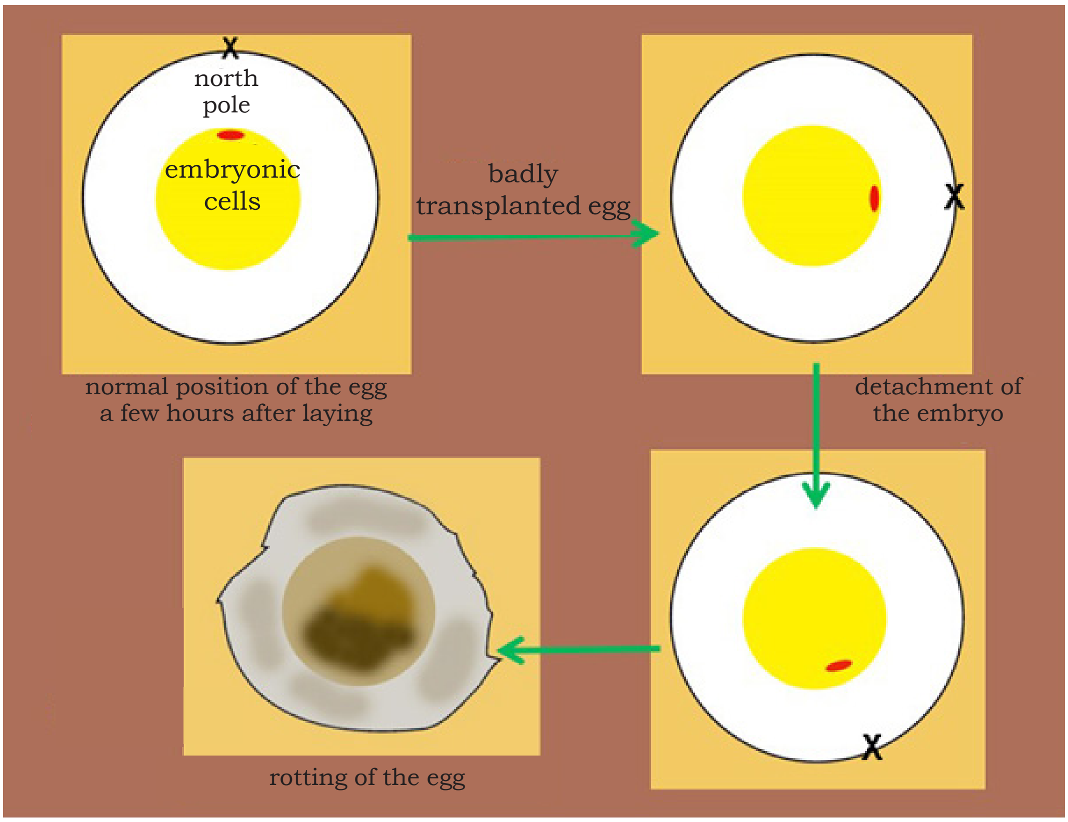


Figure 26. An egg transplanted without respecting its original orientation can cause the embryonic cells to fall out and rot (© J. Fretey).

bryos, the fragile balance of temperature, humidity and gases, as well as introducing bacteria or other pathogenic micro-organisms.

Incubation in an enclosure does not permit, as with incubation on trays in closed hatcheries or polystyrene incubators, to eliminate rotten eggs or those that do not show any development (absence of a characteristic white spot). Therefore, it is not necessary to open the nests during incubation.

VII.7. Hatchling release protocol

In an enclosure, the net cylinder permits the isolation of hatchlings when they emerge, so that they can be counted nest by nest, measured, weighed, etc. However, it has the disadvantage of delaying their release after emergence, and they can suffer from exhaustion, dehydration, loss of energy and injuries.

It is important to release the hatchlings as soon as possible after they emerge from the sand so that the stimulus of emergence will not be lost.

A wrong method of holding and releasing hatchlings from an enclosure, despite a good incubation success rate, can lead to high hatchling mortality. Hatchlings left unattended after emergence in screened cylinders above the nest can become unnecessarily exhausted, injured, strangled, dehydrated in the sun, etc. Releasing all the hatchlings in one place on a beach may attract predatory fishes, birds or crabs, which will destroy almost 100% of the group **(Figure 27)**.

Under natural conditions, groups of hatchlings, after emerging and running in a fan-like pattern on the beach, enter the sea over a wide coastal strip. Turtles emerging from enclosures must be released in groups, and as soon as possible after the exit of the nest, without waiting and especially without keeping them several days in containers with sea water.

To introduce an element of randomness into the release points, and to avoid concentrations of predatory fishes, each release should be made within 100 meters of the previous releases. The personnel associated with an enclosure must be able to predict nest emergence within a few days and monitor the enclosure frequently during this period. It is absolutely necessary to avoid that hatchlings taken out at the end of the day or at night spend the whole morning, even the whole day in full sun.

To promote natural soak in relation to a site, emerging turtles should be able to crawl on the sand, and enter the sea without assistance. Do not permit

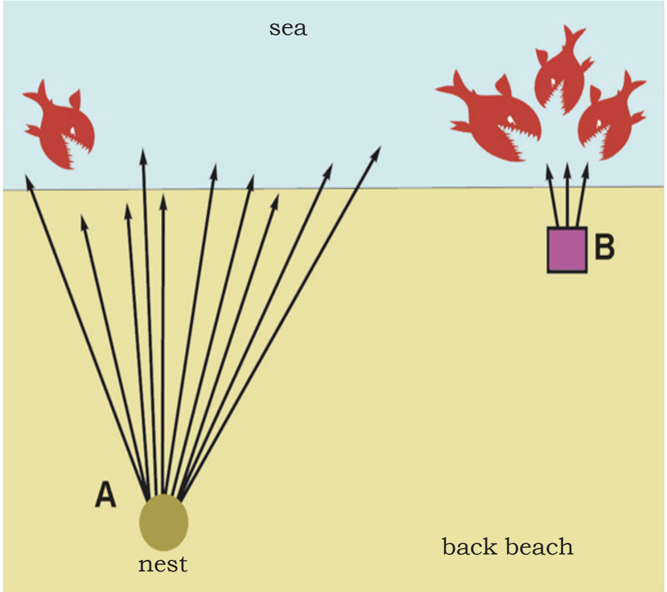


Figure 27. When leaving a natural nest (A) on the backshore, emerging hatchlings (shown here with arrows) move out to the sea in a cluster that becomes wider the further away the first waves are. The friction of the plastron over a long distance helps umbilical healing and perhaps permits chemical impregnation at the site. The release of hatchlings from an enclosure flush with the waves (B) under the pretext of facilitating their departure is therefore a serious mistake by preventing these important factors. And in the natural cluster with dispersal, the attack of marine predators is low, whereas a release of grouped turtles creates waves in one place when they enter the water, which attracts some predatory fishes (© J. Fretey).

visitors to the enclosure or tourists (willing to assist the movement of these hatchlings) to pick them up and carry them into the first waves. When immediate release is not possible, hatchlings should be placed in a thin bag with some moist sand, and kept in a cool, quiet place. They should not be put in water before release. Hatchlings kept in a container of water have a detrimental « frantic swimming » behavior, and probably deplete the energy contained in the residual yolk sac.

Be careful: kept for several hours after emergence and before release, hatchlings Leatherback turtles may then lose the stimulus of excitement associated with emergence, and at the time chosen for their departure the sea, remain prostrate without leaving.

A good technique that was used in French Guiana permitted to come as close as possible to natural conditions. The bottom of the enclosure, on the seaside, was equipped with a device permitting a flap (about 15 cm high over the entire width) to tilt and thus free a passage. When a nest was in phase of emergence and after examination, if necessary, the shutter was tilted at the end of the afternoon, and the departure towards the sea of the emergents was done without human intervention **(Figure 28)**.

Chelonia mydas **in seagrass (© F Presles)**

Figure 28. Hatchlings leaving directly to the sea after opening the mobile flap at the bottom of the transplantation enclosure on the seaside (© J. Fretey).

VII.8. Knowing how to measure the incubation success rate

Analysis protocol

Beforehand, emerging hatchlings were counted. We must find an identical number between hatchlings and membranes.

To analyze a nest, you need:

- two people: one who digs and takes out the elements (membranes, eggs…), and one who takes notes;
- a blank *ad hoc* form **(Appendice 5)** and a pencil to note what is found;
- disposable gloves;
- pillboxes and jars with ethanol if you wish to preserve dead embryos;
- a tape measure to note the approximate depth at which you will find an egg of interest;
- a bucket to store unhatched or hatching eggs for the duration of the analysis;
- three basins in the sand: one for storing rotten eggs, one for undeveloped eggs and one for membranes.

The procedure is as follows:

- sit close to the nest;
- dig vertically and delicately at the level of the cone of emergence and the well of the nest until the incubation chamber is completely emptied;
- beforehand, the emerging hatchlings will have been counted. You will have to find an identical number between hatchlings and membranes. Each element is removed. The analysis of a nest requires time (at least 1 hour), and must be done with calm and precision. When membranes are in the form of fragments, they should be collected until they represent approximately one complete membrane and count one egg with hatching. Smaller membrane fragments should be discarded. The whole membranes are white on the outside, smooth and dry on the inside;
- To differentiate clear eggs with dead embryos, using gloves, open the eggs and empty them to check the contents. Note the stage of development of the embryo (see **Appendice 6**, for an embryonic development table to estimate the stage), distinguishing between uncolored embryos and embryos resembling a small turtle, at a terminal stage.

Chelonia mydas **hatching (© J Fretey)**

VIII. Techniques of individual identification of the turtles

VIII.1. Why identify? Interest and pathological risks

The ability to identify individuals within a population is often the starting point for ecological and conservation studies. Realistic estimates of population size and knowledge of life history parameters are essential for effective wildlife management, but are often difficult to measure in elusive, long-lived migratory marine vertebrates. This is the case for marine turtles with complex life cycles.
Any field project on marine turtles almost always includes individual marking of nesting female turtles. But marking is not a trivial act. It can be costly, requires a great amount of energy from project staff, and cause significant injuries (entry points for bacteria or viruses) to tagged turtles.

Before any individual identification project, questions should be asked?:

- **Why does a project want to identify turtles? Is it to do « like everyone else »?**
- **How often and for how long in order to anticipate the necessary means?**

It is always necessary to be aware that the individual marking, whatever it is, of a turtle can be a stress and that injuries caused can be a cause of mortality.

The individual identification is however quasi-indispensable for any evaluation of population for the study of the individual behavior. Several techniques, more or less invasive, have been developed and used throughout the world. Some of them can be combined to maximize the chances of recapture in the long term and to permit a quick identification in the short term.

Many field projects have decided in recent years to stop using external tags (plastic or metal rings) for the following reasons:

- too much waste: large investment compared to benefit;
- very intrusive: during the implementation and bringing too many injuries on the long term;
- the tag wound is an entry point for bacteria or viruses (fibropapillomatosis) and no disinfectant is strong enough against the infecting organisms concerned;
- attraction of predators (Barracuda).

There is a positive point: The visible tag on one leg can be a deterrent for fishermen and poachers.

If you decided to identify the turtles individually, you will have to adapt the techniques according to the species and to the context (beach frequentation, depth of the feeding site…).

If you can replace the tags by less invasive techniques:

- Internal markings: magnetic transponder ((*Passive Integrated Transponder Tags,* PIT);
- Photo-identification, rather for identification in feeding habitats than for females on land;
- Couple several techniques : internal marking (PIT) + photo-identification

VIII.2. Metal or plastic tags

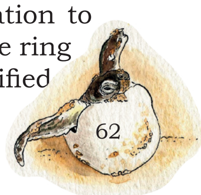
There are 4 types of tags for external identification of marine turtles: plastic, Monel, Inconel, titanium alloy model.

Types of metallic tags

The American Monel tags **(Figure 29)** The American Monel tags (figure 29) can be used in 2 different sizes: the largest are 1000-49s, and the smallest 1005-62s. The 49s model is used on adult Leatherback while the 62s model is devoted for other species. The widely used Inconel model is 1005-681. National Band and Tag Company manufacture these tags.

http://www.nationalband.com/nbtear.htm

On one side of the tag (upper side), a unique identification number is written: it is the number permitting to identify individually a turtle as long as it keeps this mark. On the other side (lower side), are written the coordinates of the organization to contact to get in return the history of the ring and thus also the features of the identified animal.



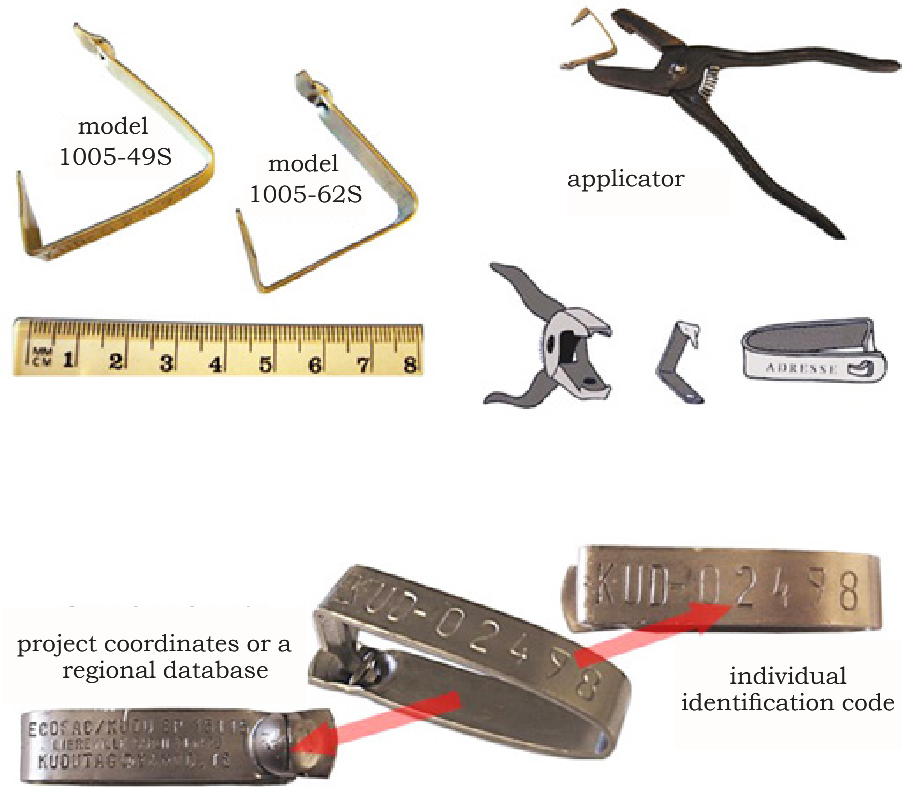


Figure 29. Models of Monel tags, their recto and verso sides (© J. Fretey).

Apart from the Monel type tags, there is a second type of rings: the Inconel type. If both types of tags are used, it is imperative not to put on the same turtle 2 rings of different types (a Monel tag and an Inconel tag). This apparently causes electrolysis between both alloys, which could be harmful to the animal. These tags are similar; they have a point (male part), which is clipped into a female part by the action of the applicator (**Figure 30**).

Plastic tags

Plastic tags, such as the Rototag or the larger Jumbo Tag, are manufactured by the English company *Dalton ID Systems, Ltd.* (**Figure 31**).

(http://www.dalton. co.uk/ID.htm)

Figure 31. An exemple of marking with a plastic tag (© J. Fretey).

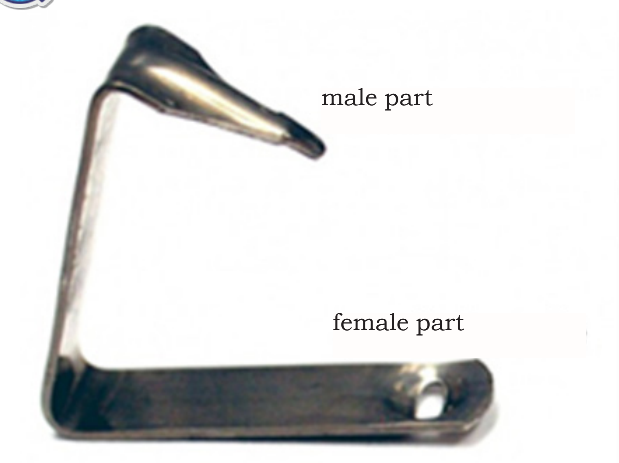


Figure 30. Closing system of a metal tag (© J. Fretey).

VIII.3. Where to place a tag?

Ideally, the tag should be stapled on the back edge of a flipper **(Figure 32)**, in the middle of the large scale closest to the body. If the leg is too thick or horny at this point, try the next largest scale or the thinner part in between.

The tag should be placed with the numbering at the top to make it easily readable.

In the Leatherback, metal tags are best held by being stapled into the soft skin between the hind legs and tail. Inconel 1005-681 bands are not recommended for this species.

A recent study on Pacific Black Turtles shows that hind leg tagging is also more durable in Hawksbill turtles, and reduces the risk of the tag becoming entangled in nets.

VIII.4. When to tag?

Tagging hould not be a barbaric act and a rodeo. It is a delicate operation and the staging of a metal tag, if it is correctly made, should not generate any reaction of the turtle.

It is strongly misadvised to want to tag a female turtle, which having nest, goes back to the sea. This will require to block her in force, and the beating of her front legs will make the tagging very violent.

In many technical manuals, it is advised to wait until the female turtle has nest or while the nest is being refilled, to undertake the tagging. By experience, we have another approach **(Figures 33 à 35)**:

When the turtle digs the nest, its hind legs work alternately. One leg goes down into the hole in formation (pass 1), scrapes the sand in several movements of the clenched leg in a kind of shovel (phase 2) and then goes back up (phase 3), while the other leg sweeps sand where it was resting (phase 4), and then goes down in its turn to work (phase 5).

We advise you:

1) While digging the nest, gently touch the leg where you want to place the tag, in order to locate by touch the right place; if your gesture is good, the turtle will not react to the touch. If the turtle stops digging, or even seems to abandon the site, give up tagging. During this touch, you should concentrate on what you are doing and don't make any sudden movements.

2) If you are tagging a flipper, you kneel next to the turtle, and you need an assistant to stay behind and watch the handles. Prepare the open tag in the applicator, and present the tag in the chosen place (large scale or between 2 large scales). Put the applicator and the tag together in the axis of the leg.

3) Close the pliers gently, but not completely, only to make the male tip penetrate slightly. Again, the gesture must not be abrupt and the turtle must not react to the prick.

4) The assistant informs you that a hind leg sends sand (phase 4) before going down to dig, you close the applicator completely. The male tip of the tag has then passed completely through the leg and has come to be clipped in the female buttonhole (sometimes double closure on certain models of tags).

5) Before getting up and withdrawing from the turtle's side, check with your bare hand, by feeling the underside of the band, that it is well closed. If it is not, remove it from the leg, and abandon the tagging of this turtle.

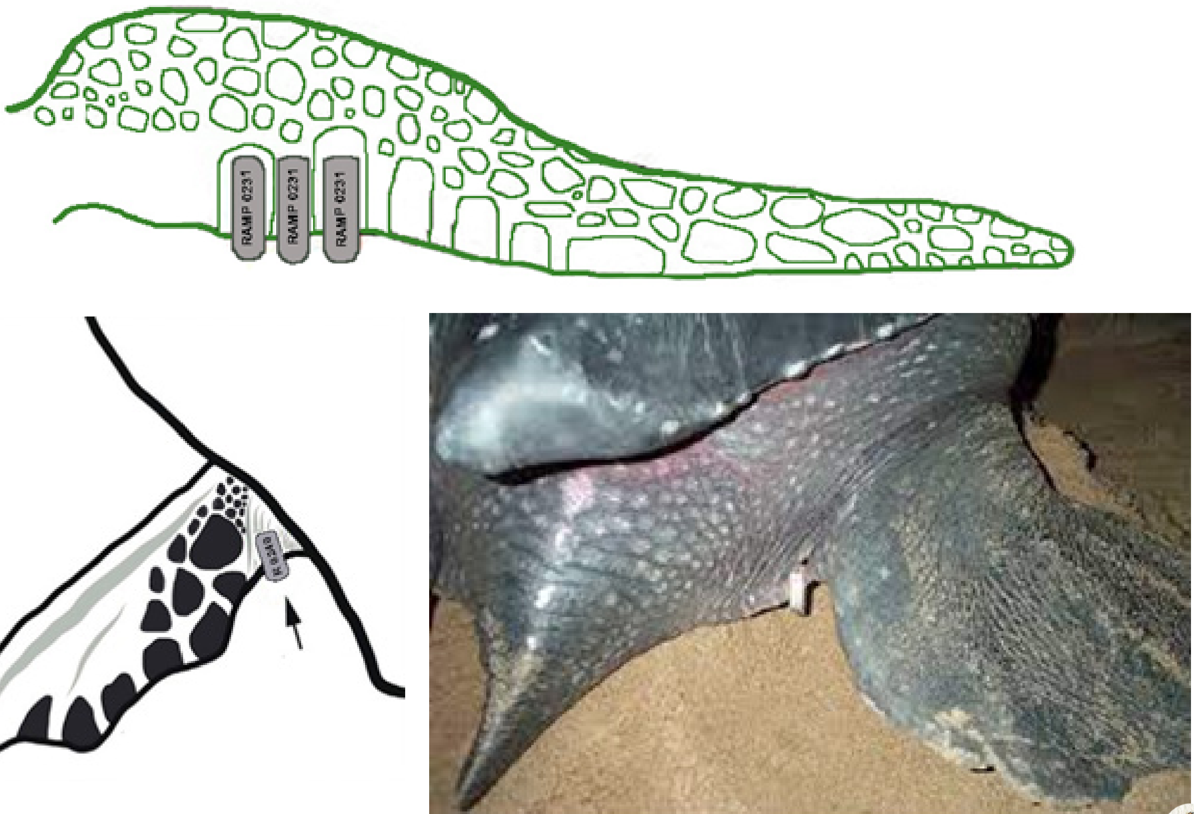


Figure 32. Recommended positions for stapling metal tags to the front and back legs (© J. Fretey).

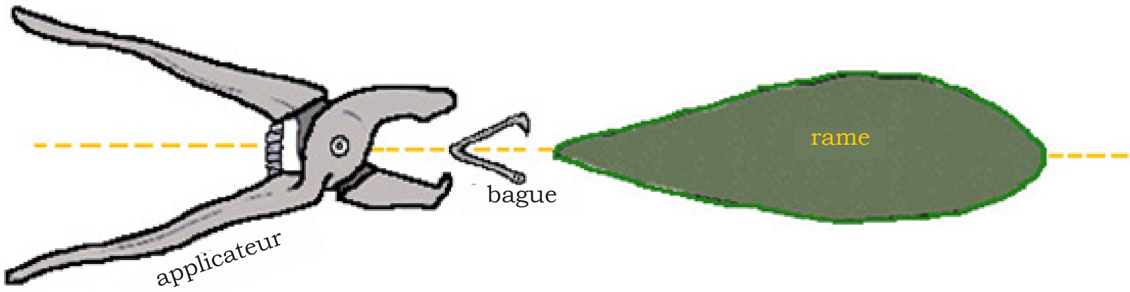


Figure 33. The applicator tag assembly and back edge of the tab should be aligned (© J. Fretey).

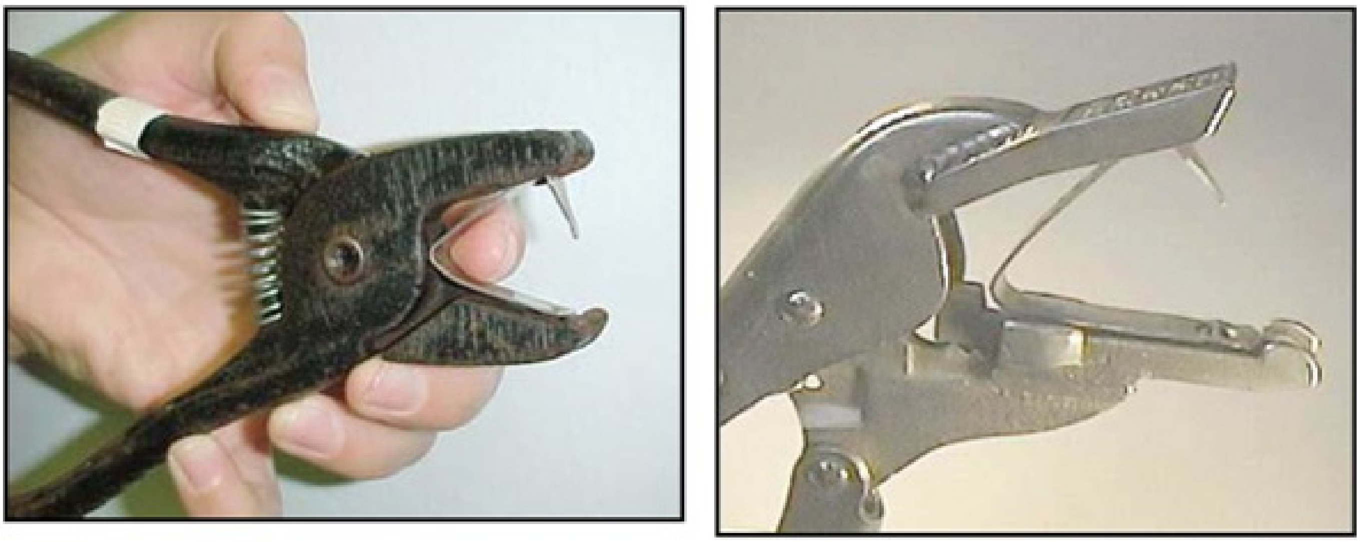


Figure 34. Position of the Monel tag ready to be stapled in two applicator models.

Figure 35. On the left, a metal tag not deep enough in the edge of the leg. It could cause the turtle to get caught in an obstacle and fall quickly. On the right, correct marking.

VIII.5. Magnetic transponders (PIT)

General data

Passive Integrated Transponder tags (PITs) are uniquely coded passive electronic tags. It is a very small, minimally invasive capsule, barely larger than a grain of rice, that is injected subcutaneously or intramuscularly **(Figure 36)**.

The PIT consists of an inert wire, a chip and a capacitor encased in glass. The PIT is not active by itself. When a scanner (reader) passes over the location where the PIT was injected, the radio frequency from the scanner and the code number is displayed on a screen.

Radio Frequency Identification (RFID) is an automatic identification technology that consists of microchips and readers that communicate with each other via radio waves.

Biocompatible passive integrated micro-transponders were originally used extensively for race horses, animals in zoos and pets (dogs, cats). Unlike external rings that are lost very quickly, PITs are durable. But their disadvantage is their cost. A metal ring (purchased in lots of several dozen) costs about 0.25 US dollars each. A PIT, depending on whether it is sterilized or not, will cost less than 5 US dollars, or even up to 10 dollars each. And the scanner has a significant cost in the order of 1,500 US dollars.

Which models to use?

There are two main models: that of the English company Trovan (creator of the concept about thirty years ago), with a frequency of 128 kHz, and the American company Avid/Destron-Fearing, with a frequency of 125 kHz. Pay attention, the frequency used by the different IP producers is not yet standardized.

This means that if you have a Trojan scanner, and a turtle coming from the North American coasts arrives on your shores an « chipped » by an Avid/Destron-Feraring PIT, you will not be able to read it.

Trovan microchips are approved by ICUN, WWF and CITES, are used by 150 government agencies, and are generally the ones that are posed in Africa for wildlife.

Trovan society offers a range of microchip sizes and handheld readers at prices to suit field project budgets.

(https://www.trovan.com/en/products/trovanunique-animals ; email contact : inform@trovan.com)

In marine turtles, the ID100 model is usually used as a transponder, with a single-use needle. Each PIT comes in a sterile cannula with a cap that can be removed for use with a plastic injector. Non-sterile PITs can also be purchased and sterilized by the user, which is less expensive but requires careful handling for a field project.

Figure 36. A PIT is a microchip included in a small sterile glass capsule injectable with a syringe.

The most commonly used Trojan scanners for sea turtles are the LID500 and LID570. It is therefore advised to keep and use them in sealed plastic bags.

Before injecting a PIT, make sure the turtle does not already have a PIT!

Where to inject the PIT ?

There are several options on the ideal location to inject a PIT. The range of the scanners is limited to a few centimeters. Therefore, it is important to avoid injecting a PIT anywhere, as scanning an entire turtle for a transponder would waste time unnecessarily. Some injection sites make it easier than others for the chip to migrate into the tissue. Unfortunately, researchers and organizations using PITs in sea turtles for individual identification have not yet reached standardization, and migration into tissue or not seem to differ between species. Ideally, you want to choose a location where the PIT becomes encysted and does not migrate. Here is a list of different sites that are used for PIT placement in sea turtles:

- shoulder muscle;
- neck muscle;
- middle of the left or right flipper (connective tissue of the forearm between the radius and ulna, parallel to the bone, or parallel to the humerus) **(Figure 37)**;
- between the phalanges of the tip of a flipper;
- left or right hind leg.

It is advisable for Hawksbills to inject the PIT, at an angle of about 15° to the skin surface of a flipper, into the triceps muscle complex to avoid touching the bone.

In the Leatherback, we recommend injecting into the back of the neck instead, because if the turtle dies, the legs tend to detach from the corpse while the head remains attached to the rest of the body for a longer time **(Figure 38)**.

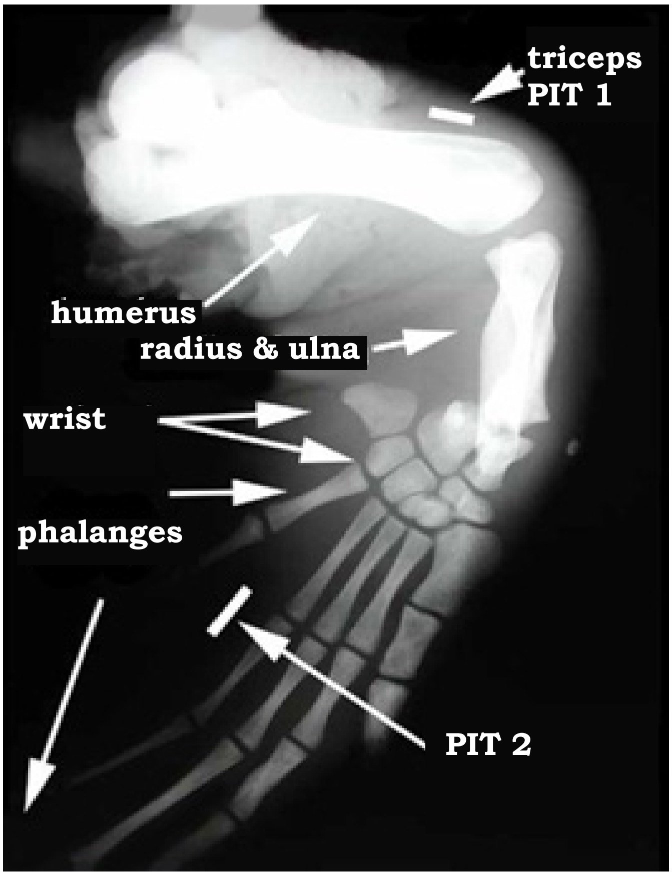


Figure 37. Radiograph showing the successful injection of a PIT into the triceps muscle complex, parallel to the humerus. Here we show another option of placing a PIT in the blade of the flipper. Source : Turtle Hospital, Florida Atlantic University.

If blood is leaking from the syringe penetration site, apply pressure with a swab soaked in an antiseptic, such as Betadine, until the flow stops. It may be necessary to apply a small amount of surgical glue to close the opening.

When it is desired to inject a PIT into a Hawksbill during nesting, many researchers recommend injecting at a hind leg during egg evacuation so that the legs are immobile; this distance from the head reduces the risk of disruption and results in less bleeding.

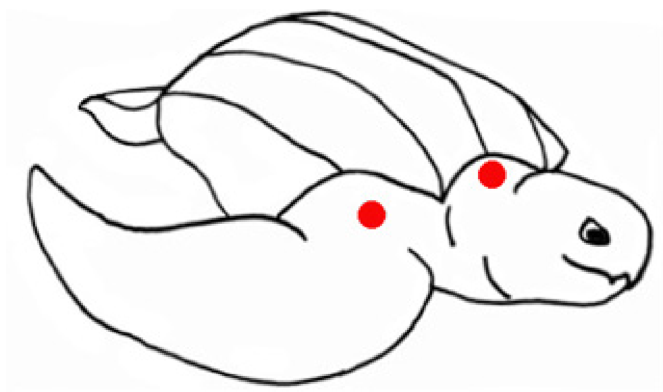


Figure 38. In the Leatherback, the injection is usually made into a muscle of the left or right shoulder, always perpendicular to the dermis (and not at an angle, as is sometimes suggested), and the needle pushed to full depth to penetrate beyond the thick layer of fat, into the underlying muscle (© J. Fretey).

One of the most commonly used AVID/Destron-Fearing transponders for sea turtles in the United States is the TX1406L, which comes in a sterilized package, loaded into a single-use needle delivery system, and requires an injector.

(http://www.biomark.com/products.html).

When reading or rereading a PIT, perform several scans of the nuchal and shoulder areas, tilting the scanner at different angles. The number displayed on the screen consists of an upper case letter, A through F, and numbers from 0 to 9, a total of 10 or 15 characters depending on the model.

An assistant notes the PIT number. The person who made the injection, then passes the scanner over the PIT and confirms the number to the assistant. The PIT number is very long and at night, errors are frequent.

Beware of iron objects or electric motors in the vicinity that can neutralize the scanner's ability to detect a PIT.

In any case, the used needle must be disposed of safely, ideally in a bin provided for this purpose. It is essential that used needles do not become beach trash.

Can we inject a PIT in a young turtle?

It is of course possible to inject a PIT in a hatchling without any known physiological problems. Except that the tissues being very thin, it would be necessary to inject it in the body cavity. But what would be the point? Out of thousands of hatchlings leaving the nesting beaches for the sea, how many survive beyond a few hours or days? The microchip might end up in the stomach of a barracuda quite quickly!

On the other hand, there is no disadvantage to inject a PIT in a turtle whose backbone is longer than 30 cm. Therefore, it may be possible to individually tag immature turtles in nursery areas.

Passive magnetic transponders have been adopted by many projects as a permanent method of tagging sea turtles, with a much lower rate of loss than with external tags.

However, injecting a magnetic transponder into the flesh of a sea turtle is a non-harmless veterinary procedure. We strongly recommend a training of the field actors before using this technique or to ask advice to experienced colleagues of the region.

VIII.6. Photo-identification

Introductory data

Ringing or PIT operations tend to preferentially target adult female turtles because of their accessibility on nesting beaches, which gives a distorted picture of adult population structure. In addition, significant levels of lost rings or PITs not found on reading always reduce the reliability and scientific value of the data collected.

An alternative to the application of invasive markers (rings, PITs,...) in marine turtles is to use visual identification of individuals. The ability to recognize individuals from natural characteristics has many advantages over conventional tagging techniques, including: (i) animals are not physically captured or manipulated, (ii) identifiable characteristics are stable over time, and (iii) the animal's behavior is less likely to be affected by the identification system.

Photographic identification, in which researchers and field project managers photograph these natural markings to identify and re-identify individuals, is proving to be a useful tool for long-term monitoring of marine turtle populations.

What is photo-identification?

The photo-identification (often called photo-ID) is rather used for the phases of life in water than during the nesting because of the conditions of light and the fact that the female, after scanning, is partly covered with sand.

For photographs on land, it is necessary to take care to clear the sand (without of course disturbing the turtle) of the body zones to be taken in photographs. The digital photographic technology permits today to acquire images in high resolution, including for underwater shots.

Photo-ID by comparison of the facial scales

The method of using cephalic scales patterns (almost always the post oculars, but sometimes all scutes behind the eye including parietal and tympanic) has been tested as reliable means of recognizing individuals. To our knowledge, there is no change in tortoiseshell as the turtle ages, sometimes only changes in coloration.

This technique, increasing used, requires first of all creating a database, if possible at least regional because marine turtles do not know borders.

The idea of this photo-ID technique is to store images of turtle profiles. And then, using special software (TORSOII and APHOS software, for example, which delineate an area of interest using three reference points, and then use several additional points within that area to mark intersections), the goal is to get a quick comparison of a newly photographed turtle with a large picture collection of previously recorded turtles to see if that turtle is already known.

If possible, it is necessary to photograph both profiles of the same turtle, the patterns of scutes being not identical. The photo-ID by comparison of post oculars is mainly used for the studies of Green Turtles, Hawksbill and Loggerhead **(Figures 39 à 41)**.

During a similarity search in the database, the program first selects a set of picture records, which will then be visually compared to the target image.

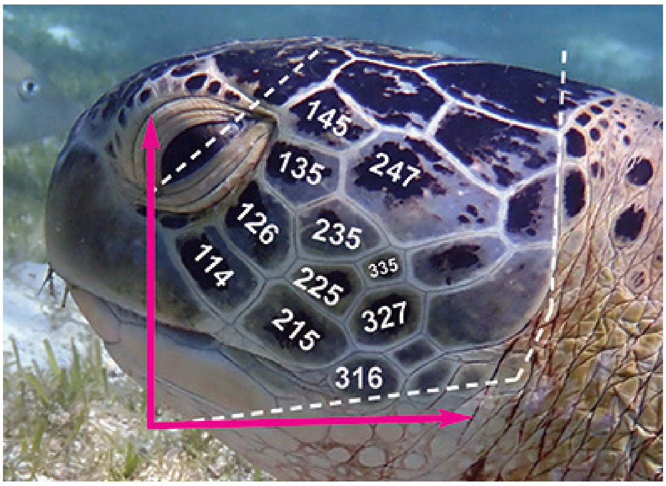


Figure 39. The database created for the marine turtles of the Western Indian Ocean codes each scute according to its position: the first number indicates the row after the eye; the second number indicates the position of the scute in this row starting from the jaw. And the third number indicates the number of facets of the scutes.
The area taken into account by the program is here delimited by dotted lines

Photo-ID by comparison of the patterns of the flippers

The objective is to photograph a flipper on a vertical view. This technique is successfully used in the Green Turtle and the Olive Ridley. The interest of this method when it is used on females during the nesting is to be less disturbing than a photo of the head requiring almost always a flash.

Photo-ID of Olive Ridley Turtles

We put here apart the Olive Ridley Turtle, which presents such variations of scaling, especially on the shell, that photo-ID in this species must target several body zones for the same individual, thus multiplying the identification factors **(Figure 42)**.

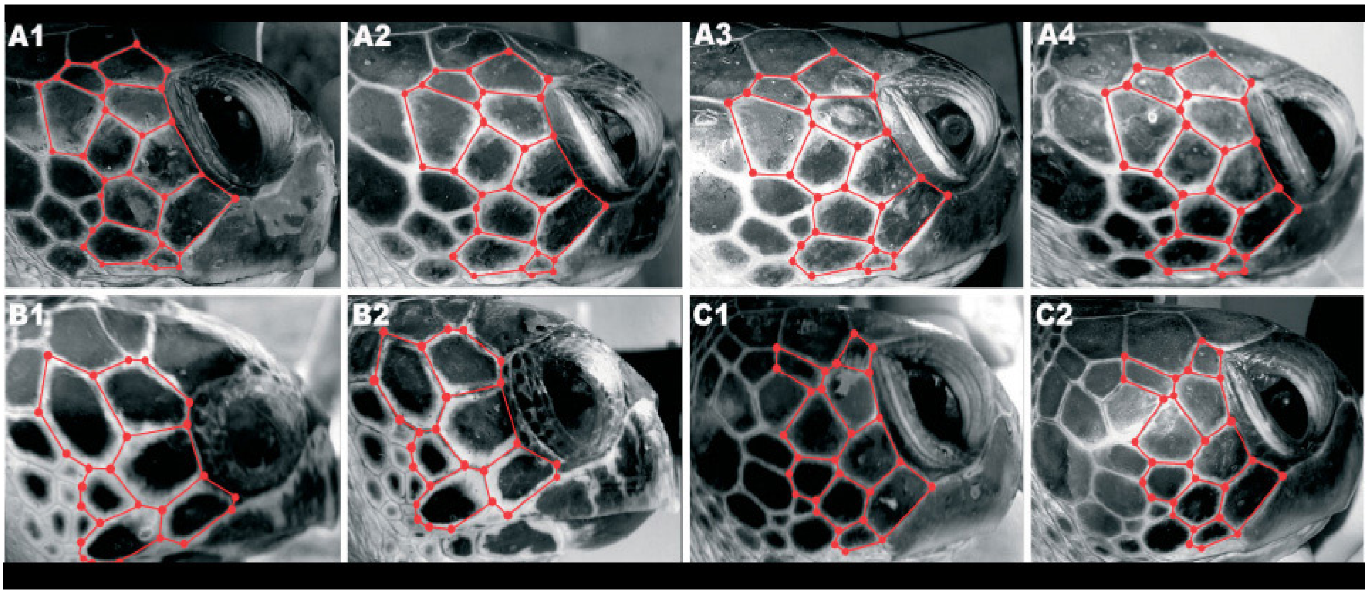


Figure 40. Examples of comparisons made by the facial recognition program.

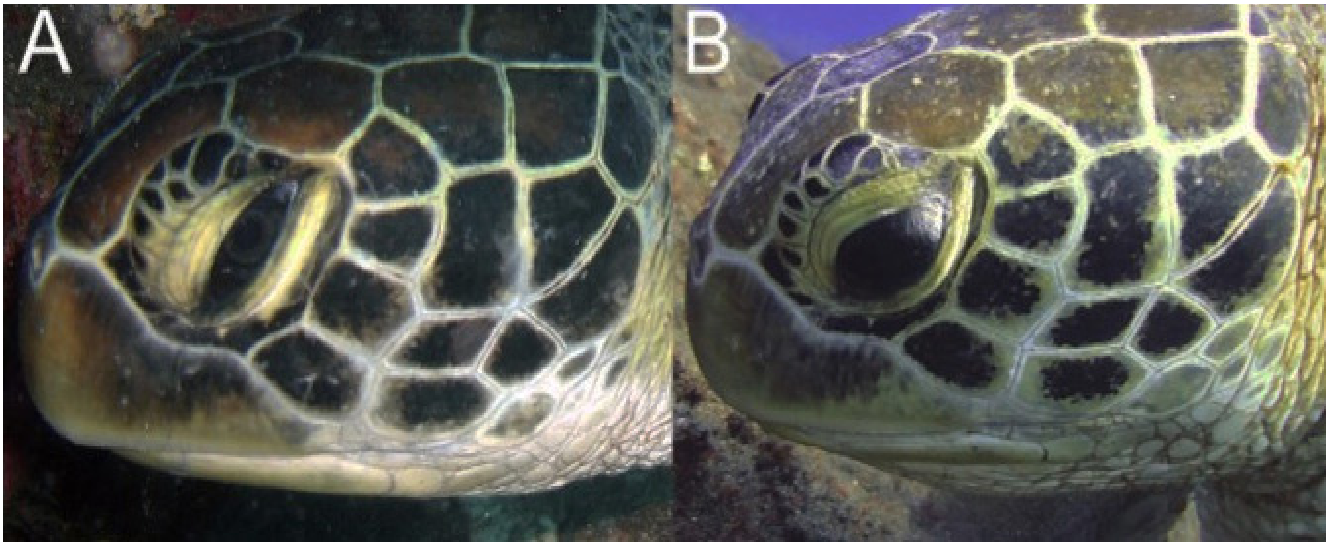


Figure 41. Example of a young Green Turtle seen at 5 years interval (Carpentier *et al.*, 2016).

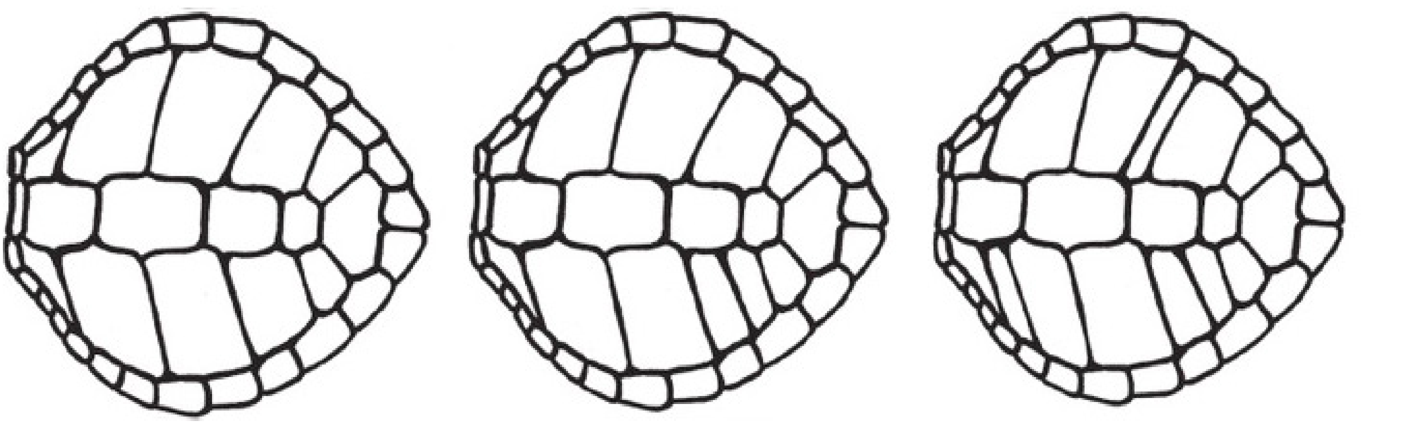


Figure 42. Examples of 3 Olive Ridley Turtles backs permitting identification by their diversified costal

Photo-ID of males

Photo-ID has also the advantage that it can be used on male turtles that are never seen on the beach for conventional tagging, and are therefore rarely identified. Photo-ID can facilitate the evaluation of the number of male and female turtles in a mating area and permit to measure the sex ratio of adults.

Photo-ID of Leatherback

Leatherbacks, with bodies and legs unprotected by hard scale armor, often show injuries **(Figure 43)**. They have the frontal zone decorated by a pineal spot (the chamfer), a pink spot with very variable forms according to the individuals. These two points make it possible by recording and combining them to have a reliable identification **(Figure 44)**.

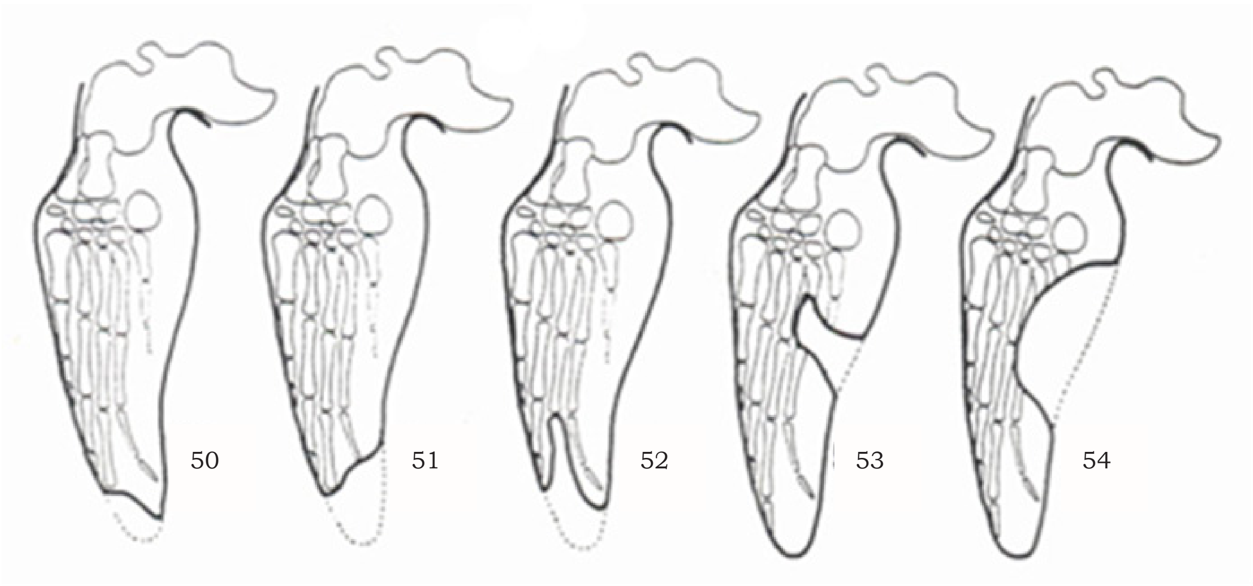
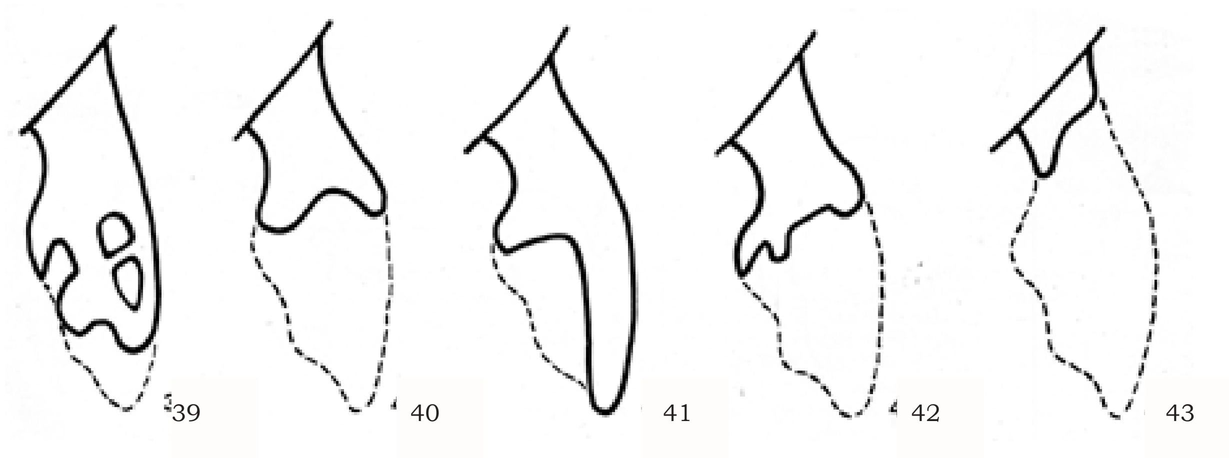


Figure 43. Examples of leg trauma in female Leatherbacks (© J. Fretey).



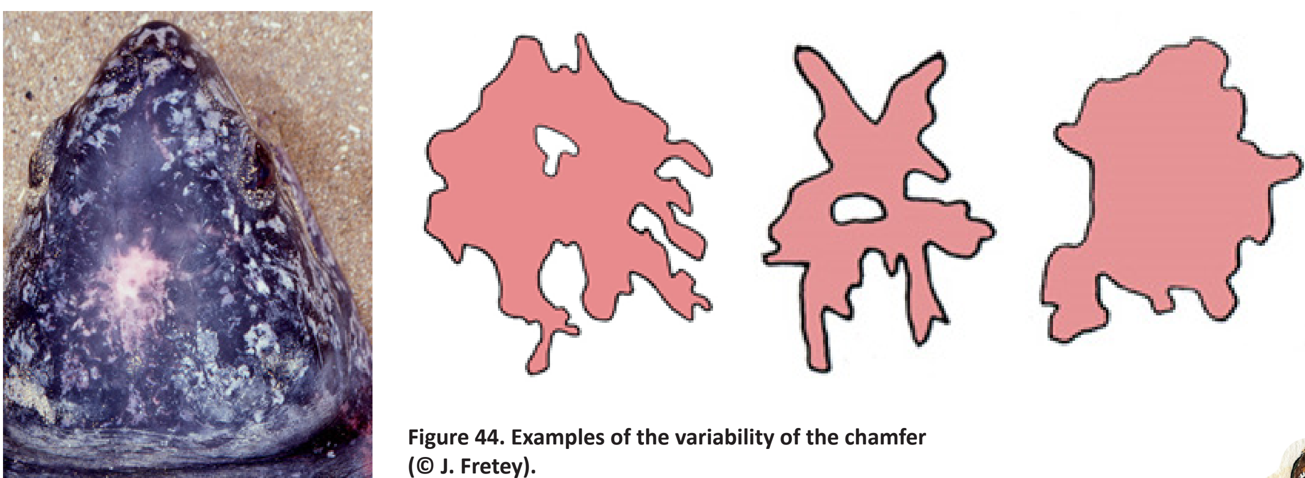


Figure 44. Examples of the variability of the chamfer (© J. Fretey).

VIII.7. Biometry

Measuring the female turtles coming to nest on a beach often leads to a lot of inaccuracies, and you need a clear objective on the need to measure.

As for the identification by individual marking, it is necessary to ask the question: Why I measure?

Marine turtles (nesting females, immatures in a nursery habitat, adults in a foraging habitat) can be measured in the framework of a project to achieve a certain number of objectives.

For example, females can be measured to link their size to their egg production.

One can also seek to determine the minimum size of sexual maturity in a breeding population. Measuring for example the Green Turtles frequenting a seagrass bed will permit seeing the different age classes on this habitat.

The size frequency of a population is an important parameter of its demographic structure.

But don't think you are doing something scientific by measuring a turtle. The measurements you take will always be approximate. To convince yourself of this, simply have several people measure the same turtle, and you will see that none will find the same measurement as you! One must therefore be very careful when analysing the data.

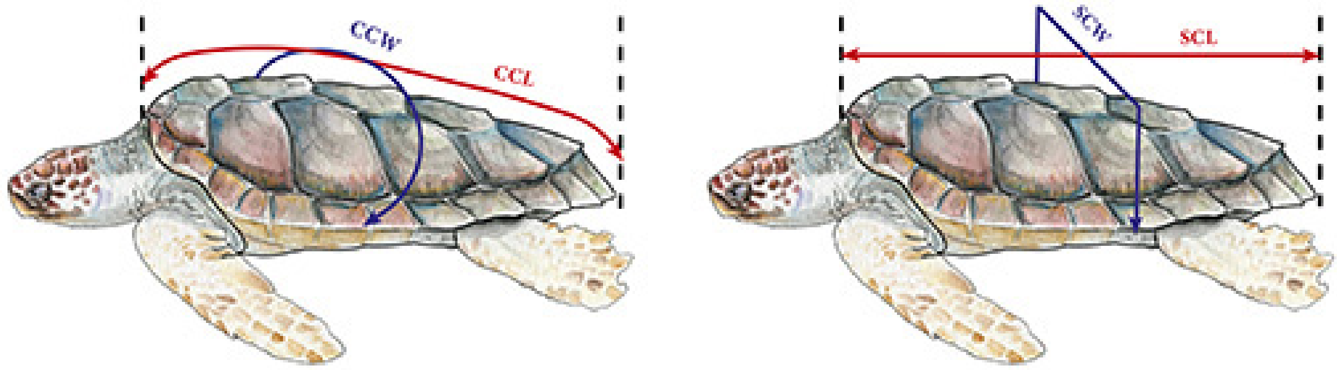


Figure 45. Types of measures: CLC: curve length of the carapace; CWC: curved with of the carapace; SLC: straight length of the carapace; SWC: straight width of the carapace (© Benhardouze *et al.*, 2009).

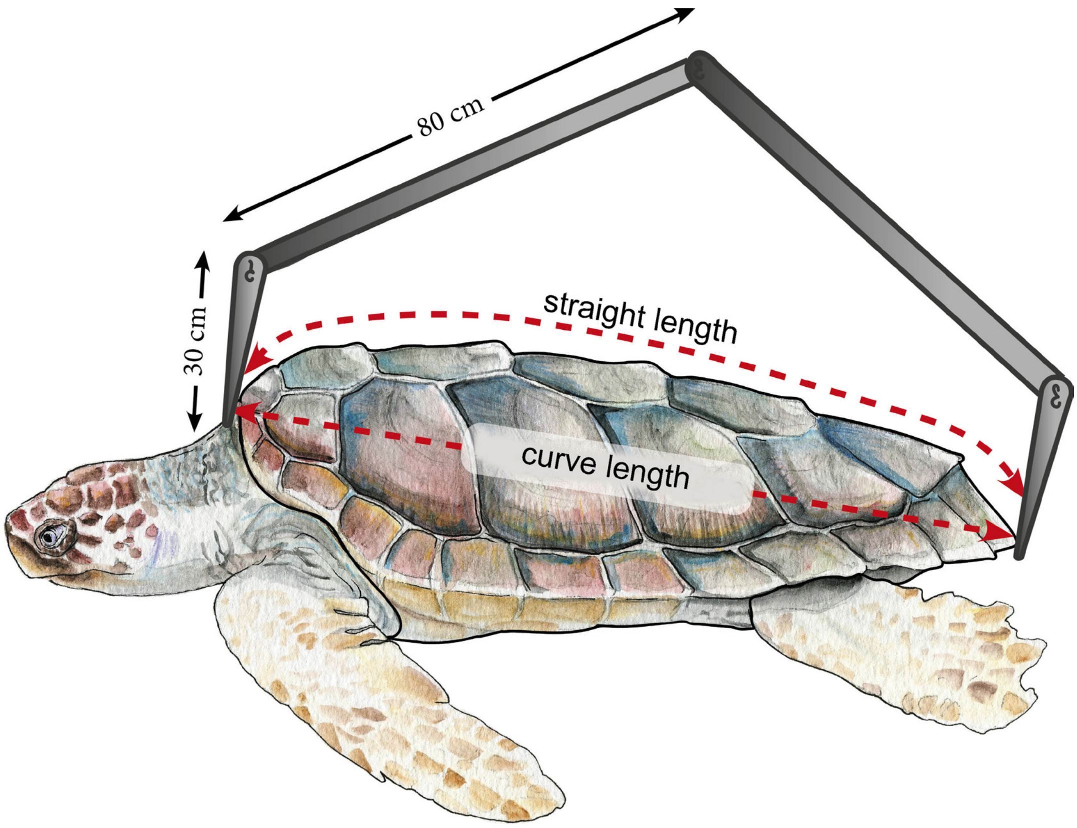


Figure 46. Straight measurement with a wooden compass (© Benhardouze *et al.*, 2009).

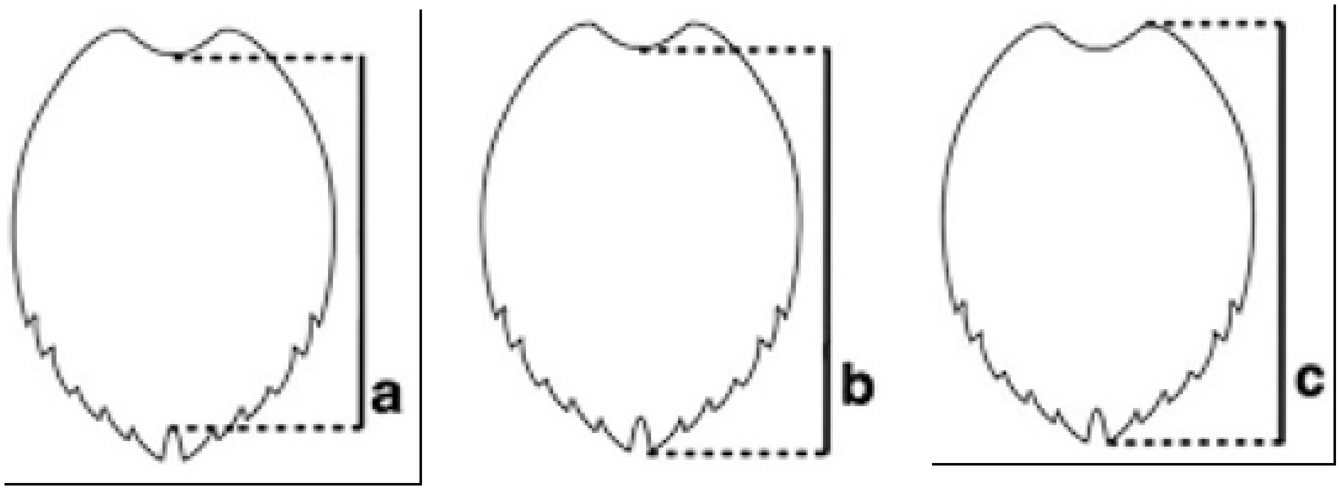


Figure 47.Three ways to measure a carapace in relation to the nuchal and supra caudal notches (after Bolten, 1999)

Straight or curved measurements?

Linear measurements can be made with a forestry caliper (straight line measurements) or with a tape measure (curved measurements). You can also make a large wooden compass and transfer the measurements to a tape measure.

Curved measurements tend to be less accurate due to irregularities, barnacles or ridges on the surface of the turtle shell **(Figures 45 à 47)**.

Straight lengths of the carapace (SLC) can be taken in three different ways:
- measurement taken from the midpoint of the nuchal notch to the posterior notch in the middle of the supracaudals (a);
- measurement taken from the midpoint of the nuchal notch to the posterior tip of a supracaudal (b). Often the tips of the supracaudals are not symmetrical; for consistency, the supracaudal that gives the longest measurement should be used;
- measurement taken from one of the shoulder pads on the carapace of a supracaudal (c).

When using a tape measure to measure the curved length of a scabbard, the lack of a clearly defined beginning and end may contribute to the variance in length accuracy. Because of the curvature and thickness of the nuchal plate, the junction of the skin and this plate should be used as the anterior point. The posterior point should be the posterior tip of a supracaudal.

Back widths are measured at the points of longest width **(Figure 48)**.

The rounding of the shoulder pads and the spur, as well as the ridges of the hull make these measurements very imprecise, and they can only be an estimate. So, it is useless to put a precision with an indication of millimeters!

Weighing turtles

The body condition of adult females is generally a good indicator of the health of the populations. If you wish to know that of the females frequenting your beach, you can seek the indices of body condition (Body condition index = BCI) by weighing them.

You will need to build a tripod with a pulley and a hook to lift the turtle. The turtle will be carried on a net with a looped rope, the hook going into the loop.

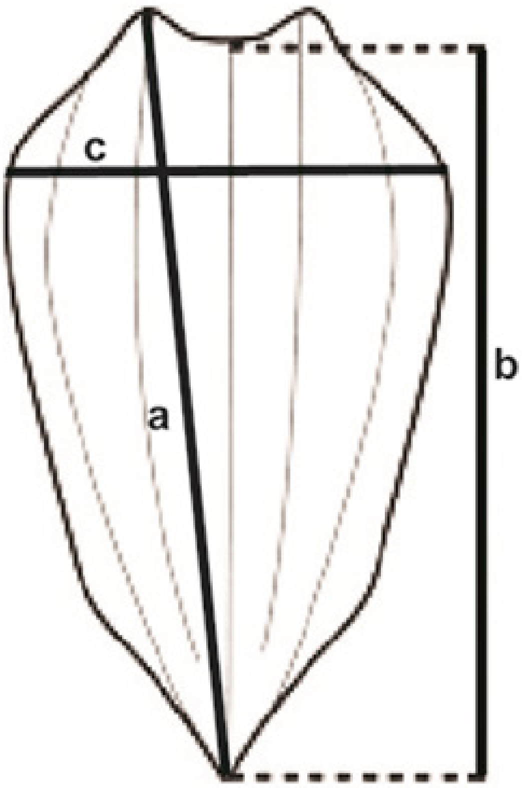


Figure 48. Whether in straight or curved length of the carapace, the measurement in Leatherback Turtle can be taken either from the middle of the nuchal notch (b- vertebral measurement) or from the end of a should pad (a), diagonally, at the end of the supracaudal spur

(© J. Fretey).

Once the straight length measurement is taken and the turtle is weighed, it is possible to know the BCI by this formula:

$$BCI = \frac{Mass\ (kg)}{(\ straight\ length\ of\ shell\ (cm)\ )^3} \times 1000$$

Dermochelys coriacea **on a beach (© J Fretey)**

IX. Knowing what to do about bycatch at sea

IX.1. General data

Bycatch refers to unintentionally caught species whose occurrence is low, or at least should remain low **(Figure 49)**. They include fish species that are not targeted by fishermen because of their size or lack of commercial value, but also other vertebrates such as sharks, dolphins, seabirds and sea turtles that may pay a heavy price. Caught in nets, turtles may not come to the surface to breath, and eventually drown. They may also be severely injured and unable to face the dangers of the ocean. Finally, bycatch can lead fishermen to consider that their catch has a value, even if only culinary, and to take turtles for food, despite their protected status. Knowing the conditions of incidental catches can permit the implementation of solutions aiming at reducing them to what they should be, exceptional accidents.

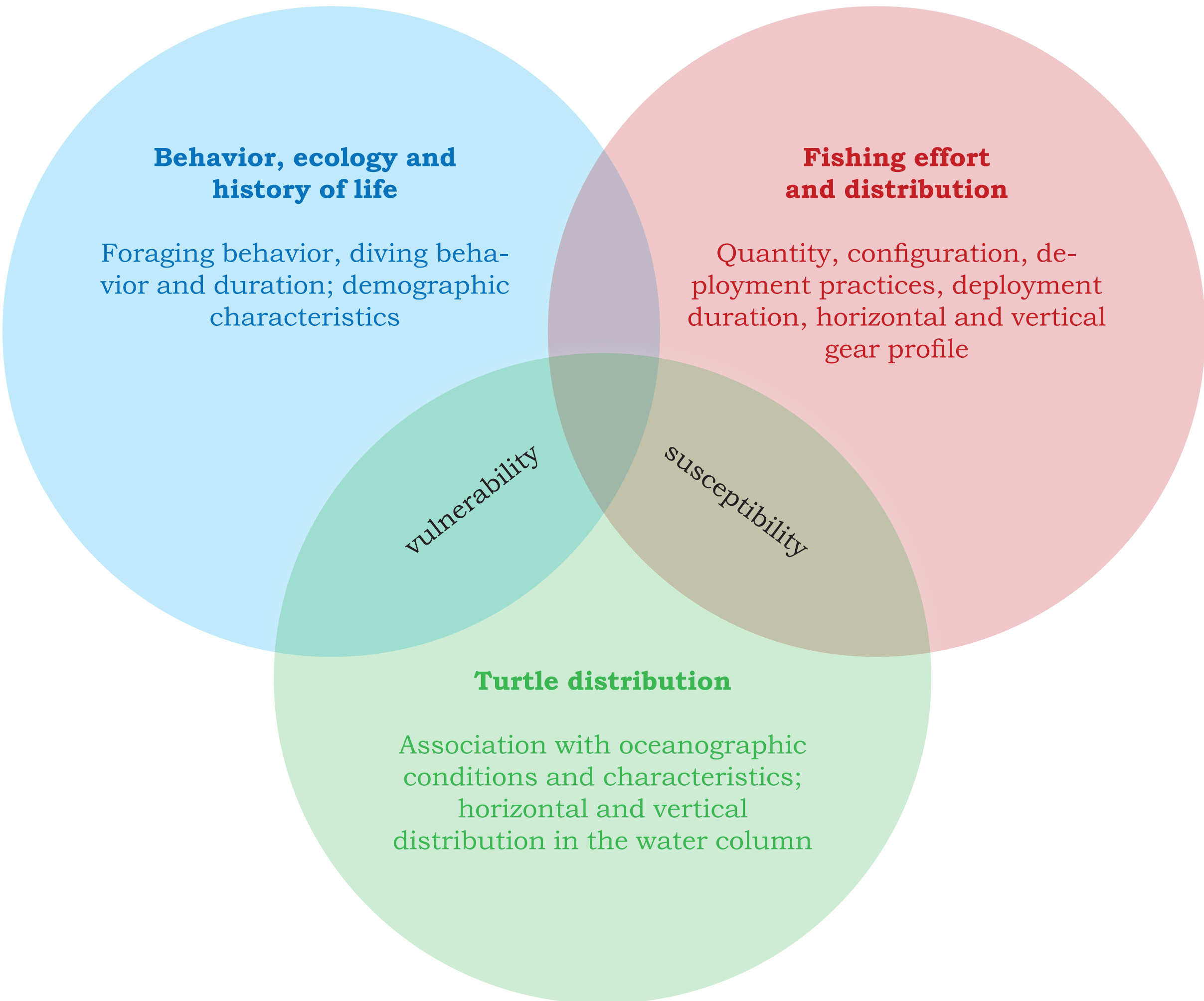


Figure 49. A conceptual model of the different factors that determine sea turtle bycatch. Susceptibility is primarily determined by the ecological and life history attributes and characteristics that govern behavior and distribution. Susceptibility, on the other hand, is largely determined by the horizontal and vertical overlap of fishing vessels and sea turtles, and represents the elements of the system that can be managed
(Lewison *et al.*, 2013)

IX.2. Fishing methods used in West African marine protected areas

The guide for the recognition of artisanal fishing gear and nets used in West African marine protected areas (Le Douguet, 2009) describes the different fishing methods encountered in marine protected areas (MPAs).

The knowledge of these fishing methods is the first step to be carried out in order to try to provide solutions. The used gears concern coastal fishing and the staff of the marine protected areas can only really act with local fishermen and the subject of this chapter will therefore be limited to actions that can be carried out towards them.

Nets and seines

These are the main problems encountered in the marine protected areas, notably the dormant gill nets, i.e. nets immersed for a specific period of time which generally does not exceed 24 hours, and the different mono- or multi-filament nets. These nets are at the origin of ghost nets, a term designating nets that are lost, but which continue to fish and are therefore very destructive for marine diversity. A turtle caught in one of these nets inevitably drowns.

Bycatch of turtles in gillnet fishing gear is considered a significant threat to sea turtle populations worldwide. Areas where small-scale fisheries overlap with important marine wildlife habitats should therefore receive special attention. This is particularly important as currently no protective measures are 100% effective in preventing turtles from being caught or drowned.

Longlines

Longlines are a series of hundreds or thousands of hooks that hang from a main line of variable length, sometimes several kilometers long (« longline ») set various depths to target fish species such as tuna and swordfish. Much of the bycatch of sea turtles occurs when the lines are set at shallow depths (between the surface and 100m), a depth range where all species of marine turtles dive intensively. Turtles may become hooked when they attempt to ingest bait placed on the hooks or become entangled when their flippers meet the main line. Bottom longlines can also cause bycatches. Longlines are passive gear. This type of fishing gear is related to longlines, which are hand lines with multiple hooks and leaders, and jigs, which are hand lines designated to target cephalopods: octopus, cuttlefish and squid.

Generally, turtles stay alive if they are able to reach the surface. If, however, entanglement prevents them from reaching the surface to breathe, they drown.

Circle hooks result in a significant reduction in mortality of turtles particularly Loggerheads, by reducing the incidence of hook ingestion as well as the catch rate.

Industrial trawls

Industrial trawlers generally drag one or more large funnel-shaped trawls through the water. The target species are caught in a bag at the end of the net, called the coded. Trawls can be deployed at different depths depending on the targeted species. For marine turtles, inshore or shallow trawls used to catch shrimps and other coastal species can result in a significant bycatch, especially of species such as Lepidochelys and Loggerheads attracted to this type of prey. Once turtles enter the coded, they cannot escape and die if the trawling operation lasts too long. The duration of a trawling operation exceeds the physiological capacity of a sea turtle to remain submerged without surfacing to breathe.

IX.3. How to act to avoid accidental captures and save a turtle caught in a gear?

Investigate with fishermen

The first step is the knowledge of the existence and the importance of the accidental captures. A survey of village artisanal fishers should be done in their vernacular language, when they are at rest, and without trying to impose a rhythm on them. Let them talk, even if what they say does not correspond to the order of the questions on the survey form **(Appendice 7)**. It is rare that a fisherman will give the exact number of turtles he catches in a month or a year, often knowing that these are protected species and that he fears a sanction. By cross-checking questions, the investigator will be able to get closer to the truth.

Making the right decisions to save a turtle caught in the nets

A marine turtle accidentally caught in a net or on a longline hook may be dead when it is brought back to the boat. If the accident occurred shortly before the fisherman's intervention, it may be alive and flailing around trying to free itself. At a depth where it could not return to the surface, it may have asphyxiated and be in a coma. **Appendices (8 à 11)** .

Reducing the risk of accidental capture

The best way to mitigate fishing interactions with marine turtles would of course be to avoid them, which is very difficult because areas rich in food resources are also rich in fish and attract fishermen. So, several solutions must be adopted, depending on local conditions and uses. It may be possible to consider:

- modifying fishing methods and gears so that they become less likely to trap and injure marine turtles;
- to set up a protocol to be able to return accidentally caught turtles to the water, in the best possible conditions;
- to create no-fishing zones, either temporarily, if sea turtles only come at certain times of the year, or permanently, although this is more difficult to implement. In particular, during the nesting period, marine turtles stay in shallow waters where it is preferable not to fish. It is also possible to limit the fishing effort (number of boats, fishing time) during sensitive periods, but this method must be applied with caution as it can lead to a serious loss of income for fishermen. It can also lead to an intensification of fishing outside the MPA, including in areas that may be heavily frequented by marine turtles, which ultimately only displaces the problem;
- to inform fishermen about the sensitive areas where they risk to catching accidentally marine turtles;
- changing the shapes of hooks on longlines from J-shaped to more circular shapes **(Figure 50)**, which has proven to be effective in different areas. Researchers distinguish here between Leatherback turtles frequently entangled in lines, orins (trap liens) or hooked externally and other turtle species usually caught with the hook at the beak or deep in the digestive tract. When using circle hooks, turtles are captured mainly in the mouth, whereas with J-shapes, they pass more easily into the digestive tract.
- increase the size of the hooks and change the bait;
- leaving more space between the leaders (a piece of fishing line made of a strong material placed before the lure to avoid being cut by the teeth of a fish) to avoid turtle entanglement, especially of the Leatherback turtle;
- in the case of quasi-industrial fisheries, to implement turtle exclusion devices (TEDs) that include various gear modification options to reduce the risk of capture. These can exclude sea turtles that may enter a trawl net. The most common designs use an angled grate to prevent large animals from entering the trawl. A funnel/guide net panel in front of the grate can be used to keep animals away from the escape opening and maximize the length of grate available to separate large animals from the shrimp catch. The escape opening is a hole in the codend and is usually covered with a flap of netting or other material to prevent shrimps from escaping;
- to provide at low-cost or finance fishing equipment that is appropriate to avoid bycatch, for example, nets with exclusion devices or more circular hooks. Biodegradable nets are also starting to appear and help avoid ghost nets;
- to propose to the fishermen to participate in the effort of knowledge of the marine turtles by reporting all their observations. Being at sea every day, they know, better than anyone, where and when the turtles are and involving them permits to raise their awareness;
- to encourage fishermen to bring back the turtles they catch to protected area authorities, who may, for example, give them a bonus (when the means to do so are sufficient) or seek sponsorship for release, which permits the fishermen to understand that a release turtle can be a source of income and consideration by the local community;
- to educate fishermen about on-board turtle handling to explain how to handle captured turtles, in particular, when the hook is attached externally or in the mouth, how it can be removed to prevent the turtle from suffering or dying. They should also be told that a comatose animal should not be returned to the water but taken to the MPA for treatment and release once it has recovered;
- to develop positive incentives by valuing fishermen recognized for their caring behavior towards marine diversity and, in particular, towards marine turtles, for example by ensuring their promotion so that they can sell fish labeled « compatible with safeguarding of marine turtles »;
- to propose fishermen ecotourism activities, for example to introduce tourists to their trade and the sea, in order to increase their income and mitigate possible losses related to the need to adopt

Figure 50. Different models of circle hooks (*Gilman et al.*, 2006)

measures for marine turtles. Modifications to gear, bait types, hooks, set locations, and the timing and duration of net and longline sets were all explored as possible measures to reduce sea turtle bycatches.

Modifications to gear, bait types, hooks, mooring locations, and the timing and duration of net and longline moorings were all explored as possible measures to reduce marine turtle bycatch.

For more information on bycatch in the RAMPAO area, refer to Diallo (2019).

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X. Knowing how to identify strandings

X.1. Introductory data

The term « stranding » refers to a marine turtle that is found either dead, alive on a shoreline or floating at sea, but in this latter case is weakened and unable to behave normally due to injury, disease, or other problem.
Strandings are not quantitatively the same throughout the year or even from year to year.
Among the causes of strandings, impacts with boat propellers are an important cause of mortality.
Systematic collection of stranding data can provide managers and scientists with information useful for understanding movements in the region, conservation of the species. The data collected (wounds, tumors, entanglement in fishing gear, ...) can identify pathologies and human interactions with turtles at sea.

The turtles found stranded are either freshly dead or already in the process of decomposition, with or without the release of a foul smell. In the first stage of decomposition, the tissues collapse, then the gases swell the rotting flesh. After degassing, the limbs become disarticulated and the flesh is invaded by insect larvae. After a few days in the sun, the carcass dries, the skin settles on the bones, with little or no smell. The next stage is a scattering of bones from the skeleton that has become completely disarticulated.

If a project is going to record many strandings, we advise to establish a code according to the state of the corpse or the body parts. This code will be entered on a form **(Appendice 8)** with the date, location, and measurements of the body if they were taken, photos **(Figure 51)**, etc.

Here is an overview of the classification that can be made of the different states in which strandings are found, with a thorough examination:

Start by examining the outside of the turtle, from head to tail, for any abnormalities, injuries, signs of pathology:

- nostrils: Is there blood or mucus coming out of the nostrils?
- mouth: The oral mucosa should be pink. Red or blue-grey colors are abnormal. Note ulcer, cut, plaque, mass, spot, or lump in the mouth. Also note the presence of foreign material (fishing line, hooks), blood or algae in the mouth.
- - Eyes: Are the eyes droopy, unclear, watery? Are there any abnormal tumors or pustules around the eyes?
- paws: Are there any tumors on the skin? Are the legs intact? Is there fishing line twisting the legs or hooks stuck in the skin?

fresh corpse

fresh corpse in perfect condition, still washed up on the waves

Fresh corpse with plastral opening (due to a predator?)

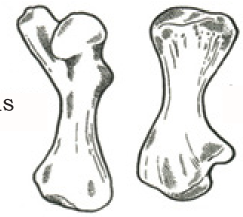
opening of the plastron allowing organs to escape

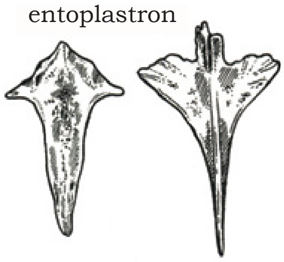
putrefied but not bloated corpse, an opening having allowed the escape of gases. Change of color of the soft parts, desquamation of the plates, head ready to detach from the body before the flippers.

In the Leatherback, the body is completely flattened, in decay

Cadaver with very involved putrefaction

corpse swollen by gases





Single shell with attached head

The head remains attached to the carapace by a flap of skin from the neck

The carapace is whole (dossiere and faceplate intact), the soft parts are missing, but remain hung of the emaciated legs

Faceplate only

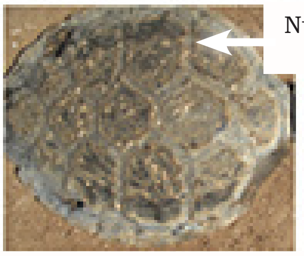
Faceplate separated from the backrest

Mummified corpse

The turtle is more or less whole, dried out, mummified by the sun

Barnacles on the shell

big barnacles



Numerous barnacles tiny

Very localized barnacles, in small numbers

Numerous barnacles and concentrated

Barnacles occupying almost all the the plates of the backrest

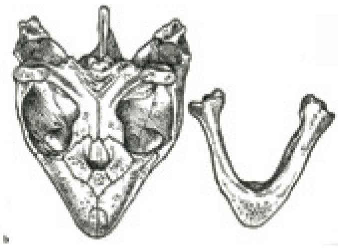
Pathology

Carapace with amputation due to a predator

tumors in a live turtle

tumors in a dead turtle

Skull



skull with its maxilla still present

Figure 51. The corpses and remains of stranded turtles can be classified into about 20 categories (© J. Fretey)

X.2. How to photograph cadavers or remains to validate the determination?

Taking pictures of a stranded turtle is essential, whatever the conditions **(Figures 52 et 53)**.
The photos must imperatively:
1) permit the identification of the species;
2) permit a good visualization of wounds, amputations, the presence of an entanglement in a fishing equipment or a rostrum (Marlin), a parasite interference by algae and invertebrates.

It is necessary, before taking any picture to clean as much as possible the carapace and the skin surfaces from sand and algae that may have covered them.

For the identification, pictures must be taken vertically of the back plate and the plastron, and permit to see clearly the sutures of the scutes. Photos should also be taken of the head in profile and of the frontal area.

If the corpse has been on the shore for a long time, the scutes may have dried out in the sun, cracked and disappeared. In this case, the general shape of the back scute can give indications on the species.

If a skull is found, it should be photographed from above, below and in profile. The identification will then be easier.

Figure 53. In order to store the pictures without risk of errors, each stranded body or part of a stranded body will be identified, on pictures, by a school slate with a recording code written with a chalk. This code will be written on the description form of the stranding as well as on possible samples (© J. Fretey).

X.3. Presence of a band

If the stranded turtle still has its limbs, check for the presence of one or more rings. If so, remove it or them if you have a tool to do so, otherwise take pictures of it on the top and bottom.

If you have a PIT scanner, run it over the shoulders and neck to check for the presence of a transponder.

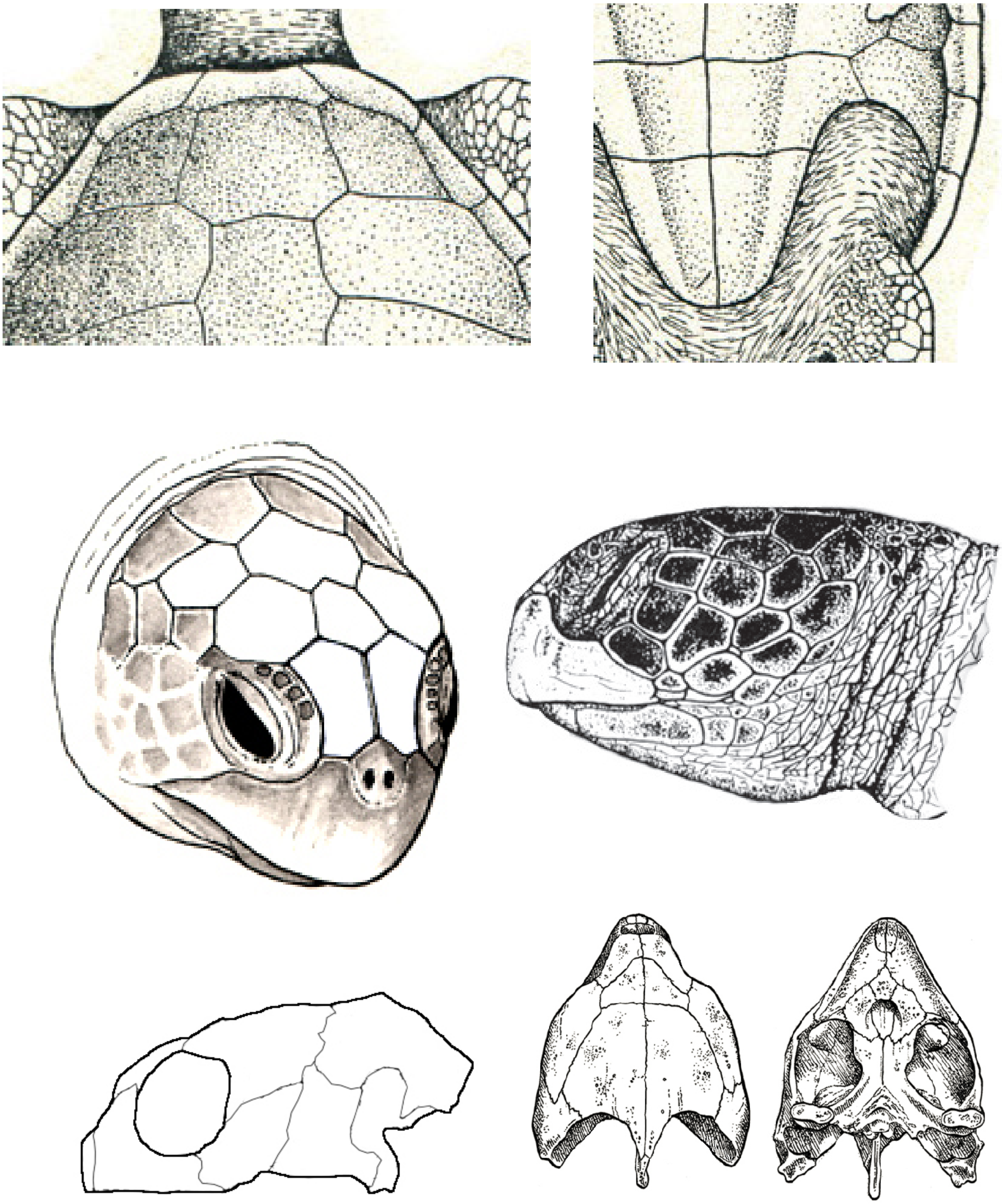


Figure 52. Body details to photograph on entire stranded turtles and various faces if it is only a skull (© J. Fretey)

XI. Learn how to perform a necropsy and take samples

Necropsy is a post-mortem examination performed on animals and corresponds to autopsy, which is the same type of examination in humans.

XI.1. Why doing a necropsy? What are we looking for?

If the purpose is to study micropollutants, pectoral muscle, liver, kidney, claw and/or fat should be collected. This can be done easily, as the recognition of these organs is relatively easy.

If it is a question of trying to identify the cause of death of a stranded turtle, a medical necropsy is necessary and thus it is a veterinary act that cannot be improvised. It implies a rigorous external and internal examination of a fresh or not yet decomposed corpse, to locate possible lesions, in order to detect any indication of the cause of death. Only experience will permit to evaluate, for example, if a liver is normal. The liver of healthy turtle is firm with fine borders and a homogeneous mauve brown color. An abnormality may be manifested by an abnormal coloration, spots or stains, an unusual consistency (too soft, too hard), an unusual size (too big, too small), or an odd shape (with lumps). Obviously, these observations require recognizing what is normal and what is not.

Freezing and thawing a carcass can compromise the appearance of the tissue.

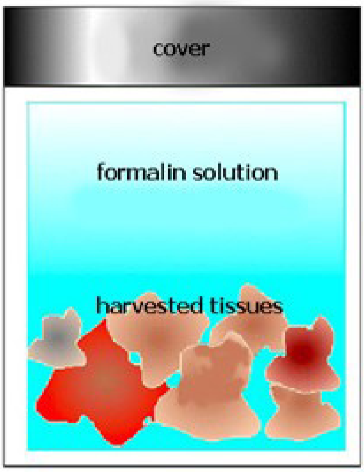


Figure 54. Ensure that there is enough formalin in a vial to permit adequate tissue fixation. The ratio of formalin should be at least 2 parts formalin to 1 part tissue by volume (from Work, 2000).

Equipment needed for a necropsy
Cutter, scalpel with disposable blades, saw, scissors, disposable gloves, plastic bags of various sizes, vials, pillboxes, 10% formalin, indelible marker, labels, aluminum foil, pencil.

Do not eat or drink when dissecting a carcass. Remember, you do not know if this is a disease that can be transmitted to humans.

XI.2. How to collect and store samples

The samples are stored in a formalin solution **(Figures 54 et 55).** Be careful, formalin (formaldehyde) is a dangerous product for human health; do not use it without gloves and in non-ventilated rooms.

We recommend two preparations according to the possibilities in terms of purchase of products and equipment (test tubes, precision balance). Mix the following products:

Recipe 1
If you do not have a balance, but only a measuring cylinder, measure 150 ml of formalin (37%) and 850 m of seawater.

Recipe 2
If you have a scale, mix 6.5 g of dibasic sodium phosphate (Na2HPO4), 4,0 g of mono basic sodium phosphate (NaH2PO4.H20), 100 ml of formaldehyde, and 900 ml of freshwate.

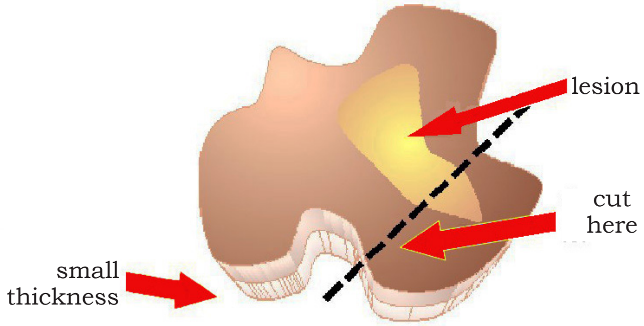


Figure 55. A piece of tissue should generally be not thicker than more or less 0.5 cm. If there is a lesion, be secure to take a portion of « normal » tissue adjacent to the lesion. This is very important, as many diseases are diagnosed by microscopic observation of the border between normal and abnormal tissue (from Work, 2000)

Labels should be affixed to the bottles and pillboxes and written in indelible ink or pencil, not ballpoint pen. The minimum information on a label should include the collection location, date, and unique collection identification number that will be transcribed to the turtle identification card.

To retrieve organs, follow the steps outlined **(Figures 56 à 58)**:

1) Place the turtle on its back, plastron side up.

2) Separate the plastron from the carapace by cutting along the outer edge (along the red line). The blue points indicate the position where the clavicles (anteriorly) or the pelvis (posteriorly) are attached to the plastron. These can be detached from the plastron by cutting the ligaments and cartilage.

3) Cut the ligamentous attachment to the pectoral and pelvic belts.

4) Raise the breastplate.

Be careful to use a short blade, and cut on a horizontal angle so as not to affect the integrity of the organs.

5) After removing the plastron, you should see the pectoral muscles and the intestines. Note that the pectoral muscles, which are the « propulsive engines » of the turtle, occupy a large part of the cavity.

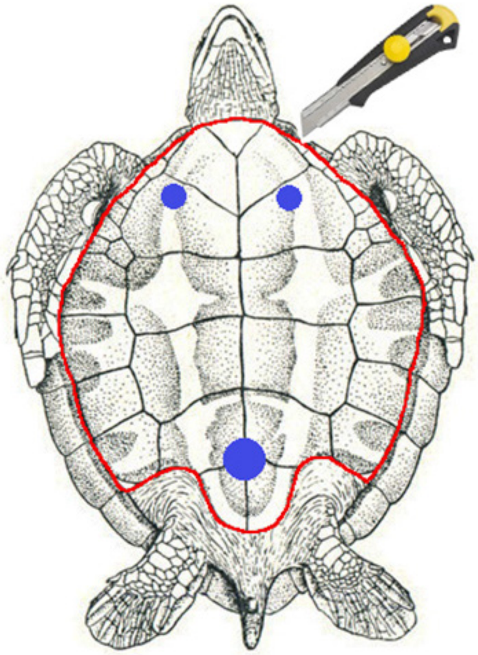


Figure 56. Opening line of the plastron (© J. Fretey).

Figure 57. Lift the faceplate as it is opened to loosen the adhesions (© C. Dyc).

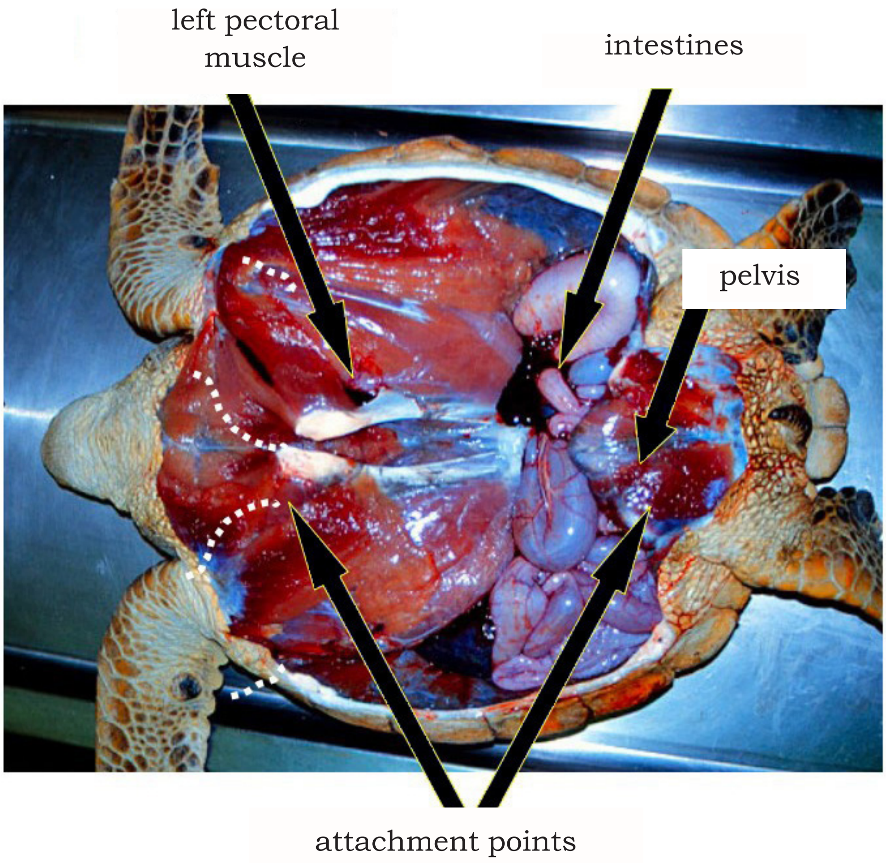


Figure 58. Location of ligamentous attachment points to the pectoral and pelvic girdles (fromWork, 2000).

The intestines should be smooth and a uniform beige color. The intestines should be filled with algae in a Green Turtle. Note if they are empty.

1) Cut along the inside of the lower jaw to release the tongue, glottis, trachea and esophagus. The trachea and esophagus will be behind the hyoid apparatus. Cartilaginous rings characterize the trachea. The esophagus is a collapsed muscular tube. If you have difficulties to find it, you can pass a blunt instrument or a tube down the throat and locate the structure by moving your sonde.

2) To expose the viscera, remove the foreleg and shoulder belts by breaking the attachments of the scapula to the carapace. Release the shoulder muscles attached to the carapace and neck by cutting or breaking them.

3) If you have not already removed the liver with the intestine, do so now by carefully freeing it from its attachments to the lungs and peritoneum.

4) Once you have located the esophagus, tie it near the mouth with string. You can then cut it away from the mouth and begin to remove the intestine for later examination.

5) Separate the esophagus and the stomach from the trachea and liver. The stomach is attached to the left ventral lobe of the liver and the left lung. These parts must be cut away to free the stomach, liver and left lung.

6) Continue to remove the intestine by tearing or destroying the flat tissues (mesenteries) that support the organs and blood vessels. The stomach joins the small intestine at the pyloric sphincter. Immediately after this one, the pancreas can be distally along the duodenum after the common bile duct, and a short vesicle that lies in the right lobe of the liver.

All the data could be gathered in a **(Appendice 13).**

XI.3. Knowing how to analyze the diet

Knowing the diet of a turtle permits to provide data on the areas which provide such food, thus to identify habitats to be conserved.

Two cases can occur: a dead turtle stranded or a live turtle captured accidentally in a net.

Dead turtle

See above how to access the stomach and large intestine. Open them with a scalpel, remove all the contents in a bowl.

Alive turtle

A simple and reliable technique of gastric lavage or rinsing of the stomach has been developed, without harming the animal. It permits to quickly recover large volumes of undigested food from the esophagus and the anterior stomach.

Secure the turtle, head down

Turtles are placed on their shells at a height that permits the head to be positioned lower than the shell dome while still permitting free access to the animal's head. The shell must be supported to prevent the animal from swaying. The easiest way to do this is to place the turtle on a car tire laid flat in a wheelbarrow, which provides excellent support for holding and transporting the animal later.

For optimal drainage, the rear end of the turtle should be elevated a little higher than the head. Turtles rarely struggle once they are set up this way. Small turtles can be placed between the knees.

Getting the turtle to open its mouth

The turtle's mouth is opened by holding the head firmly, and gently inserting a pry bar (steel blade, large screwdriver, or scalpel handle) between the maxilla and mandible, being careful not to injure the turtle. Apply gentle downward pressure until you feel the lever about the palate. This movement should be done gently as the objective is not to force the mouth open, but to exert irritating pressure that will cause the turtle to open its mouth. Attempting to force the jaws open may damage the jaws and prevent the animal from feeding.

Holding the mouth open with a muzzle

The bar is quickly slid into the mouth cavity and out the other side and held in place until a muzzle can be applied. A standard veterinary canine muzzle is inserted into the mouth while an assistant holds the lever in place. The muzzle should be inserted at the front end of the mouth and then widened. The muzzle should be checked for stability before removing the lever. If you do not have a canine muzzle, a piece of thick-walled PVC water pipe about 3.5 to 4.5 cm in diameter will work just fine!

Inserting the tubes

Before inserting the collection tube, one person should firmly grasp the head and fully extend the neck while keeping the head aligned with the midline of the plastron. This position should be maintained throughout the flushing procedure to avoid injury to the animal.

The end of the extraction tube should be soaked in a lubricant such as vegetable cooking oil and then gently placed in the anterior end of the esophagus. If glottis interferes with the entry of the tube, it can be depressed with the lever.

Once the extraction tube has passed the esophageal muscle group, the lubricated water injection tube is slid laterally along the extraction tube. The lateral positioning of this tube will reduce the risk of penetrating the trachea, which should already be sealed by the extraction tube.

Both tubes are now passed into the esophagus until resistance is felt from the food bolus at the junction of the esophagus and stomach. In newly fed turtles, a food bolus is normally encountered before the junction.

Recovery of the food bowl

Fresh or salt water is now delivered through the injection tube. The flow valve of the water supply system should be nearby so that it can be shut off quickly.

Water should not be delivered at high pressures through the injection tube, as the build-up of excess water in the turtle could cause serious injuries. Once the water enters the turtle, it should be returned through the recovery tube within seconds. The stomach content is collected in a bowl.

The volume of the outflow should be equal to the inflow. The actual washing should not exceed 3 minutes to reduce the risk of inhalation by the turtle. Once the desired amount of food bolus has been collected, the water in the injection tube is turned off and the water and food are permitted to flow freely.

The turtle's hindquarters may be lifted slightly at this point to facilitate drainage. Complete drainage is important before removing the tube because the turtle can only breathe when the tube is removed, and the airway must before of standing water to prevent aspiration.

The water injection tube should be removed first and then the extraction tube. Immediately after removal of both tubes, the muzzle should also be removed quickly and the head raised slightly to clear any retention and water draining from the glottis. The head should be held in this position until the first breath, which should be almost immediate. At this point, the procedure is complete.

Gastric lavage specimens should be stored in a 6.5% seawater buffered formalin solution. Stronger formalin will discolor most plant material as well as some animal material, making identification more difficult. Gastric specimens should be stored away from direct light.

XII. Knowing how to organize educational activities and awareness

XII.1. What it is possible to show to children

The ascents of the marine turtles being essentially nocturnal, showing them to children must remain in the domain of the exception and be realized only with the full agreement of their parents. On the contrary, during the day, when tracks are clearly visible, it is possible to show them and, with the help of pictures of tracks, to encourage them to identify the species. Following the tracks can lead to the nest, which can then be marked, or moved with them, depending on the risks of poaching, predation or destruction by erosion.

The children can then wait until the hatching and departure of the hatchlings to the sea (figure 59). A transplantation enclosure is convenient to realize an awareness session with schoolchildren. At the time of a release of hatchlings, children can take place between the nest and the sea and thus follow the progression of the small turtles, while ensuring, by their presence, a form of safety against the specialized predators (birds, crabs…).

As a general rule, it is better to avoid any contact of emerging turtles with human hand. Even more so, believe to do well by shortening the path from the nest to the sea to the small turtles. But in a conservation project, there is theory in the office and effective action in the field. Making children aware of the fragility of young turtles, permitting them (whose existence they may have only known through the meat on their family plate), being able to talk with passion about them in the evening with their parents, saying that turtles must be protected, tilts the balance in favor of such an awareness, even if it causes a little discomfort for the turtles handled.

Figure 59. Hatchlings reach the sea under the look and benevolence of children (© J. Fretey).

XII.2. Simple activities to set up with schoolchildren

It is possible and necessary to move from contemplation or awareness to action with children. In the Marquesas Islands, it was while listening to scientists talking about the richness but also the fragility of the marine world that children had the idea of creating a marine educational area (MEA), a concept that was then developed on all the coasts of France. The French MEAs are based on three pillars:
• Training schoolchildren in eco-citizenship and sustainable development;
• Reconnecting schoolchildren with nature and their territory;
• Encouraging dialogue between students, marine stakeholders (users, economic actors) and protected area managers.

The concept can be replicated in West Africa. It consists, for a given class, in considering that a beach becomes their place of vigilance. This is a moral appropriation. The children take care, according to their means, of the respect of places and species. Under the responsibility of their teacher and with the impetus and involvement of MPA staff, they organize different activities according to the characteristics of the area they have selected.

The first awareness action is often a beach clean-up. In partnership with the MPA staff and all the local goodwill, the school children make sure that their environment is not polluted by plastic waste. The first collection is usually the most complicated because of the large amount of waste, but the repetition of the operation at regular intervals, and the relay provided by adults, permit to obtain good results. A clean beach is attractive to humans and birds and permits sea turtles to come and nest without risk of hindrance or injury. The principle of MEA management is relatively simple. A children's council can be set up in charge of defining the monitoring program and actions on the ground for the school year. MPA staff should be present when requests directly concern the protected area. This can be an opportunity to better explain nature protection and the jobs of the wardens that permit the MPA to function properly.

A set of educational activities can be implemented with the children:

• A simplified version of this guide so that children learn to identify the different species of marine turtles; a room can be set up at the MPA headquarters with carapaces of the different species (except for the Leatherback, of course) to be identified, reproductions of the species made of resin or cardboard, comic books and puzzles on turtles, coloring books, « goose games » explaining all the threats in a turtle's life cycle, African tales with marine turtles to be read…;
• An awareness raising by an animator, with a slide show, on their way of life, on their annual cycle, on the problems they encounter in the open sea or when they come to nest on the beaches. The awareness must permit the fishermen's children to understand the need to return the turtles to the sea or to bring them to the staff of the nearest MPA. This can also take the form of a drawing contest on human-turtle relations, on the fate of the turtles with rising sea levels and beach erosion, etc. It can be organized with the children (as in Benin, Mayotte, Costa Rica…) a small play or puppet show with a fisherman, a turtle, a predator (Shark, Killer whale…).
• The establishment with them of a list of good practices to adopt, at their level and at the level of adults to ensure the peaceful coexistence between marine turtles and humans;
• The development of an exhibition on the theme of marine turtles and the marine environment and simple awareness messages **(Figures 60 à 65)**;
• Discovery outings or feedback evenings during which the children can present the results of their work to adults.

Figure 60. Example of an awareness-raising poster (reproduced with permission of its designer, Mustapha Aksissou).

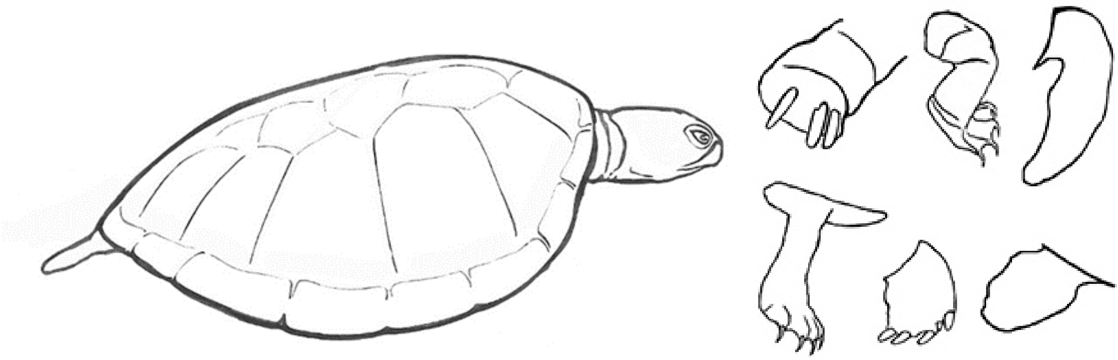


Figure 61.Example of a game: give this turtle back its legs (source: Kelonia, The Sea Turtle School, 2017).

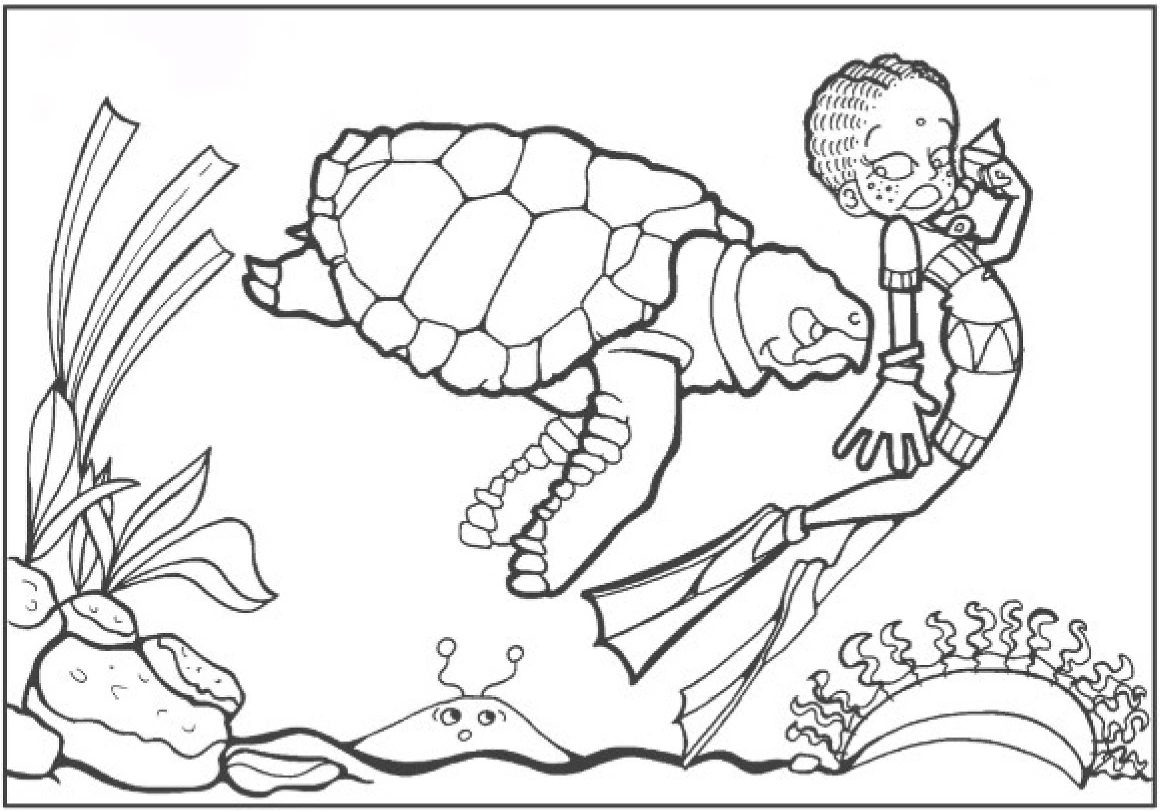


Figure 62. For younger children, a coloring book can be an awareness-raising support (source: Kelonia, The Sea Turtle School, 2017).

Figure 63. A sand turtle contest can be offered to young students (© J. Fretey).

Figure 64. Here, young children in Sao Tome are introduced to sea turtle conservation through a classroom video (© J. Fretey).

Figure 65. Natural science teacher explaining sea turtle reproduction to her middle school students standing behind a day nesting female Leatherback (© J. Fretey)

XIII. Knowing how to develop ecotourism micro-projects

Almost everywhere in the world, the marine turtles were killed for their meat, their fat, their carapace and their eggs. In West Africa, this exploitation (fortunately in huge decrease) aimed to improve family meals or, by the sale of the products, to improve the ordinary.

But living turtles can also be sources of income for local populations through ecotourism activities.

XIII.1. Village socio-economic benefits

A good project of ecotourism is economically profitable for a village by creating a stewardship with jobs of guides, lodgers, cooks. As a result, it quickly changes the way villagers view conservation efforts for an endangered species. Ecotourism is therefore an interesting economic alternative to the consumption of species products, with the creation of jobs, the education of women, as well as the valorization of traditions and folklore during cultural evenings, for example.

The creation of well-located ecolodges will permit local enterprises to get some work for the construction as well as for villagers for guarding, maintenance, cooking... The accommodation infrastructures, contrary to those of mass tourism, must be developed in harmony with the environment and minimize their impact on it.

It was demonstrated by various projects of ecotourism in the world that an living turtle was more profitable than a dead turtle. It is better to have an ecotourism project that is a little disturbing for the turtles, whether on land or at sea, than to have turtles killed.

It is up to each project to police itself and to improve the visits in order to limit the disturbances.

The best guides to accompany visitors in the evening to nesting or diving female turtles in a feeding habitat are the local poachers.

There are two advantages to employ them: removal of a major anthropogenic threat to females on land, eggs, and turtles feeding on a seagrass bed, and a good knowledge of how to find a turtle by the tracks on a beach.
We identify five possible ecotourism activities: observation activities on a beach during nesting season, hatcheries, education activities, turtle observation in a marine environment, and assistance to scientific research.
Volunteers, through the money they spend on their stay, help to finance the research projects they participate in, in addition to providing free labor for the projects. But be careful, concerning the help of volunteers to scientific research, we advise to involve in a project only people with a real scientific competence (or computer science for data collection), at the risk of having to manage unnecessary and time-consuming « dead weight ».

XIII.2. Ecotourism on a nesting beach

The activity, here, consists in waiting on a beach, generally at nightfall **(Figure 66)**, in order to observe a female coming to nest or the emergence of hatchlings from their nest and their departure towards the sea. This activity permits visitors to come closer to the turtles, a rare spectacle and a possibility of infrequent direct contact with an endangered animal species.

But when it comes to ecotourism on land, there is a great principle to keep in mind:

Better a disturbing flash than a deadly machete blow!

XIII.3. What behavior should the ecotourist have?

It should be noted that it is easier to do sightseeing with female Leatherbacks, not very sensitive to disturbance **(Figure 67)**, than with Hawksbill Turtles. As for the operations of marking and biometry, humans approaching a turtle must maintain a calm behavior.

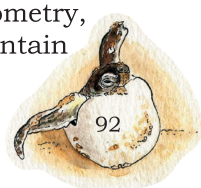


Figure 66. Obviously, the presence of unsupervised tourists on a nesting beach can be a factor of disturbance for female turtles, especially in reason of an undesirable behavior of the observers (campfires, inappropriate use of flashlights, physical interactions with the turtles, etc.), and can drive to the precipitous departure of the turtle, without nesting, to the sea. (© J. Fretey).

XIII.4. Sensitization enclosure

The initial goal of a nest transplant enclosure is to produce more hatchling turtles than in the wild where various natural (mammals, insects, roots, erosion) or man-made threats would destroy the eggs. This enclosure can be an excellent place to do awareness to adult and school visitors.

Beware, some sea turtle ecotourism projects keep hatchlings in pools of sea water while waiting for ecotourists to come and offer them a show. This practice weakens the turtles and causes them to lose their initial stimulus.

Some projects have also the philosophy to keep in basins the young turtles coming from an enclosure in order to remove them from the first marine predators and also to be able to show them, and have them handled by ecotourists. We advise you against such a practice, which requires expensive installations with permanent renewal of seawater and care of the pathologies which do not fail to appear in captivity.

If your transplantation exclosure is well maintained and has good results, do not hesitate to use it as a place of awareness. If not, don't do that, for fear of giving a bad image of your project.

Figure 67. Tourists behind a Leatherback turtle on the beach of Yalimapo, in French Guiana. This little fearful species is ideal for an ecotourism project, provided that certain rules are respected (© O. Grünewald – J. Fretey)

We do not advise to let intervene adult tourists in a release of hatchlings, but they can take pictures or films without any problem. On the other hand, to make intervene children of a school in the release will be very positive. You can thus tolerate that the children handle some hatchlings. This contact will aware them more than the words of the animator and then, they simply observing baby turtles leaving for the sea.

Back home, children will tell their parents what they saw and did, and will become effective ambassadors for the protection of sea turtles.

The animator, after explanations in the museum or towards the enclosure, can also send the children of a school in search of traces of locomotion of female turtles, of nests predated by crabes, etc.

Figure 68. A small museum at the entrance of a site is a privileged place to explain to school children the biology of marine turtles (© J. Fretey)

Figure 69. Small museum created by the association Gabon Environment behind the beach of Pongara, in Gabon (© J. Fretey)

XIII.5. Museography

It is easy and very inexpensive to create a small museum in an MPA **(Figures 68 et 69)**. It will be the ideal place to welcome both adult and school visitors.
Visuals will be proposed, either by simple wall painting or by posters. If the budget permits it, resin representations of the species coming to the site can be made or purchased.
Shelves will be able to accommodate jars containing eggs of the different species, hatchlings and embryos at various stages, depending on what is found on the beach. Skulls and carapaces recovered from massacres or standings will complete this exhibition.

Panels can also give this information with laminated posters next to a transplantation enclosure.

XIII.6. Create an educational trunk

If the ecotourism project, whether directly managed by an MPA or by a village ecotourism association, welcomes schoolchildren, an educational trunk on the MPA environment can be created, with documents on marine turtles, which can be used by the facilitator.

The educational trunk can, for example, contain games permitting the children to test their knowledge. The game can consist in knowing how to place names on the different parts of the body of a turtle or to identify the predators of the marine turtles in each of their habitats, or to put in chronological order the different phases of reproduction.

Printing drawings or photos on card stock can easily make these games.

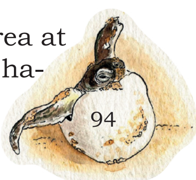
XIII.7. Organize dives among the turtles

Sea turtle watching in clear water is a popular activity for Western travelers in the tropics, especially for snorkelers. This activity takes place mainly in coastal habitats where sea turtles feed, in coral reefs and sea grass beds.

In terms of ecological impacts on the conservation of marine turtles, turtle watching in aquatic environment is more at risk than watching on land. The use of an outboard motor to go by boat over a site should be avoided as it could represent a danger for the turtles, because when the turtles come to the surface to breathe, there is a risk of collision and serious injury with the propeller.

If the boat must be parked over a sea grass bed, be careful with the anchor, which can cause damages. You should not try to feed the turtles, but be there as simple observers. Be careful, it was noted that Green Turtles disturbed by divers while they were eating deserted the meadow concerned or fed only at night.

A local villager who well knows the area at sea should accompany visits to a feeding habitat.



XIII.8. Organize turtle sponsorship

If bycatch is still prevalent in the area, an agreement can be made between the MPA and/or the village ecotourism association and local fishermen. The fisherman-partner who has accidentally caught a turtle in his net, returns to the port and has a call with a project contact person, who comes to pick up the turtle. The turtle is kept in a shaded enclosure, while a project contact person searches nearby hotels and restaurants for a tourist or businessman interested in rescuing a turtle **(Figure 70)**.

The price to be asked to the sponsor can be, for example, 10,000 FCFA for an immature turtle and 20,000 FCFA for an adult turtle. Half of the amount obtained will go to the fisherman and half to the project for operation.

The turtle is ringed. The number of the ring is indicated on a diploma given to the sponsor, as well as on a booklet owned by the fisher-partner.

XIII.9. But beware, the greatest danger of ecotourism is you!

By classic definition, ecotourism consists of bringing a few travelers to a fragile and protected site. Let's say that a community association linked to an MPA decides to accept only 5 travelers per week. These 5 travelers will generate interesting resources for the villagers and will bring a positive activity, and even income, for the MPA. Very quickly, the managers of the ecotourism micro-project will think that by accepting 15 visitors per week, the profits will be multiplied by 3. But why 15 visitors and not 30 which will bring in much more? It is not uncommon to see good ecotourism projects turn into mass tourism.


CERTIFICAT
DE PARRAINAGE

KUDU
Projet Cameroun

DECERNE A :
Estelle Hinds et Orjan Lundberg
Volrat Thamsgatan 10
412 60 Goteborg Sweden

pour son action en faveur de la sauvegarde des Tortues marines de l'Océan Atlantique.

La tortue parrainée, nommée ..GENE BELL...., est une Tortue VERTE mesurant 37 cm cm de longueur et 34.2 cm de largeur et identifiée par la pose d'une bague sous le numéro KUD- 10508...............
Le Programme Kudu adresse toutes ses félicitations à l'heureux parrain.

Fait à kribi le 24/09/05

Figure 70. Operation of release of an Olive Ridley Turtle in Cameroon, in the presence of a businessman sponsor staying in a hotel (© J. Fretey).

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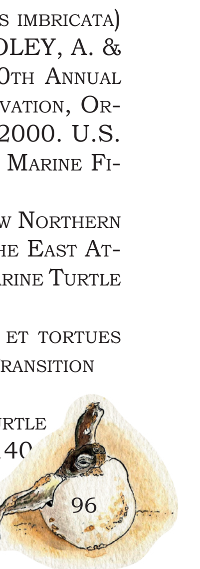

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Appendices

Appendice 1: Beach tracking form

MONITORING SHEET FOR A NESTING BEACH

Name of the beach : ……………………………………………

Area surveyed : ……………………………………………

Observer (s): ……………………………………………………

Monitoring from …./…..to …../…../20..

Time of departure of a patrol: …. h
Time of return of a patrol : …. h

Species	Trace up	Trace down	Body cavity	Confirmed nest	False nest	Distance to vegetation	In vegetation

Appendice 2: Form for census of tracks and nests.

MARINE TURTLE PROJECT
Track and nest count sheet

Year: 20..

Sheet n° ....

Name(s) and surname(s) of patrollers(s):
....
....

Night of :............./........
to................./.........

Patrolled area:
....

Name of the Marine Protected Area :
....

Name of the beach :
....

Patrol start time :.................. h
End time of patrol :.................... h

Method of travel :

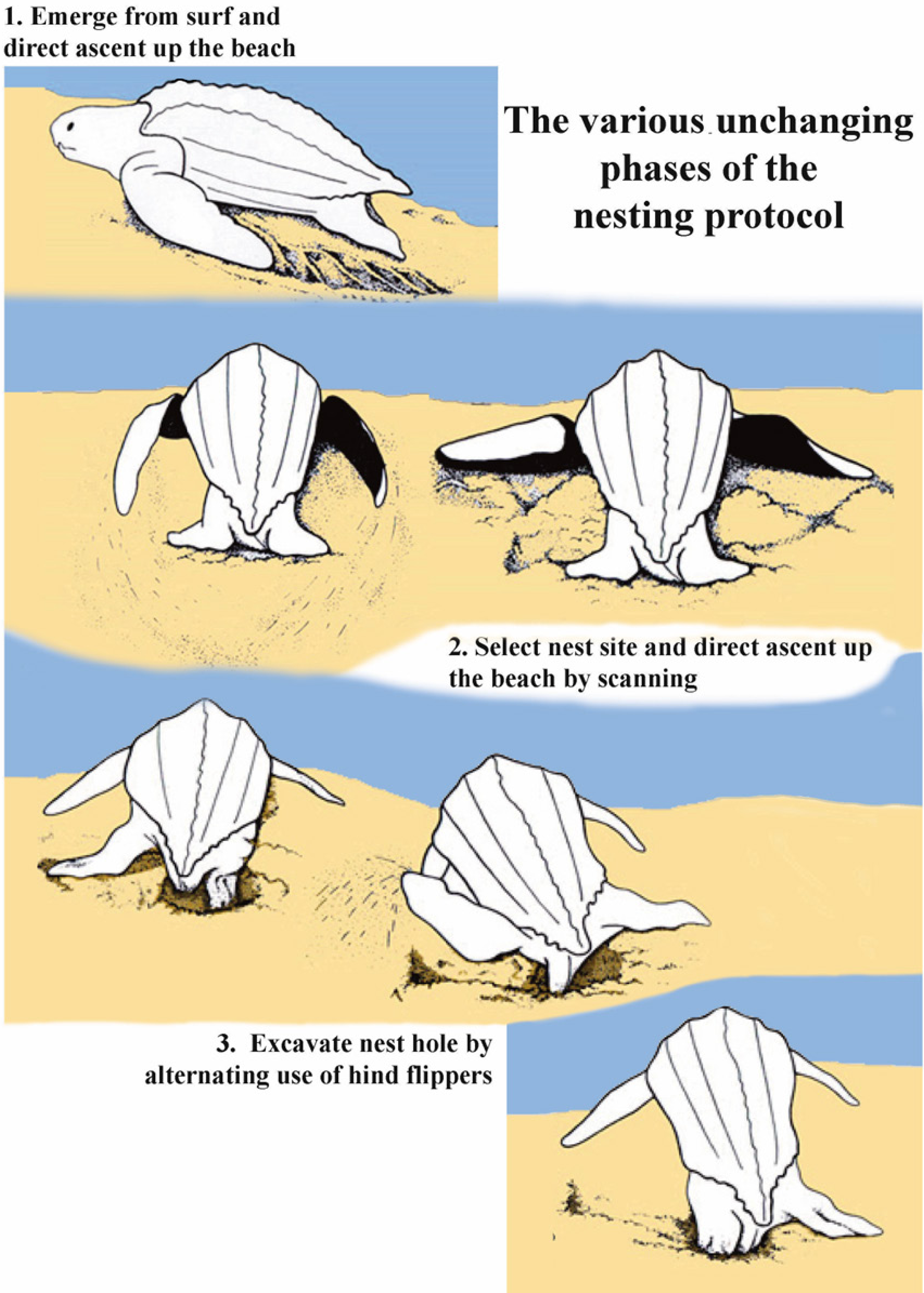
on foot ☐ by bike ☐ by quad bike ☐ aerial flight ☐

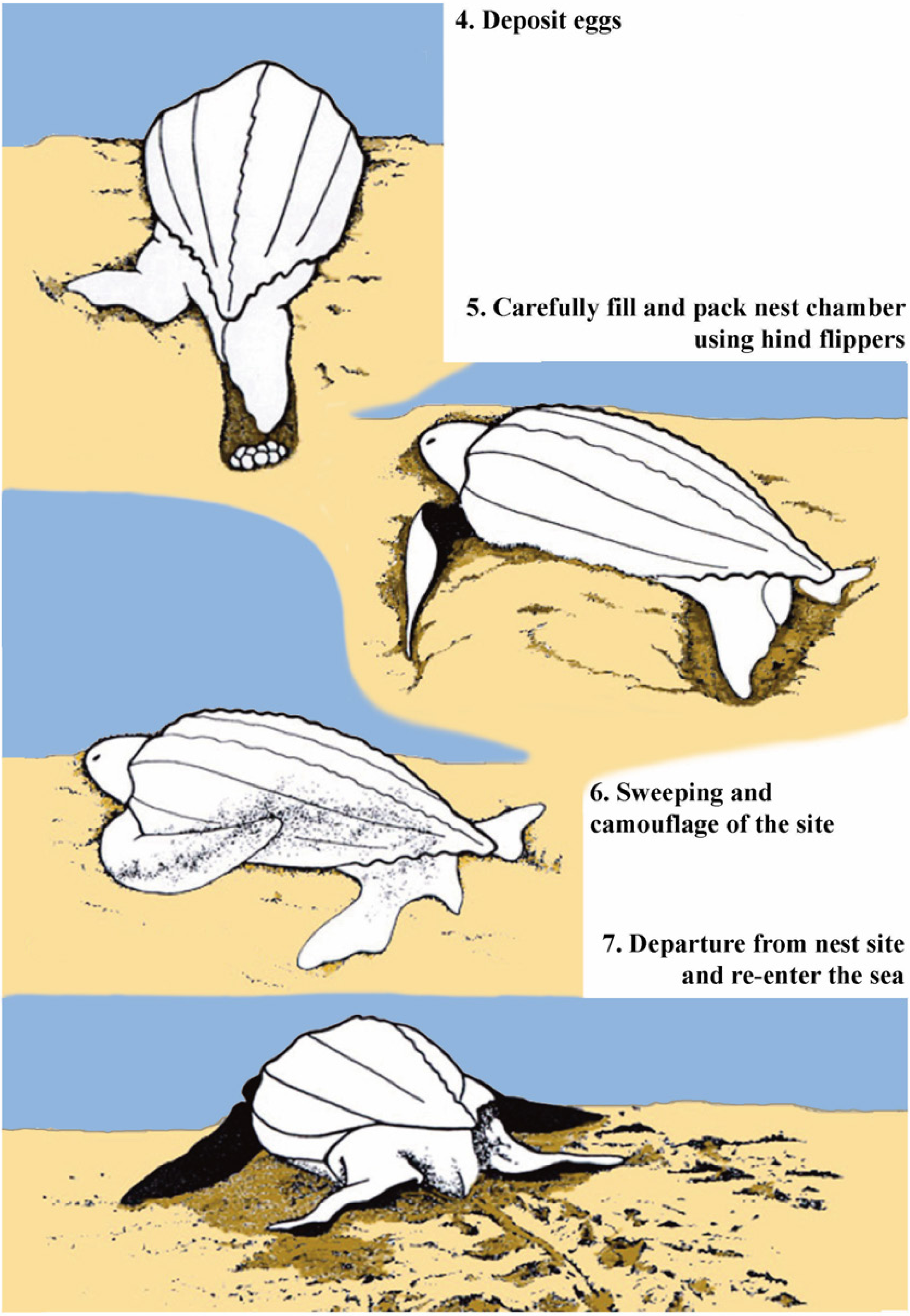
Time of hight tide : ....h

Night weather : wind ☐ rain ☐ Morning weather : wind ☐ rain ☐

Species	Number of tracks	Presence of body pits	Number of nests identified	Climbs without nests / False nests	Pretaded nests	Eroded nests	Nests removed
Chelonia mydas							
Caretta caretta							
Eretmochelys imbricata							
Lepidochelys olivacea							
Dermochelys coriacea							

Comments : ....
....
....
....


1. Emerge from surf and direct ascent up the beach
The various unchanging phases of the nesting protocol
2. Select nest site and direct ascent up the beach by scanning
3. Excavate nest hole by alternating use of hind flippers


4. Deposit eggs
5. Carefully fill and pack nest chamber using hind flippers
6. Sweeping and camouflage of the site
7. Departure from nest site and re-enter the sea

Individual identification form for marine turtles

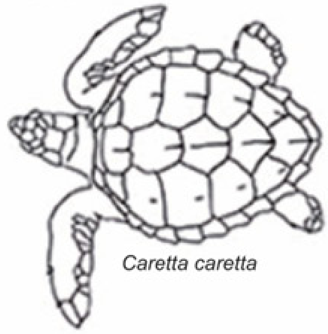
Name of the Marine Protected Area:
....

Sheet n°

Species:...

Name(s) and surname(s) of patroller(s):
....
Date: ..../......../20..

Location of observation :...



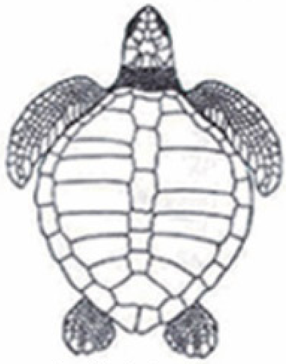
Caretta caretta

Tagging

Turtle is already tagged. un
Tag number(s) or PIT

Turtle is untagged
Tag(s) stapled / PIT injected

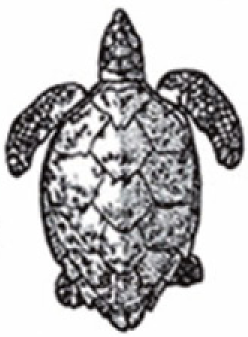
Left flipper	Right flipper



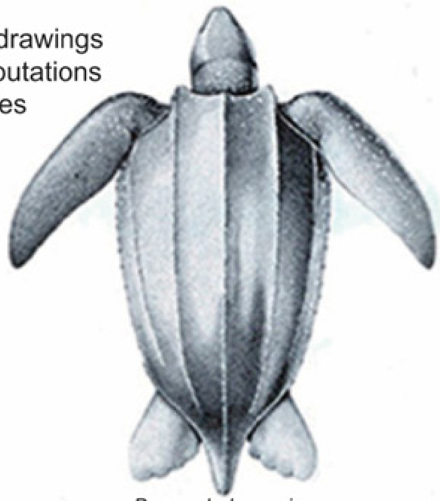
Lepidochelys olivacea

Chelonia mydas

Draw on these drawings the various amputations and injuries



Eretmochelys imbricata



Dermochelys coriacea

Scutes

Number of vertebrals:

Number of left costals:

Number of right costals:

Biometry

Curved lengh of carapace: .... cm
Curved width of carapace: .... cm

If it is a female on a beach, has she nesting? ☐ Yes ☐ No

Were the eggs transplanted into an enclosure ? ☐ Yes ☐ No How many eggs ? ....

Comments: ....
....
....

Nest analysis after emergence

Nest in situ ☐ Area/GPS: ....

Transplanted nest ☐

Nest number: ....

Date: ..../.........../202.

Name(s) of observer(s): ....

Species: Green Turtle ☐ Hawksbill ☐ Ridley Turtle ☐ Loggerhead ☐ Leatherback ☐

Date of nesting and/or transplanting of nest: ..../.........../202.

Total number of eggs:

Total number of eggs without development :

Number of membranes :

Number of rotten eggs :

Unhatched eggs with one embryo present :

Number of predated eggs:

Number of viable hatchlings and out of the nest:

Number of dead hatchlings in the nest:

Number of live hatchlings in the nest:

Hatching in progress: alive ☐ dead ☐

Success rate

Successful emergence

$$\frac{\text{Number of hatchlings x 100}}{\text{Total number of fertile eggs}}$$

Result : ***%***

Incubation success

$$\frac{\text{Number of hatchlings + alive and dead hatchlings in the nest + dead or alive hatching x 100}}{\text{Total number of fertile eggs}}$$

Result : ***%***

Dead embryos

Approximately between stage 12 and stage 24:

Approximately between stage 19 and stage 23:

Approximately between stage 24 and stage 28:

Approximately between stage 29 and stage 31:

Incubation time and emergence

Date of 1st emergence.......... days

Date of last emergence..........days

Total duration

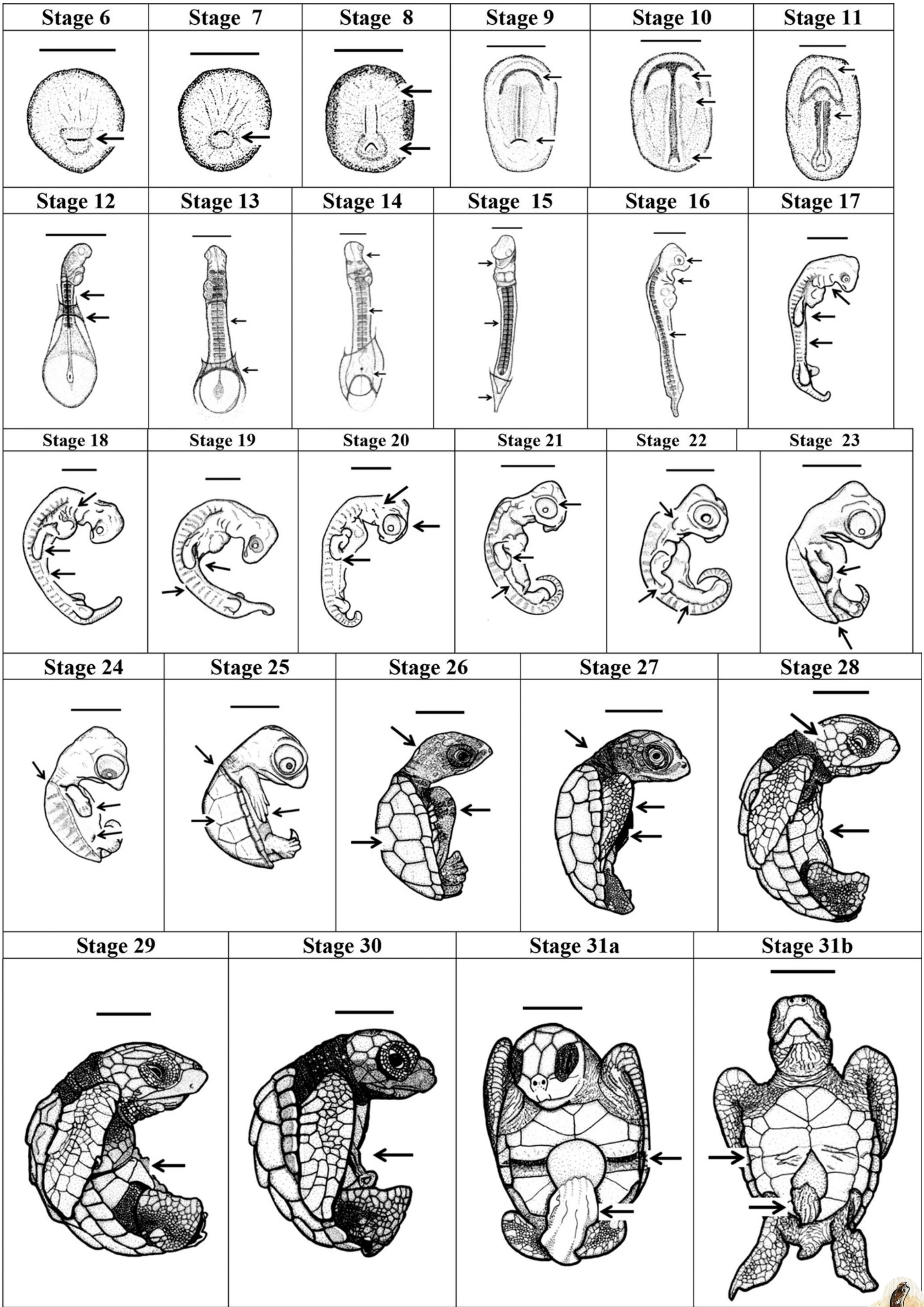
.... days

Comments: ....

....

....

Appendice 6: Table of development: the example of the Olive Ridley Turtle



Identification sheet for a turtle caught in fishing gear (bycatch)

Sheet N° ....

Species : ....

Adult male ☐

Adulte female ☐

Juvenile ☐

Unknown ☐

Name or code of the veesel (trawler, pirogue concerned)

....

Name and contact details of the boat captain :

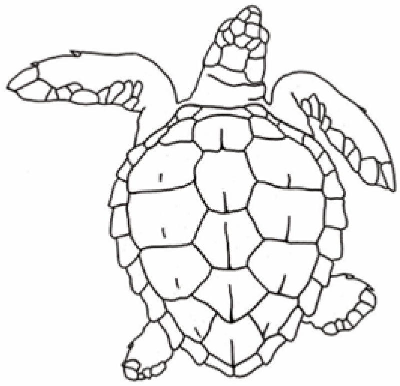
....

Name of the writer of this sheet : ....

Date : .... / .... / 20......

Location of capture : ....

Indicate on these drawings the various wounds and show any fishing equipment (net or nylon thread entanglement, hook,...)



Scutes

Number of vertebrales:

Number of left costals:

Number of right costals:

Biometry

Curved lengh of carapace: .... cm

Curved width of carapace: .... cm

This dead ☐ live ☐ turtle

was caught by:

trawl ☐ trammel net ☐ dormant net ☐

gill net ☐ seine ☐ longline ☐ other ☐

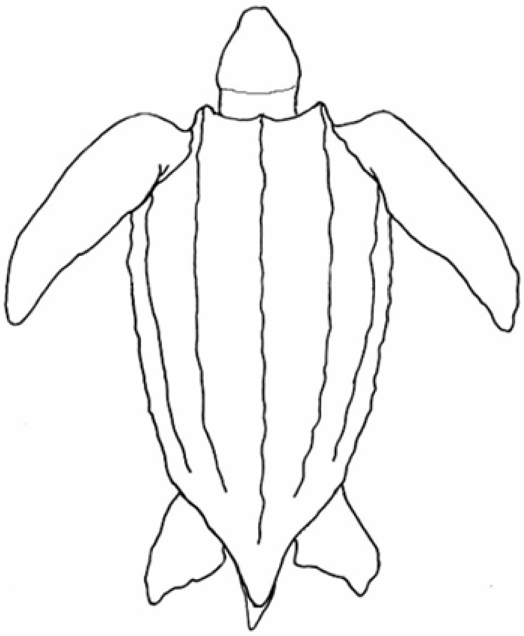
Comments :

....

....

....

....



Tagging (The turtle is tagged).
Number of the tag(s) or PIT

Stranding identification form

Identified species:..

Unidentified species ☐

Sheet N° ....

Name of the writer of this form:...

Date : .... / .... / 20.....

Location of the observation : ....

The whole turtle or its rests (carapace, bones, skull,...) were found:

At the level of the waves ☐

At the middle of the beach ☐

At the top of the beach ☐

On the back of the beach ☐

Strande turtle still alive ☐ or dead and whole ☐ with all the back scutes present

Scutes

Number of vertebrals:

Number of left costals:

Number of right costals:

Biometry

Curved lengh of shell : .... cm Skull width: .... cm

Curved width of shell : .... cm

Adult male ☐ Adult female ☐

Juvenile ☐ Unknown ☐

Tagging (The turtle is tagged)
Tag number(s) or PIT

☐

Status of stranding

injured turtle ☐ freshly dead turtle ☐ putrefied turtle ☐

gas-swollen turtle ☐ turtle with intestines escaping ☐

legs detached and back with head attached ☐ whole turtle mummified by the sun ☐

carapace with legs remaining but head detached ☐ scattered bones ☐

body attacked by predators ☐ skull alone ☐ legs alone ☐

presence of tumours on legs ☐ at the neck ☐ around the eyes ☐ at the shoulders ☐

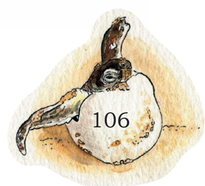
presence of acorn barnacles on the carapace ☐ pedunculate barnacles ☐

corpse with traces of a ship's propeller ☐ amputation by large predator ☐

Comments : ....

.

....



NECROPSY FORM

Species: ....

Date of recovery of the specimen: ...../......./20..

Date of necropsy: ..../....../..........

Location of recovery of the specimen : ....

Presence of identification (tag, PIT...):...

Sex: male ☐ female ☐ juvenile ☐ Weight: .... kg Carapace length (CCL/SCL):.......... cm

Condition of the body: good ☐ fair ☐ poor ☐ Post-mortem condition: fresh ☐ several days ☐

EXTERNAL EXAMINATION (shell, skin, eyes, nostrils, cloaca):..

....

....

MUSCLE SKELETON
Atrophy of the pectoral: none ☐ moderate ☐ severe ☐

Fat : firm ☐ soft ☐ gelatinous ☐

Body cavity : lot of fluid ☐ small amounts of fluid ☐ no fluid ☐

LIVER
Surface : smooth ☐ rough ☐ granular ☐ wrinkled ☐ Consistency: firm ☐ crumbly ☐

Color: homogeneous ☐ red ☐ black ☐ brown ☐ purple ☐ yellow ☐

HEART
Surface : smooth ☐ rough ☐ granular ☐ wrinled ☐ Consistency : firm ☐ crumbly ☐

Color: homogeneous ☐ red ☐ black ☐ brown ☐ purple ☐ yellow ☐

LUNG
Surface : smooth ☐ rough ☐ granular ☐ wrinkled ☐ Consistency: firm ☐ crumbly ☐ squishy ☐

Color: homogeneous ☐ pink ☐ yellow ☐ grey ☐ red ☐ brown ☐

TRACHEA:smooth ☐ rough ☐ Color:homogeneous ☐ white ☐ red ☐ brown ☐ green ☐ pink ☐

KIDNEYS : Surface : smooth ☐ rough ☐ ....Consistency : firm ☐ soft ☐

GONADS : Surface : smooth ☐ rough ☐ Consistency : firm ☐ crumbly ☐

LARGE INTESTINES
Mucosa : smooth ☐ rough ☐ Color : homogeneous ☐ red ☐ yellow ☐ black ☐ brown ☐

Contents:..

STOMACH mucosa : smooth ☐ rough ☐ Contents ....

Eretmochelys imbricata on a **beach (© J Fretey)**

Chélonée

rampao

MAVA
FONDATION POUR LA NATURE

PRCM
PARTENARIAT RÉGIONAL POUR LA CONSERVATION DE LA ZONE COTIÈRE ET MARINE EN AFRIQUE DE L'OUEST