Inter-American Convention for the Protection and Conservation of Sea Turtles

Manual of Management Techniques for Sea Turtle Conservation at Nesting Beaches

PREFACE

This manual is the result of a major effort of several years of revisions and the collaboration of many sea turtle experts and members of the Inter-American Convention for the Protection and Conservation of Sea Turtle's (IAC) Subsidiary Bodies. The first draft was done by members of the IAC Scientific Committee and regional experts and it was based on D. Chacón, N. Valerín, M. Virginia Cajiao, H. Gamboa and G. Marín (2000) Manual para mejores prácticas de conservación de las tortugas marinas en Centroamérica. The resulting document went through field testing and review in a workshop in Tortuguero, Costa Rica (August 31-September 4, 2008), which was conducted with support from Conservation International, Humane Society International, International Fund for Animal Welfare, The Nature Conservancy and WWF. The final editing of the manual was done by a Working Group of the IAC Scientific Committee (M. Abrego, B. Dick, E. Harrison, P. Hoetjes, J. Horrocks, R. Marquez-M, J. Martínez y L. Sarti,) at the 8th meeting of the Committee in San José, Costa Rica (September 28-30, 2011). This document is the finished product that we hope complies with its objective of providing a practical guide to promote standardized work at nesting beaches in the IAC region.

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Along the coasts of the countries of the Inter-American Convention (IAC) region, six of the world's existing seven species of sea turtles may be found: *Lepidochelys olivacea*, *Caretta caretta*, *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata*, and *Lepidochelys kempii*, the latter being an endemic species of the Gulf of Mexico. The increase in anthropogenic threats during the past and present century, including habitat loss from tourist and urban development, marine contamination and an increase in fishing effort that causes incidental capture, as well as direct take (legal or illegal), have put the world's species of sea turtles in danger of extinction. Therefore, the IUCN's Red List of Threatened Species classifies the *Lepidochelys olivacea* turtle as "Vulnerable", *Caretta caretta* and *Chelonia mydas* as "Endangered" and *Dermochelys coriacea, Eretmochelys imbricata, and Lepidochelys kempii* as "Critically Endangered".

Sea turtles have a very complex life cycle, using several developmental habitats and carrying out extensive migrations of thousands of kilometers between feeding grounds and nesting beaches. They can live for many years and reach sexual maturity at a late age. These characteristics make their protection difficult; exposing them to diverse threats over a very large geographic scale. Also, since sea turtles are reptiles whose metabolism and development are determined by the temperature of their environment, and their nesting areas and feeding grounds are very sensitive to changes in oceanographic variables, this makes them particularly vulnerable to climatic change.

Note: More information on the words in bold can be found in the glossary.

Due to their highly migratory nature, sea turtles represent shared resources among many nations. The conservation efforts for a population of turtles in one country can be harmed or benefited by activities in another country. Therefore, international cooperation is essential for achieving their conservation and management. This cooperation must recognize interconnections between habitats as well as between sea turtle populations and human beings, making use of the best scientific evidence available.

To achieve effective cooperation, it is important to have standardized conservation and management techniques that use the same terminology and scientific methods that allow different regions and countries to compare results from their conservation programs. Furthermore, the use of standardized techniques and terms facilitates the precise evaluation and comparison of sea turtle population sizes and trends, the distribution and the status of critical habitat, and protection and prevention of threats.

To offer a basic manual that promotes standardization of the techniques used in sea turtle management and conservation at nesting beaches in the IAC region. The manual is designed to complement "hands-on" training with an experienced instructor. This is particularly important when undertaking invasive techniques such as flipper tagging or PIT tagging for the first time.

The specific objectives are:

- To offer national sea turtle programs a tool to help train project leaders in charge of managing nesting beaches.
- To strengthen the capacity of local and national institutions in implementing beach conservation of programs.
- To promote the use of standardized methodologies and terminology in the conservation of sea turtles.
- To promote the implementation of the Convention's (IAC) objectives.

WHAT IS THE IAC?

The **Inter-American Convention for the Protection and Conservation of Sea Turtles** (IAC) is an intergovernmental treaty that provides a legal framework for countries in the Western Hemisphere to take actions in favor of these species.

The objective of the IAC is to promote the protection, conservation and recovery of sea turtle populations and the habitats on which they depend, based on the best available scientific evidence, taking into account the environmental, socio-economic and cultural characteristics of the Parties.

Although sea turtles have adapted to marine life, they depend on land to complete one of the most critical stages of their life cycle: reproduction. They nest on tropical and subtropical beaches, since these have the specific characteristics needed for their eggs to develop. The tropical coasts of the countries of the IAC region offer numerous beaches where six of the seven species of sea turtles in the world nest. Many of these beaches have developed protection and management projects and a great number of these projects are in the hands of local communities. It is important to recognize the great efforts these individuals make to protect turtles, their eggs and hatchlings, as it is not an easy task, especially since many of them do not have the basic technical knowledge or the human and economic resources necessary to help them obtain the best results using the most appropriate conservation methods. Significant technical progress has been made by some projects in the region. However, this knowledge has not yet been shared with other projects for various reasons, among them the lack of financial resources. Training in conservation techniques using one adopted manual is a way to ensure standardized methods are being carried out; thereby generating information that is comparable between different projects in order to obtain a regional perspective, a situation that currently is not possible.

This manual can be used as a base document, with countries adapting it to their own legislation and specific conditions. It can also be used as a point of international reference for sea turtle conservation work.

SEA TURTLES OF THE IAC REGION

All sea turtles derived from a common ancestor of the suborder Cryptodira, whose oldest members date back to some 150 million years ago (Márquez-M., 1994, 1996; Pritchard, 1997). Today, sea turtles are characterized by their many adaptations for life at sea: streamlined body; tear glands that allow them to remove excess salts from their body; flat, paddle-shaped limbs; and physiology that permits them to dive to great depths and remain there for relatively long periods of time. Furthermore, they are differentiated from other groups of turtles due to their inability to retract their heads and limbs into their carapace, to close their carapace and to spend long periods outside of the water (Meylan & Meylan, 1999).
Sea turtles are similar to their terrestrial ancestors in that they have scales like other reptiles and they lay eggs, which are incubated on land. They are also similar in that they do not provide prenatal care for their hatchlings. The majority of their immature stages are spent in pelagic habitats; as they mature they move towards coastal zones, this tends to happen when they reach between 20-40 cm in carapace length, depending on the species (Meylan & Meylan, 1999).

The six sea turtle species found in the IAC region are known by the following common names:

1. Leatherback, trunk *(D. coriacea)*
2. Green turtle, greenback, black turtle *(C. mydas)*
3. Hawksbill *(E. imbricata)*
4. Loggerhead *(C. caretta)*
5. Olive ridley *(L. olivacea)*
6. Kemp's ridley (*L. kempii)*

Figures 1 and 2 illustrate some of the external morphological structures used to identify sea turtles species.

External morphology of sea turtles

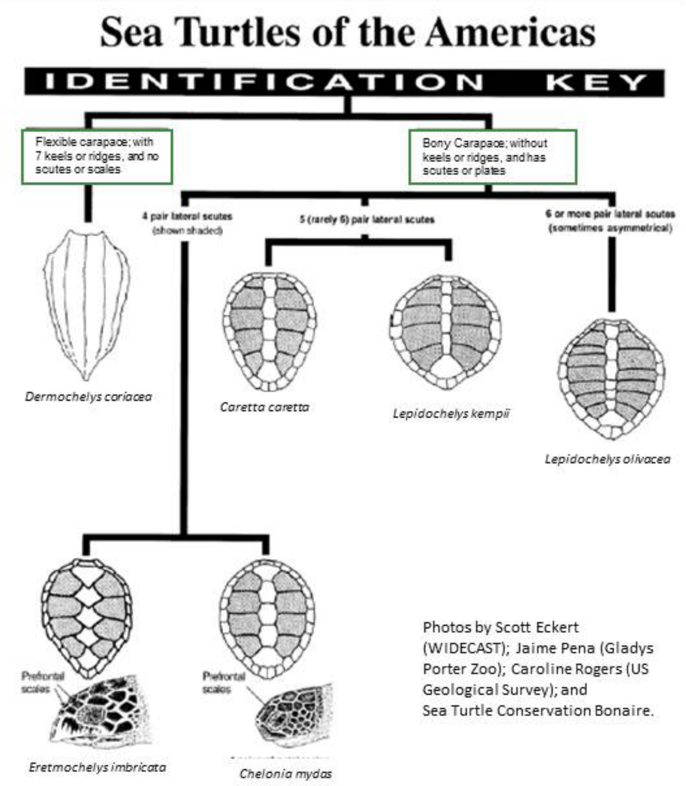


Figure 1. Key to identify the different sea turtle species found in the IAC region.

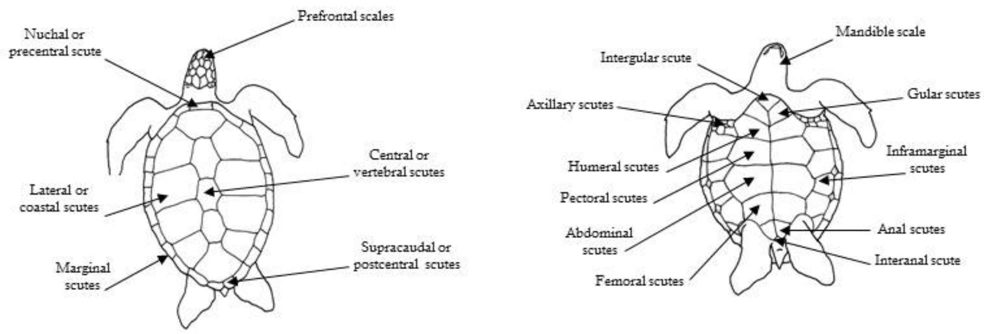


Figure 2. General sea turtle morphology.

Their growth rates indicate that they are very slow growing animals; reaching sexual maturity between 10 and 50 years of age, depending on the species and geographic area. Sea turtles spend most of their lives at feeding grounds, which are usually located far away from nesting beaches. Sexual dimorphism is apparent only in the sub-adult or adult life stages. Members of the Family Cheloniidae have one or two claws on their foreflippers and hindflippers; in the males these are more developed and curved. Individuals of the Family Dermochelyidae do not have claws. Males in both families have much longer and thicker tails than the females (Fig. 3).

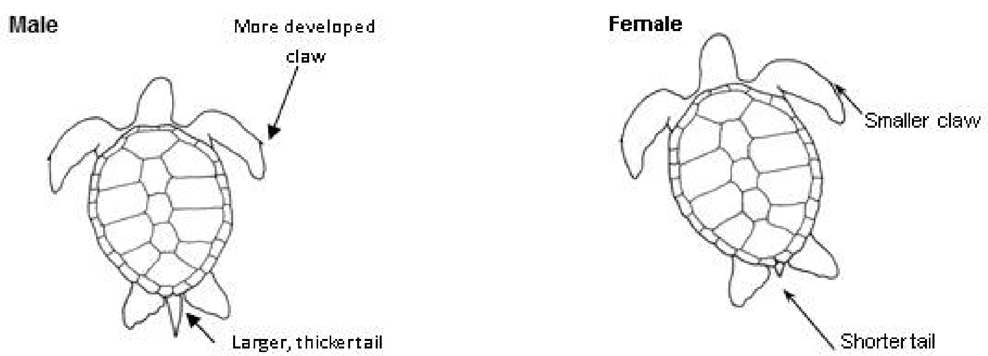


Figure 3. Sexual dimorphism in specimens of the Cheloniidae family (Adapted from Márquez-M., 1996).

The adults of each species have unique diets: *D. coriacea* feeds mainly on jellyfish and zooplankton; *E. imbricata* feeds mainly on sponges associated with coral reefs; *C. mydas* feeds on algae and seagrasses; *L. olivacea* and *L. kempii* prefer shrimp and other small crustaceans, whereas *C. caretta* consumes crustaceans and molluscs.

During reproductive periods, mating generally occurs in the vicinity of the nesting beach, but it can take place during the migration from the feeding grounds. Each species has its own unique way of courting, mating and egg-laying.

Females from some species are able to store sperm in their bodies for more than one nesting season. Furthermore, they are receptive to more than one male, thus the eggs from a single **clutch** can have multiple paternity. Each female has the ability to nest several times in the same season; this phenomenon is known as **renesting**. Renesting can occur several times (two or more times depending on the species) during a single nesting season. For example, *D. coriacea* may nest up to 11 times in a season, laying a total of 900 eggs. A female nesting for the first time in her life is called a **neophyte**. When a female returns to nest in subsequent seasons, it is called a **remigrant**. These remigrant turtles can have annual, biannual or triennial cycles or sometimes longer. It would be impossible to determine whether a female turtle is a neophyte or remigrant without having a good saturation tagging program for females in place. Figure 4 explains the general life cycle of sea turtles.

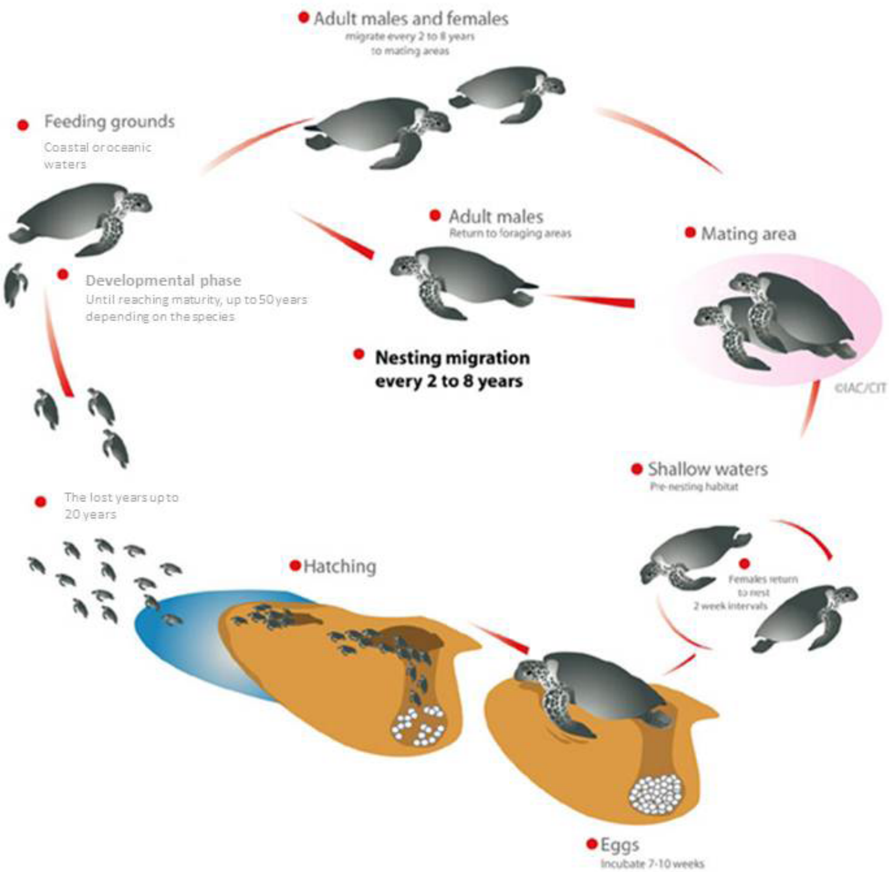


Figure 4. Generalized life cycle of sea turtles.

Females remember their natal beach through a process called **imprinting** or site fixation. This process occurs when hatchlings emerge from the nest and enter the sea, registering a series of parameters that imprint their natal beach into their memory in order to identify the beach or region where they were born. Once the turtle reaches sexual maturity this information is used to return to the beach to nest. Although the parameters that influence this process and the science behind it are still not fully understood, it is believed that they use magnetic, olfactory, and auditory cues, among others.

The following tables describe the different species of sea turtles in the IAC region. The parameters shown are the most frequently reported in the literature.

Table 1. Species description D. coriacea.

Common name	**Leatherback**
Conservation status	Critically Endangered (IUCN Red List)
Average curved carapace length	150 cm
Nests per season	5-7 times/season
Inter-nesting interval	9-10 days
Remigration interval	2-3 years
Clutch size	60-90 eggs with yolk and a variable number of smaller yolkless "eggs"
Depth/width of nest	70/40 cm
Incubation period	50-70 days
Pivotal temperature	29-29.9°C
Track width	150-230 cm
Type of track	Symmetrical
General Characteristics	
The leatherback is the largest of all species of sea turtles, typically measuring up to 2 meters in curved carapace length and weighing up to 1000 Kg. Size differences exist between leatherbacks found in the Caribbean Sea and Pacific Ocean, the latter tends to be a bit smaller (130 - 140 cm curved carapace length). The flexible carapace is made up of a mosaic of small polygonal-shaped bones covered by a layer of fat and a leathery skin (Márquez-M., 1990). Adults lack scutes and scales, and are typically black in color with white spots and a pink-colored spot on their head (Gulko & Eckert, 2004). They are also identified dorsally by having seven longitudinal ridges or "keels".	
Main Threats	
The main threats are incidental capture in fisheries, unsustainable exploitation of eggs and direct take of turtles, as well as the destruction or alteration of their nesting habitat due to coastal, urban and tourism development and climate change. This species is found to consume indigestible marine debris, especially plastic bags, which they confuse for their food - jellyfish- resulting in their death.	

Figure 5. Example of a nesting D. coriacea. Photo: Projeto Tamar.

Table 2. Species description C. mydas*.

Common name	Green Turtle (or Black Turtle)
Conservation status	Endangered (IUCN Red List)
Average curved carapace length	100 cm
Nests per season	3-6 times/season
Inter-nesting interval	10-14 days
Remigration interval	2-3 years
Clutch size	65-115 eggs
Depth/width of nest	60/35 cm
Incubation period	48-78 days
Pivotal temperature	28.6°C
Track width	100-130 cm
Type of track	Symmetrical
General Characteristics	
The average carapace size of an adult green turtle is about 100 cm and weighs from 100 to 225 Kg. Their carapace is covered with scutes, ranging in color from yellow to dark green, with four non-overlapping lateral scutes, and a yellow plastron. Each front flipper has one claw. One pair of prefrontal scales can be found on the front of their head and four postorbital scales behind the eyes (Gulko & Eckert, 2004). **Chelonia mydas* in the Pacific is smaller in size, darker in color (to almost black) and has a smaller clutch size than those in the Atlantic. For these reasons, it is still controversial whether these are different species, subspecies or different populations. Published research on their morphology, genetics and biochemical composition show inconclusive results (Bowen *et al*., 1992; Pritchard, 1999). This manual considers them to be part of the species *Chelonia mydas*.	
Main Threats	
One of the most significant threats to green turtles is the intentional capture of adults and intensive egg harvesting. The meat of the green turtle is also considered to be a delicacy, thus is commercially harvested. Bycatch in marine fisheries, habitat degradation and disease are some of the other detrimental threats faced by this species.	

Figure 6. Example of a nesting C. mydas. Photo: Eduardo Espinoza.

Table 3. Species description *E. imbricata*.

Common name	**Hawksbill**
Conservation status	Critically Endangered (IUCN Red List)
Average curved carapace length	89 cm
Nests per season	3-5 times/season
Inter-nesting interval	13-16 days
Remigration interval	2-4 years
Clutch size	140 eggs
Depth/width of nest	55/30 cm
Incubation period	52-74 days
Pivotal temperature	29.3°C
Track width	70-85 cm
Type of track	Asymmetrical
General Characteristics	
The hawksbill gets its name from its narrow head and bird-like, pointed beak. The hawksbill measures between 65 and 90 cm and weights between 45 and 70 Kg. Its carapace has four pairs of overlapping lateral scutes and ranges in color from yellow to black, including different tones of orange and red. Each of their flippers generally has two claws. Two pairs of prefrontal scales can be found on the front of their head and three postorbital scales (behind their eyes) (Gulko & Eckert, 2004).	
Main Threats	
The main threat to hawksbill turtles is the commercial harvesting of juvenile and adult turtles for their beautiful carapace, which is locally made into jewelry and other products. This continues to be a global problem despite the fact that hawksbill trade is prohibited through listing in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). There are other direct threats, such as egg harvesting, and indirect threats, such as the destruction of habitats critical for their survival, especially coral reefs which are negatively impacted by climate change, increased sedimentation and nutrient run-off, and nesting beaches which are negatively impacted by coastal development.	

Figure 7. Example of a nesting E. imbricata. Photo: Emma Harrison.

Table 4. Species description C. caretta

Common name	Loggerhead
Conservation status	Endangered (IUCN Red List)
Average curved carapace length	87 cm
Nests per season	4 times/season
Inter-nesting interval	12-15 days
Remigration interval	2-3 years
Clutch size	100 eggs
Depth/width of nest	60/30 cm
Incubation period	56-80 days
Pivotal temperature	27.7°C
Track width	70-80 cm
Type of track	Asymmetrical
General Characteristics	
The loggerhead is named for its very large head. Adults weigh an average of 150 Kg with carapace measurements from 75 to 100 cm in length. The carapace is elongated with five pairs of lateral scutes (these scutes do not overlap one another). There is a "hump" at the fifth vertebral scute and the nuchal scute is in direct contact with the first pair of lateral scutes. The carapace is dark, reddish-brown in color and the plastron is yellowish-cream (Gulko & Eckert, 2004).	
Main Threats	
The most significant threats to the loggerhead are coastal development, marine contamination and commercial fisheries, as well as habitat alterations due to climate change.	

Figure 8. Example of a nesting C. caretta. Photo: Projecto TAMAR.

Table 5. Species description *L. olivacea*.

Common name	**Olive Ridley**
Conservation status	Vulnerable (IUCN Red List)
Average curved carapace length	65 cm
Nests per season	2-3 times/season
Inter-nesting interval	15-17 days
Remigration interval	1-3 years
Clutch size	109 eggs
Depth/width of nest	45/30 cm
Incubation period	45 days
Pivotal temperature	29.1°C
Track width	70-80 cm
Type of track	Asymmetrical
General Characteristics	
This species is considered to be the most numerous of all sea turtles. It is a small turtle, its carapace measures approximately 65 to 70 cm and adults weigh between 35 and 45 Kg. The carapace is almost circular and dark green in color. It has five to nine pairs of lateral scutes, often in odd numbers, and two pairs of prefrontal scales on their head. Each flipper has one or two claws (Márquez-M., 1996; Gulko & Eckert, 2004). This species nests in massive, synchronized aggregations often called "arribadas". At beaches that experience this type of nesting between 5,000 and 150,000 females have been observed coming to nest over the course of a few nights. These arribadas occur several times during the same nesting season.	
Main Threats	
Direct harvest of adults and eggs, incidental capture in commercial fisheries, and habitat loss are the main threats faced by this species.	

Figure 9. Example of a nesting L. olivacea. Photo: Scott Handy.

Table 6. Species description *L. kempii* .

Common name	**Kemp´s Ridley**
Conservation status	Critically Endangered (IUCN Red List)
Average curved carapace length	65 cm
Nests per season	2-3 times/season
Inter-nesting interval	15-18 days
Remigration interval	2.5 years
Clutch size	99 eggs
Depth/width of nest	45/30 cm
Incubation period	45-50 days
Pivotal temperature	30°C
Track width	70-85 cm
Type of track	Asymmetrical
General Characteristcis	
It is a small turtle; the carapace measures between 65–77 cm and adults weigh between 35 – 45 Kg. The carapace is almost circular, is light green to grey in color and typically has five pairs of lateral scutes, occasionally up to seven pairs, sometimes in odd numbers. It has two pairs of prefrontal scutes on the head. Each flipper has one or two claws (Márquez-M., 1996; Gulko & Eckert, 2004). This species mainly nests during the day, occasionally forming small arribadas that coincide with high tides. This species nests mainly along the central coast of Tamaulipas, Mexico, but it can be found nesting from Texas, USA to Campeche, Mexico.	
Main Threats	
Depredation by coyotes, raccoons and skunks; incidental capture in commercial fisheries and direct take of adults and eggs at sites with solitary nesting. Nesting habitat loss is not a current threat, but warrants close monitoring due to the fact that there is only one principal nesting beach for this species.	

Figure 10. Example of a nesting *L. kempii*. Photo: Rene Márquez-M.

The morphology of **neonate** sea turtles is not that different from their adult stage; the relative proportion of the size of the head to the body decreases as the organism grows.

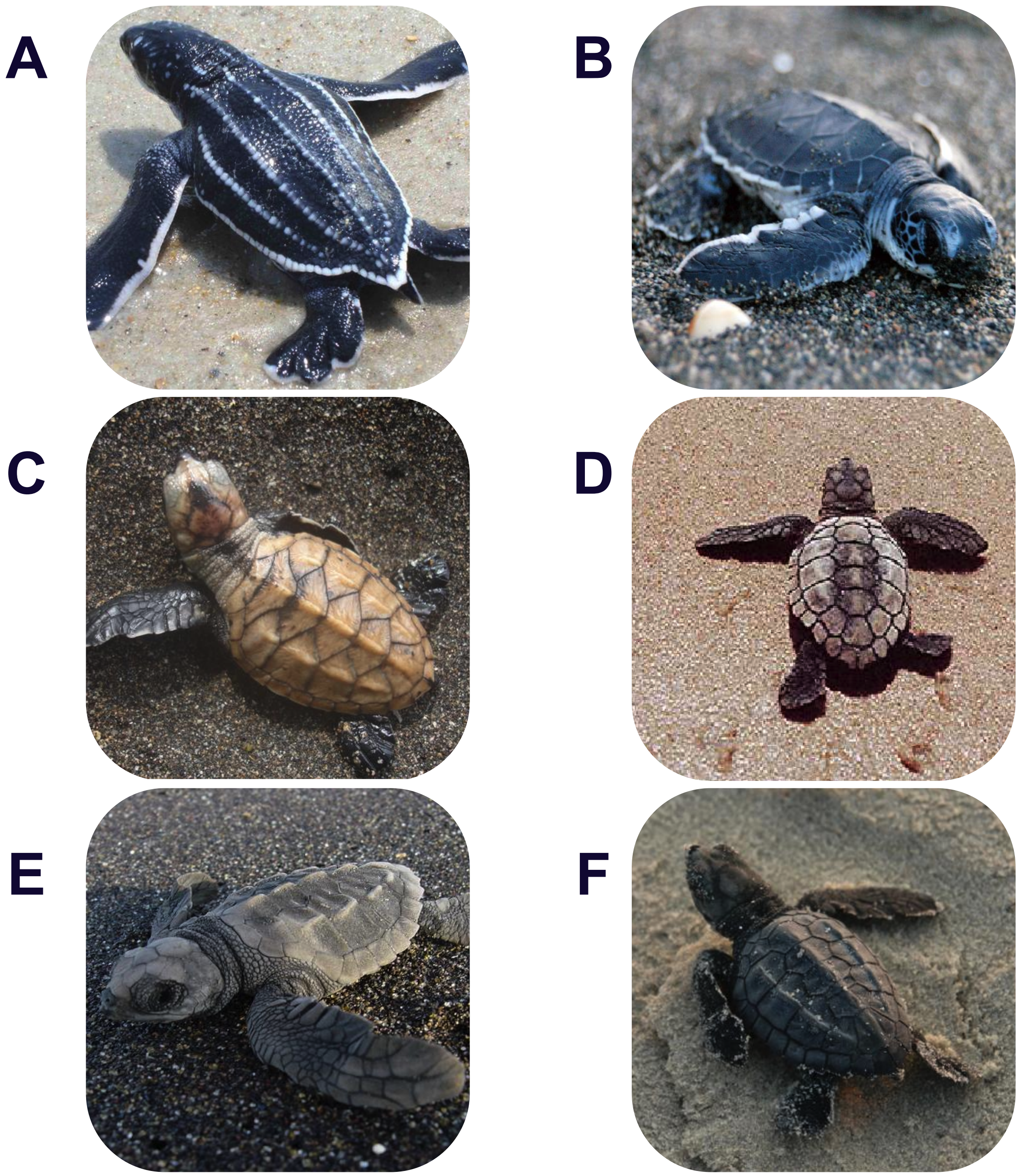


Figure 11. Morphology of neonate sea turtle species found in the IAC region.
A. D. coriacea (Photo: K. Rittmaster), B. C. mydas (Photo: E. Espinoza), C. E. imbricata (Photo: M. Liles), D. C. caretta (Photo: P. Baldassin), E. L. olivacea (Photo: S. Handy), F. L. kempii (Photo: C. Rubio).

PROTOCOL FOR SEA TURTLE MANAGEMENT AT NESTING BEACHES

According to Eckert (1999), the overall goal of a sea turtle conservation plan is to promote the long-term survival of sea turtle populations, the sustainability of the resource and the safeguarding of critical habitat, while integrating these with the needs of the human communities with which they interact. A conservation plan is determined not only by the nature of the local sea turtle populations, but also by other considerations such as the amount of time, and the financial and human resources available (Pritchard *et al*., 1983). The specific objectives for each plan may differ, but should include aspects such as:

- Identification of the sites where the different species are found.
- Assessment of local and regional population size and estimation of the conservation status of the population.
- Identification of all key recruitment areas (e.g. nesting beaches and feeding grounds).
- Regular monitoring of populations and the conservation status of their habitats.
- Estimation of annual mortality and/or survivorship of different life stages on the nesting beach.
- Knowledge of the nature and extent of human exploitation.
- Effective protection of nesting beaches, feeding grounds, and migratory corridors.
- Regulation of illegal domestic and international trade of sea turtles, their parts and products.
- Management and elimination of threats such as unwarranted shoreline development, artificial lighting, discharge or other impacts.
- Generate public support to achieve the goals and objectives, including an education, outreach and public information campaign.
- Include mechanisms to explain the challenges and the importance of developing protection and management measures for sea turtles and their habitats.
- Design, implementation and follow-up on measures to mitigate the effects of climate change.
- Strengthen and integrate local and national sea turtle conservation efforts.

MANUAL FOR NESTING BEACHES

The purpose of this manual is to guide and standardize the collection of basic information along the sea turtle nesting beaches of the IAC region, in order to assess trends in nesting abundance and improve sea turtle management. The manual also includes information on procedures to improve the survival of embryos and hatchlings through concrete management measures, and for the collection of data that will enable monitoring of nesting habitat quality in light of climate change. However, it is important to follow the rules and regulations established in each country, in particular those related to obtaining research permits, and any restrictions, procedures and formats for reporting the information collected.

Nest Monitoring

Monitoring programs usually emphasize the land phase of the life cycle: nesting females, eggs, and hatchlings; stages which are accessible during a few months of the nesting season. Surveys of nests or females on nesting beaches have become a widely used strategy in the assessment of sea turtle population abundance trends. These assessments are necessary to understand the conservation status of each population, and to understand the effects of conservation activities on the recovery of these species.

Training Beach Monitors

Field volunteers or less-experienced staff should participate in a training program tailored to the specific nesting beach prior to the start of each monitoring season. Training should include identification of species and direct observation of nesting turtles, to ensure the people responsible for collecting information and working with the turtles have an appropriate understanding of the animals' behavior during the nesting process. Training should also include observation of turtle **tracks** on the beach in order to identify their different characteristics, and the characteristics of nests. The latter is key to correctly distinguish between successful and unsuccessful nesting emergences. Staff should also receive practical training in different activities such as tagging females (if a tagging program is to be initiated or is in use) and data collection.

In the training process it is important to provide knowledge on the biology, ecology and current status of sea turtle species and on the management plans for nesting populations. In addition, relevant information on the background, objectives and progress of the conservation plan should be included.

Demarcation of Study Area

Figure 12. An example of a boundary marker.

The identification and demarcation of the study area is an important component when establishing a long-term nesting beach monitoring program. The same area must be monitored each year in order to make comparisons with the data generated in previous years. It is useful to divide the beach into equal segments, to manage the data at a finer scale. This will enable determination of the spatial distribution of nesting activity throughout the beach and the analysis of spatial trends over the long term. It is recommended to mark the beach with posts, stakes or boundary markers (Fig.12); the ideal distribution is to place them every 50 to 100 meters or, if the area is very extensive, adapt the distance between markers accordingly. These markers should be placed along the vegetation line, far enough away so that tides and strong waves do not remove them. The markers should be numbered sequentially in a logical order along the orientation of the beach. Keep in mind that the markers must be big enough to be read by people walking the beach. The markers should be checked to verify their correct position, and any that are lost or damaged should be replaced at the beginning of the season and, if necessary, during the season. A measuring tape of appropriate length can be used or a Global Positioning System (GPS) depending on the required level of accuracy and what the data will be used for (Fig. 13).

In the event that there are not enough resources or time to adequately maintain markers, the area can be divided up using geographic references such as rivers, rocks, lagoons, estuaries or even property lines or buildings on the shoreline. The aid of a GPS is highly recommended in these cases since these reference points may move or change over time.

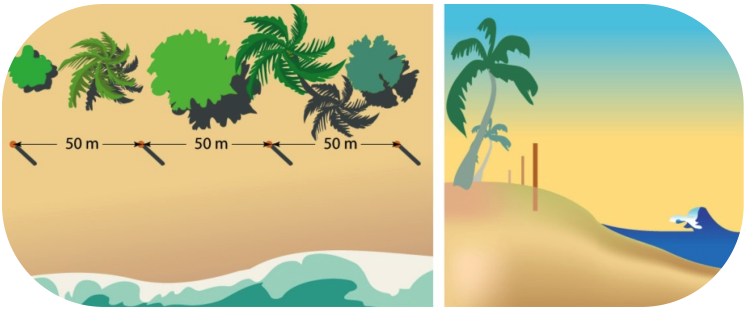


Figure 12. Spatial distribution of markers.

Coastal Characterization

The size, shape and location of the nesting beach may change over time for various reasons, including coastal development patterns, alterations in marine currents, extreme weather events, and increases in sea level due to climate change, among others. A record should be kept of the location, shape and size of the beach, to identify areas of high vulnerability for the nests, as well as gradual changes that may hinder or favor nesting. Movement inland as the sea level increases, for example, may be blocked by rivers or coastal lagoons, by infrastructure (i.e., roads, walls and/or rows of buildings) or natural cliffs, which may lead to a loss of available nesting habitat.

The characterization of the coast, and of a nesting beach in particular, can be done using sophisticated topography tools, aerial photography and/or geo-referenced high-resolution remote images, among others. It is recommended that a periodic record should be kept of the distance to several points on the beach (i.e., extreme points, high and low tide marks) relative to fixed points on the coast, such as buildings and markers. These records are necessary to design the inclusion of buffer zones (infrastructure-free areas behind the beach) in land use regulation plans, as an adaptive measure for rise in sea levels.

Nest Survey Duration and Schedule

The period of nest monitoring should include the peak of the nesting season and should be designed to accommodate any changes in peak nesting from one year to another. Ideally, it should include the entire nesting season; however, shorter periods may be appropriate depending on local conditions (e.g. financial, available personnel, etc.) and a complete understanding of nesting season variability (CITES, 2002).

Beaches that have not been previously studied, or for which the nesting season has not yet been determined, will require preliminary reconnaissance studies to identify the start, peak and end of the nesting season prior to establishing the duration of the monitoring period. Preliminary studies should be conducted for a minimum of three years, during which time the entire nesting season should be studied (CITES, 2002).

The frequency of nest surveys (numbers of days per week that nest surveys should be conducted) is dependent upon each research project. However, it is recommended that daily surveys are done throughout the entire season and along the entire beach or study area, year after year, in order to establish a basis for comparison. When logistic considerations hinder daily surveys, consistent monitoring at a lower frequency may be used, dependent on the species (e.g. shallower tracks of smaller species may be obliterated more quickly than those of larger species), the accessibility and general conditions of the area (e.g. climate and tidal conditions). It is necessary to ensure that the same nests are not being counted more than once. In order to do this (if poaching of nests is not a problem) they can be marked in some way, e.g. using a thick stick to draw a wide line through the track.

If the monitoring program includes night patrols, ideally they should be conducted every night, and should start in the early evening and continue until just before sunrise; being conducted in such a way that each section of the beach is patrolled at least once per hour, depending on the species and size of the nesting area to be surveyed. If all nesting activities are observed on these night patrols, morning surveys will not be necessary. However, to confirm the previous night's count, a nest survey may also be done immediately after sunrise, when the light conditions are most favorable to distinguish the tracks, while the tracks are not yet dry, and before they have been washed away by the tide.

For the purposes of standardizing information on nest abundance, it is important to maintain constant survey effort in terms of time (hours per night and number of nights patrolled during the season) and length of beach patrolled. If any changes are necessary to survey effort, they must be documented.

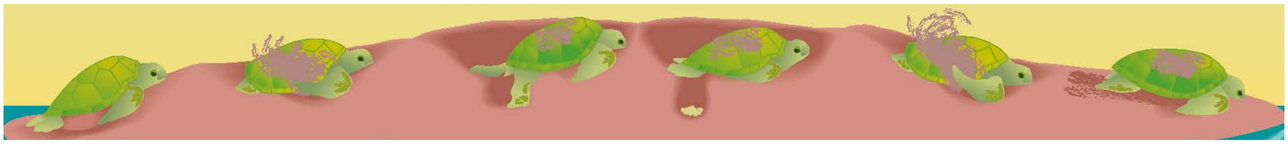
Studies on Arribada Nesting Beaches

At some beaches in the IAC region, members of the genus *Lepidochelys* are the only species that can nest in arribadas (arribazon). This mass nesting behavior features synchronous nesting by a very large number of females. In the case of *L. olivacea,* it is possible to observe concentrations ranging from 5,000 to 250,000 nests over the course of a few nights. The conventional monitoring techniques discussed in this manual are not effective for arribadas. For more details on the methodology to be used at arribada beaches see *Estudios de Poblaciones en Playas de Arribadas* (Valverde & Gates, 1999).

DATA COLLECTION AND SUGGESTED METHODOLOGIES FOR NEST MONITORING

Proper data collection will enable assessment of sea turtle population status and trends. One of the serious problems currently being faced in sea turtle management is the use of different data collection methodologies across research projects, resulting in an inability to make valid comparisons of the results obtained by the various projects. This is the case for local as well as regional projects. For this reason, it is important to use standardized methodologies and terminology that will result in comparable information being obtained from each project, thereby facilitating comparisons among beaches that will aid in making informed decisions in the conservation and protection of sea turtles.

Accurate data collection in the field should be conducted while avoiding, to the greatest extent possible, stress to the animal. It is important to have well trained and qualified staff that are able to work quickly and are familiar with the different stages of nesting and how to collect data in a way that females are least likely to be disturbed. Figure 14 provides a very generalized summary of the various stages of nesting and the degree to which females may be disturbed during each stage, as well as recommendations on how to minimize disturbance. The duration of the different stages varies depending on the species and the nesting habitat.



Nesting stages:					
1. **Leaving the sea:** when the turtle emerges from the sea, she cautiously makes her way up the beach, stopping to rest or breathe.	2.**Digging of body pit:** the turtle vigorously throws the sand away with her fore flippers forming a shallow body pit.	3. **Digging the egg chamber:** with her hind flippers she scoops out the sand to give the nest the correct shape and depth. The back half of her body may rise and lower as her hind flippers work.	4.**Egg laying (Oviposition)**: stage in which the turtle lays her eggs in the nest and, through contractions that cause small movements of her hind flippers ,the eggs fall in small groups into the egg chamber.	5.**Covering eggs**: with her hind flippers she begins covering the eggs with moist sand, pausing every once in a while to compact the sand on top of the clutch. Afterwards, using her front flippers she begins to throw sand behind her in order to hide and camouflage the nest.	6.**Returning to the sea**: she begins her return to sea by locating the slope of the beach and orients herself towards the waves
Disturbance factors for the turtle:					
1. Very high: while the turtle is emerging from the sea, the slightest bit of light or movement will frighten her and she will return to the sea. If you see a turtle, stop and/or get down immediately in order to observe it. If she continues up the beach wait until you can get behind her without being seen. Always stay behind the turtle. Many minutes can pass before the turtle moves again. Do not take photos.	**2. Very high:** getting any closer than 10 meters or any type of white light will scare the turtle and she will return to sea. There is a risk of tripping over a turtle if she is found on the lower, more irregular parts of the beach. Always move with caution and look for areas where the sand has been moved around, usually darker in color as a result of her movements or from her nesting activity. Remember to stay behind the turtle. Do not take photos.	3. **High-moderate:** you can quietly approach the turtle from behind. Maintain your distance from the turtle. Do not touch her or turn on any lights. Wait for a while after the turtle stops moving to check to see if she is laying eggs. If your objective on the beach is research or to monitor nesting, use a small red light pointed directly at the nest to observe the nesting process. Do not take photos.	4: **Low:** once the turtle begins laying eggs she is less sensitive to disturbances, which is why you can get close to her. The guide or leader will be in charge of the only red light used to observe the nesting. No one should shine the light on the turtles head. Do not take photos.	5. **Moderate**: the turtle is once again sensitive to movements and lights; therefore, she can be disturbed when covering the nest. Do not take photos.	6. **High**: do not intercept turtles returning to sea, allow them to do so freely and if they encounter obstacles on the beach you may remove the obstacle before the turtle gets there. If you happen to see this return to sea during the day photos are allowed as long as the law permits it.

Figure 13. Disturbance factors during the different stages of nesting and recommendations on how to minimize them (Adapted from Salm & Salm, 1991).

Minimum data to be recorded:

For each study (each season)

- Name of person responsible, institution and field of expertise or specialty
- Contact information (phone, fax, email and website)
- Monitoring area: site name, species, geographic location (lat/long), extension (km or ha), physical description of area, protection category
- Permits issued
- Monitoring start and end dates (season)
- Number of days patrolled per week
- Narrative description of any significant changes to the beach that might influence nesting
- Serial numbers of tags used (if applicable)
- Other important data for interpreting nesting information

For each nesting female observed (See Annex 1)

- Name of beach studied
- Date
- Time of first observation
- Stage of nesting
- Name of observer or person responsible for collecting data
- Species, use of acronym for its scientific name is recommended (e.g, *Dermochelys coriacea* = D.c.).
- Location of turtle (post, marker or GPS reference)
- Description of nesting area (e.g, inter-tidal zone or in vegetation)
- Turtle identification (Number and type of tag and its location)
- Presence and description of **evidence of previous tag** (tag scars)
- Measurements (e.g., curved carapace length)
- Time eggs were laid
- Total number of eggs laid
- Observations (e.g. scars, deformities, parasites, tumors and others)

For each nest survey (See Annex 1)

- Name of beach studied
- Survey date
- Survey start and end time
- Name of observer or person responsible for collecting data
- Total number of nests (including poached and predated nests) by sector and species
- Number of tracks that did not result in nests, by sector and species
- Location (GPS or physical description)
- Comments or observations (e.g. report any natural or anthropogenic turtle mortality)

Each project may include its own variables; however, it should be kept in mind that in order to achieve standardization of data, it is recommended that the variables indicated above be taken into consideration. This will also assist in the preparation of reports and updating of the project data base by the person responsible.

Identification of Tracks and Nests

Assessing tracks is a difficult task and errors can be made in distinguishing one species from another and in distinguishing between successful nests (i.e., those containing eggs) from those of a female who attempted to nest but did not lay eggs. Distinguishing between “fresh” or “old” tracks can also be difficult. Staff should have sufficient training to assess these characteristics and to confirm whether nesting has been successful or not.

Although all sea turtle tracks have similar characteristics, each species has its own unique features, such as the width and depth (shallow vs. deep) of the body pit and whether the track has a symmetrical or asymmetrical pattern. According to Pritchard & Mortimer (1999), a **symmetrical track** is formed when the front flippers move synchronously to pull the turtle over the sand, resulting in a track in which the left and right halves are almost a mirror image of each other. An **asymmetrical track** is formed when the front flippers move alternately to pull the turtle forward (Fig. 15).

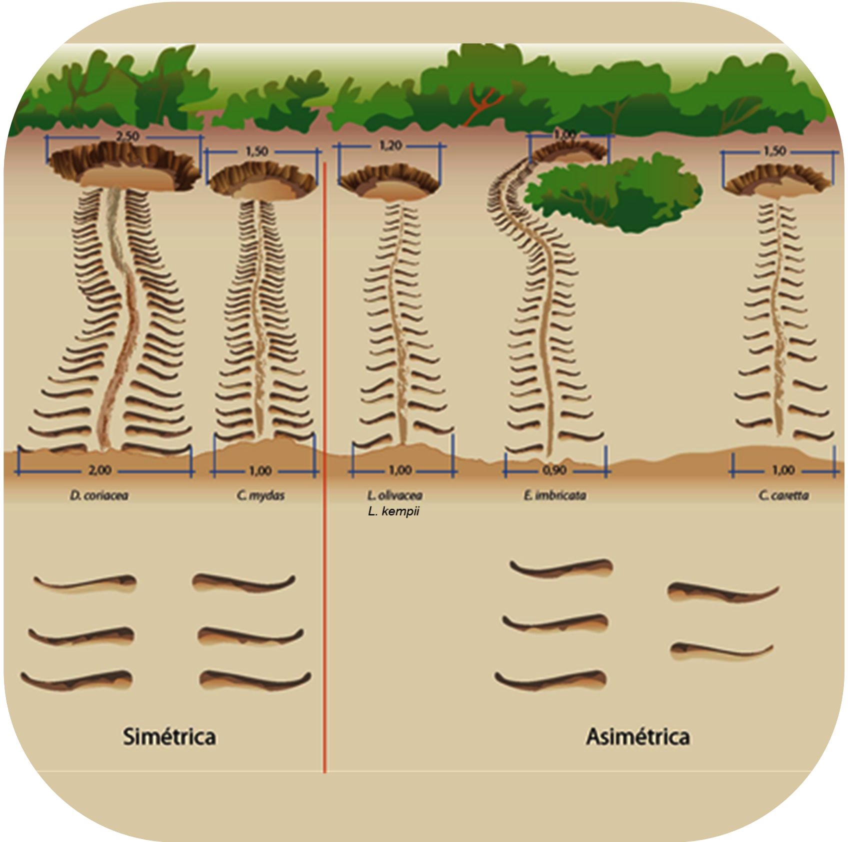


Figure 14. Types of Symmetrical and Asymmetrical Tracks

Although the only way to determine whether or not a female laid eggs is by direct observation or actual confirmation, there are several signs to help identify successful nesting. Follow the track from where the turtle emerged from the sea and look for the following evidence: 1) Sand lightly scattered or thrown onto the exit track; 2) Body pit, a secondary body pit, signs of digging and sand scattered around; 3) Moist sand, sand scattered while constructing and covering the nest usually has a higher moisture content than the dry sand on the surface.

To identify an unsuccessful nesting emergence (a **false crawl**), carefully observe the track and look for any of the following signs: 1) A track (often U-shaped) with little or no sand disturbance, and without a body pit or nest chamber; 2) a large disturbance of sand but with the crawl exiting the disturbed area and heading back to the sea, or 3) A track with one or more body pits and nest cavity, but the latter collapsed or not covered (Schroeder & Murphy, 1999).

It is vital to try and observe the egg-laying process to confirm nesting. If this is not possible and there is doubt whether the nesting activity resulted in egg-laying or not, the presence or absence of eggs can be verified through direct observation, using manual **excavation** to locate the nest chamber and eggs, if they are still there. This type of excavation should only be done by experienced people given the potential risk of damaging the eggs, and should not be practiced in areas where there are large numbers of predators since it can increase nest predation.

Predated nests can be recognized by the presence of egg shells, scattered eggs and/or animal tracks around the nest. **Poached nests** can often be recognized by the presence of an open nest cavity, human footprints, holes from a stick or pole used to find the nest, and occasionally a broken egg or eggshell left behind. During the nest survey, these nests must be recorded as being successful, but also recorded as predated or poached nests. It is also important to record all nests lost to erosion.

Sea Turtle Tagging

Sea turtles are tagged to recognize different individuals in a population, to identify migratory routes and foraging grounds, and to understand certain aspects of their reproductive biology (remigration interval, **clutch frequency** and internesting interval), population size and trends. In addition, it helps in the comparison of important factors to make conservation and management decisions at the national and international level. It is necessary to have clear and well defined objectives when beginning a tagging program to ensure high quality information, minimal tag loss and to maximize information retrieval from recaptures. Tagging females for demographic studies must be done using a **saturation tagging** program. However, there are some cases in which tagging can be used as a tool simply to identify individuals for genetic or tracking studies. In these circumstances saturation tagging is not necessary.

The most common metal tags used in the region are “Monel”, “Inconel” or “Titanium”, each with a unique series of letters or numbers. They are applied externally to the flippers. There are also internal tags such as microchips (Passive Integrated Transponder – PIT tags) that are sometimes used in addition to or instead of external tags.

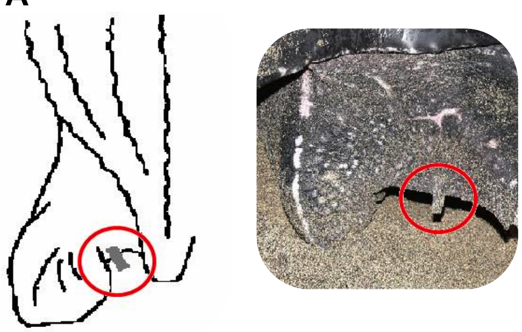
According to Balazs (1999), the degree of tagging success, in terms of tag retention and turtle recognition, can be highly variable due to multiple factors, including the following: the type of tag used, how it is applied, and the species and size of the turtle tagged; the geographical location and characteristics of the marine environment; the skill and experience of the tagger and the number of tags applied to each turtle.

Application of Metal Tags

The size of the metal tag should always be appropriate to the size and species of turtle; small tags should not be used on large or growing animals, as they can cause constriction and tissue necrosis, which in addition to hurting the animal will lead to tag loss. “Inconel” 2.0-4.2 cm size tags are recommended (Pritchard *et al.*, 1983), which have the advantage of being rectangular or oval in shape, thus preventing snagging or tangling on various surfaces, e.g. fishing nets or lines, or floating objects.

For leatherback turtles, the most advisable location for metal tags is on the thinnest part of the proximal fold of skin between the tail and the rear flipper (Fig. 16 A). The most commonly used tagging site for all species of sea turtles of the Cheloniidae family is in the front flippers, adjacent to the first large scale on the posterior edge of the flipper (Fig.15 B). However, several studies and projects have had success using additional or alternative tagging sites, such as: a) between the first and second large scales along the posterior edge of the front flippers; b) directly through the first, second or third scale; or c) on the rear flippers, making it important to check the entire turtle before applying a new tag.

A



B

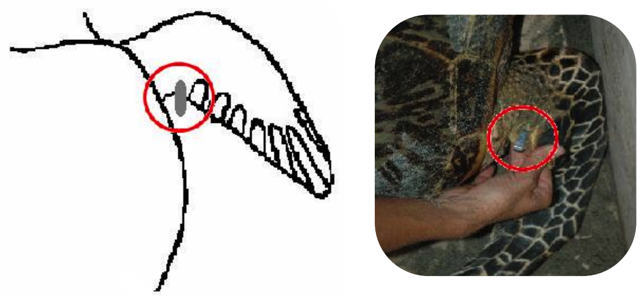
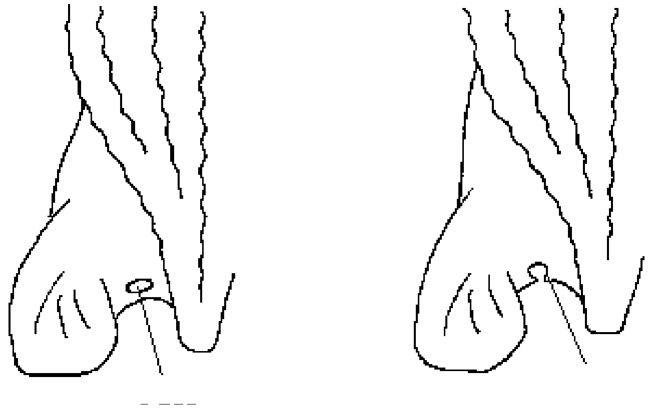


Figure 15. Recommended tagging sites for A) D. coriacea (Photo: P. Szenczi) and B) members of the Cheloniidae family (Photo: E. Harrison).

To ensure identification of individuals and to evaluate the rate of tag loss, it is recommended to tag both flippers (**double tagging**). It is important to examine the area for signs of prior tagging such as tag scars, which may be in the form of complete holes, tears, or lumps of scar tissue. Tag loss may be due to incorrect tag placement or the animal becoming entangled because of the tag (Fig. 17).



COMPLETE HOLE TAG SCAR – THIS TYPE OF SCAR IS USUALLY LEFT BY INCORRECTLY CLOSED TAGS, ROTO-TAGS OR PLASTIC TAGS.

TEAR-TYPE TAG SCAR – THIS TYPE OF SCAR IS USUALLY LEFT BY METAL TAGS THAT ARE PLACED TOO TIGHTLY AND CAUSE NECROTIC TISSUE THAT TEARS AND THE TAG EVENTUALLY FALLS OFF.

Figure 16.Scars considered to be possible evidence of prior tagging in *D. coriacea* (Taken from Barragán, 1998).

Metal tags should be cleaned with 70-90% alcohol or a broad-spectrum disinfectant (e.g. Vanodine[1]) before being distributed to the monitors, since they are covered in a lubricant that may become a source of infection of the tagging site (Eckert & Beggs, 2006).

External Tagging Procedure

- Before applying external tags all monitors must receive appropriate training from experienced personnel.
- Before tagging the turtle, look for evidence of prior tagging, both in the front as well as back flippers, and record the information on the data sheet.
- If the turtle has no tags or a single tag, it must be tagged. The turtle should be tagged only when it is covering the nest after having laid eggs (note: a turtle should only have a maximum of two external tags).
- Before inserting the tag, the tagging site and the tag should be thoroughly cleaned with disinfectant.
- The tag with the lower number shall be placed on the left flipper and the higher number on the right flipper (make the necessary adjustments if this has not been done in the past).
- There should be a distance of 0.5 – 1 cm between the edge of the flipper and the inside curve of the tag, to allow for movement without causing friction. If the distance is less than 0.5 cm, friction may cause infections and necrosis resulting in tag loss; a distance greater than 1 cm increases the probability of entanglement.
- Tag numbers should be read aloud three times for verification and recorded on the data sheet.
- The underside of any tag already present should be read to record the address.

[1] Vanodine: A quaternary, broad-spectrum disinfectant iodine used to combat fungi, bacteria or other micro-organisms. Its antiseptic action is better and faster than alcohol; however, it degrades when exposed to light.

- All tags that are incorrectly placed (e.g. hanging from the skin and about to fall) should be removed and replaced.
- When a tag is removed or changed, it is important to record the event and reason, reporting the number of the removed tag and the replacement tag, as well as the date, so that the turtle will be identified as the same animal in the future.

Internal Tagging Procedure
Microchips (PIT Tags – Passive Integrated Transponder tags)

A PIT tag is a cylindrical, glass capsule that measures 10 mm in length by 2 mm in diameter. This tag is an electromagnetic device with an integrated chip that can transmit a unique identification number. The tag is injected under the skin or into the muscle. The retention rate of this type of tag is nearly 100% (McDonald & Dutton, 1994).

A specialized reader or scanner is required to read the microchip. The advantage of PIT tags is that they are protected in a sealed glass container and lodged in the turtle's tissue, so the tag does not wear out, corrode or become lost, thus providing more reliable retention for identifying individuals for many years. In addition, it does not affect the turtle as may be the case with external tags, which are more susceptible to wear and tag loss from tissue necrosis or tearing.

One disadvantage of using PIT tags is their high cost and equipment required; each PIT tag costs between US$4 and US$10 and scanners cost between US$500 and US$1500. Therefore, many important nesting beaches do not use this technology and, since it is an internally placed tag, it is impossible to detect a tagged turtle unless the appropriate scanner is available. Another big disadvantage is that there are several brands of PIT tags and scanners. The different scanners do not read all brands of PIT tags and, therefore, a regional tagging program must agree on and standardize the brand of tag to be used throughout the geographical region.

- Before applying PIT tags all monitors must receive appropriate training from experienced personnel.
- When the turtle is laying eggs, carefully scan all possible sites (left and right shoulder muscle, front and rear flippers, and the neck region) to determine the presence of any PIT tags (Fig. 18 A).
- Once it is confirmed that the turtle does not already have a PIT, it should be applied at the site recommended for the species being tagged.
- Only one PIT should be applied to each turtle using the appropriate applicator (a pistol or sterile syringe).
- Always scan the new PIT tag before inserting it to verify that it is functional.
- Before injecting the turtle, the area where the tag will be injected should be cleaned with disinfectant.
- In leatherbacks, the PIT tag is inserted while the turtle is laying eggs. Wait until the turtle inhales to see and feel the flexing of the shoulder muscle and then inject the tag in the area shown in Figure 18 B. Holding the applicator perpendicular to the shoulder, insert the full depth of the needle and push the plunger all the way in to release the PIT into the animal's muscle (intramuscular application).
- When PIT tagging species in the Cheloniidae family, it is recommended that additional advice and instructions be obtained, because there is some controversy over the best tagging site to use (see Wyneken *et al*, 2010; Eckert & Beggs, 2006).
- In case bleeding occurs after application, apply pressure using a cotton swab soaked in disinfectant.

- Afterwards, the injected PIT tag should be read with the scanner, the number repeated aloud three times and recorded on the data sheet. The sticker with the number and information supplied by the company should also be retained.
- Never apply a PIT tag if a turtle has finished laying eggs and is moving.
- The chance of injury to the turtle or tagger (e.g., needle breaking off inside the turtle or sticking into the person) is much greater if it is not done at the correct time.
- The numbers of the PIT tags applied each season should be included in any reports submitted to the appropriate authorities.
- The scanner battery should always be fully charged to avoid PITs not being read due to low battery.

A

B

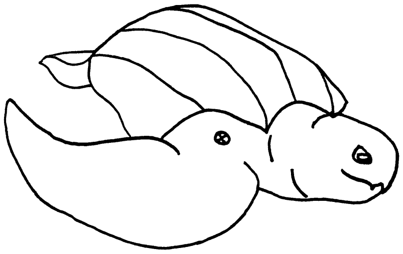


Figure 17. For D. coriacea, A) Checking for the presence of a PIT in the right shoulder (Photo: D. Chacón) and B) PIT tag application site (Taken from McDonald & Dutton, 1994).

Measuring Sea Turtles

Many types of measurements can be recorded for sea turtles and the data collected depend on the objectives for each project. At least two measurements of the carapace should be taken: length and width, which should be made using the metric system. It is recommended all measurements be taken along the curve (with a flexible tape measure[2]) although straight-line measurements may also be taken (with calipers[3]). Calibrated instruments should always be used, as these are millimetric measurements. To improve the accuracy and precision of the measurement recorded, each measurement shall be taken three times and recorded. It is recommended that the turtle is measured just as she begins to lay eggs since she is not moving.

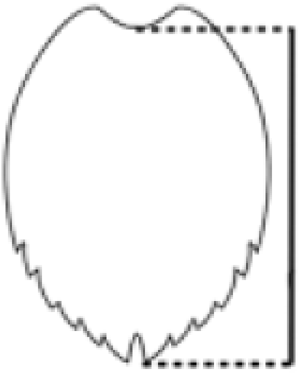


Figure 18. Where to measure the nuchal-supracaudal curved carapace length (Taken from Bolten, 1999).

[2] Tape measures are made of fiberglass and tend to stretch over time; verify their length each year and discard any that may be damaged or inaccurate.
[3] The caliper should be checked frequently; it may become loose and cause one of the ends to lose its correct position of 90° (i.e. completely perpendicular to the horizontal axis or long arm).

The recommended measurements are:
<u>Carapace length</u>: for the hard-shelled turtles, recording the nuchal - supracaudal curved carapace length (CCLn-s) is recommended. Using a flexible tape measure, measure from the anterior point at midline (nuchal scute) to the posterior tip of the supracaudal scutes (Fig. 19). If the tips of the supracaudal scutes are not symmetrical; for consistency, use the supracaudal that yields the longest result (Bolten, 1999). If the shell is incomplete or there are any epibionts on its surface, record it on the data sheet.

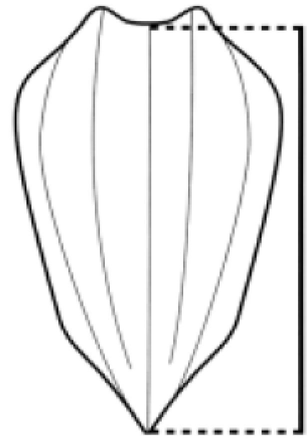


Figure 19. Where to measure curved carapace length of D. coriacea (Taken from Bolten, 1999).

For leatherbacks, the curved carapace length (CCL) is measured from the nuchal notch (anterior edge of the carapace at the midline) to the posterior tip of the caudal peduncle (Fig. 20). If the caudal peduncle is asymmetric, for consistency, measurements should be made to the longest point. If the caudal peduncle is broken or incomplete, it may modify the result of the measurement and it is necessary to record it. Curved measurements are made alongside the central ridge. The curved length is not measured along the crest of the ridge because of its irregularities and the difficulty in keeping the tape measure on the ridge. The end of the tape measure should be securely positioned at the junction of skin and carapace at the central ridge, and the tape should be pulled taut to the caudal peduncle, allowing the tape measure to follow a "natural" position along-side the ridge (Bolten, 1999).
<u>Carapace width</u>: it is recommended that the curved carapace width (CCW) be measured with a flexible tape measure. It is measured at the widest point of the carapace; there are no anatomical references points for this measurement (Fig. 21). In the case of the leatherback, the widest point can be measured from where the lateral ridges begin (1^{st} and 7^{th}, respectively).

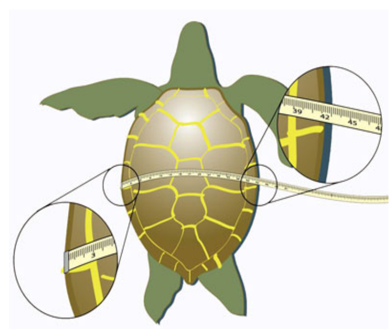
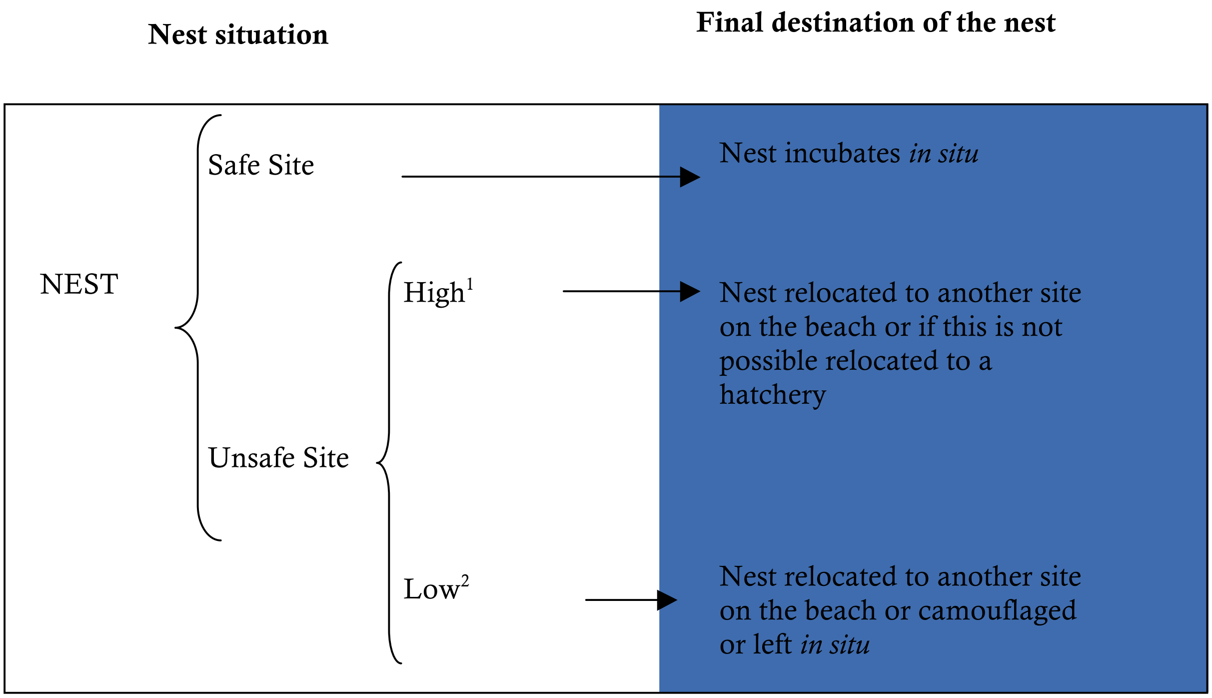


Figure 20. Where to measure curved carapace width.

In addition to carapace measurements, other biometric data can be collected, such as female weight, and size or weight of the eggs and hatchlings. Each project shall select and consistently use appropriate methods according to the study being done and clearly define the specifications used for any measurement taken.

NEST PROTECTION

Females return to sea once they have laid their eggs; the eggs and future hatchlings being left without maternal care. In this life stage they are exposed to many threats such as illegal egg harvesting, predation by wild or introduced animals, beach erosion, and vehicle traffic, among others. In addition, coastal development with artificial lighting or recreational activities may have a negative impact on the survival of eggs and hatchlings. For this reason, sea turtle management and conservation projects apply techniques especially designed to reduce these threats, such as increased surveillance, erasing evidence of tracks and nests, protecting the individual nest or beach, and/or relocation of nests to a safer location on the beach or to a **hatchery** (or **corral**). However, the best option is the one that requires the least manipulation of the nest, and relocating the eggs should always be the last option. The following criteria should be considered when relocating a nest (Fig. 22). The hatchery is always the last resort and is only used on beaches where ***in situ*** protection is impossible.



1. High probability of loss from anthropogenic or natural situations such as predation, poaching, erosion, flooding, and nests located a short distance from a river mouth, edge of lagoon, high foot and vehicular traffic, light pollution, and other situations with a high risk of losing the nest.
2. Low probability of loss from the same situations mentioned above.

   The criteria for relocating a nest will depend greatly on the knowledge that the beach monitor has of the study area.

Figure 21. Criteria to be considered when relocating a nest.

Relocating Nests on the Beach

Nests deposited in areas where erosion is severe and predictable or very close to the sea (at risk of flooding) may be relocated to a more stable and safer area of the beach. Extreme rainfall may cause a rise in the water table level which eventually floods the nest and, therefore, relocating the nest to higher areas of the beach may mitigate this threat. In case of high probability of egg poaching, the nests can be relocated to another location, even near the original nest site, away from the tracks and body pit. Nests at risk of being predated do not necessarily have to be relocated, but rather a wire or plastic fence can be placed under the sand's surface or on top of the nest to form a protective cage, which prevents it from being dug up by predators. The sites selected for nest relocation should not be near the roots of creeping beach plants, areas with drift waste (wood, plastic) or near the mouths of permanent or temporary rivers, among others.

Depending on the risks to the nests on each beach, relocation can be established as routine practice or not, but should always be the last method selected. Nest relocation should only be done if some nests are left *in situ* as controls. This should be decided by the field staff based on beach history, and should be clearly defined in the management plan and obtain the proper authorization.

Relocation of Nests to a Hatchery

A hatchery is a demarcated area of the beach to relocate nests that were deposited in high risk areas along the beach. Sea turtle eggs are incubated in the hatchery and the hatchlings are later released under supervision to crawl to the sea in order to provide them with a better chance of survival. The hatching success in the hatchery when relocating high-risk nests should guarantee a similar or higher percentage than under natural conditions, as well as a similar incubation period.

The size of the hatchery should be directly related to the number of nests that are expected to be deposited by the different species during the season. The area of the hatchery should be calculated to achieve a density of no more than 1 nest/m^2 and must be big enough to relocate all nests requiring protection (the total number of nests should be decided by the field staff based on beach history, an aspect that should be clearly defined in the management plan and authorized).

Procedure for Collecting and Relocating Eggs

When collecting eggs directly from the turtle, the following behavior standards should be observed so that the nesting process is not affected:

a. Wear dark clothes and observe the nesting activity in silence.
b. Do not use white light, only red or infrared (flashlights, cameras[4], etc).
c. Remain behind the turtle.
d. Do not allow the handling of eggs by visitors and/or inexperienced people.
e. Limit physical contact with the turtle.
f. Do not use insect repellent, perfumes or similar substances.

Collection bags: Do not use bags that have been impregnated with any type of chemicals. After using a bag, it may be recycled by washing it with water and chlorine, rinsing it out and then place it in a chlorine solution (1:1000) for six hours in the dark (chlorine degrades in the presence of direct light). Afterwards, rinse the bag well and hang it in a place where flies and other insects will not have contact with them. Another disinfectant that can be used is Vanodine. The UV rays received by drying the bags in direct sunlight can also help disinfect them at the same time.

To collect eggs from a natural nest and relocate them to an artificial one, proceed as follows:

a. Measure the depth and width of the natural nest and later apply it when making the **artificial nest** cavity. If this is impossible to measure, use the average values of a natural nest for the respective species (Fig. 23).
b. Always use latex gloves (to be worn only once) when handling the eggs.
c. If the turtle has not started laying her eggs, place a bag inside the nest as the turtle gives signs that she is ready to lay eggs. Place the bag carefully under the cloaca to allow the eggs to fall directly into it. In order to do this, enough sand should be removed from the mouth of the nest (back part) to make sufficient room to pull the bag out after the eggs are laid.
d. If this method cannot be used, the eggs can be collected by hand before falling into the nest[5], wearing gloves.
e. The mouth of the bag should remain open around the cloaca of the female to collect the eggs. Using this method, the eggs will never touch the sand and the mucus on the eggs will help maintain moisture in the nest. When the female begins to cover the nest, it is time to remove the bag. This must be done quickly and carefully to prevent the bag from tearing or getting trapped inside. Check the nest cavity with your hand to remove any eggs that might have been left inside the nest.
f. If the bag cannot be removed, quickly close it and tie a string around it that is long enough to be exposed on the surface while the turtle covers and camouflages the nest; this will mark the exact position of the nest. Make sure you hold on to the other end of the string or tie it to a stake.
g. When the female moves to another spot on the beach, dig up the bag carefully; never leave the eggs inside the bag inside the nest.
h. If you arrive after the turtle has begun laying eggs and are unable to collect the eggs in a bag or by hand, mark the exact spot where the turtle is laying with a string and hold on to

[4] Many countries require permits for filming or taking photographs, especially in Protected Areas.
[5] Depending on the situation, it is acceptable to remove the eggs from the egg chamber while the turtle is laying or even take them from a nest that was recently covered by the female. Precautions should be taken not to disturb the female or cause harm to the eggs.

the other end until the turtle finishes the process, then remove the eggs and place them in a bag.

i. Always keep the mouth of the bag closed until the eggs are relocated. Transportation of eggs should be done very carefully. It is important to minimize the time and distance from the original nest location to the relocation site (or hatchery) to reduce embryo mortality. The distance between the nesting site and the relocation site on the beach or in the hatchery can be a determining factor for hatching success.
j. The artificial nest should have the correct shape with the respective depth and width (Fig. 23). The eggs must be counted and the necessary data recorded on the data sheet (Annex 1). The bag is placed at a slight angle on the beach and the eggs are extracted one by one. Never allow dry sand to have contact with the eggs.
k. Cover the nest using the same moist sand that was extracted when building the nest. It is recommended that latex gloves be worn or at least that hands be washed before and after handling eggs.
l. All evidence of sand removal or other signs indicating the location of a nest should be cleared, especially on beaches with poaching problems.
m. The eggs must be relocated within 0-5 hours after being laid. After five hours, moving the egg threatens embryo survival because the embryo has already oriented itself in the upper part of the membrane and movement may dislodge it. Nests older than five hours should therefore remain *in situ* unless the nest is threatened with imminent and total destruction.
n. It is important to relocate the entire clutch of eggs; since as the eggs incubate, they generate heat that ensures the appropriate microenvironment for the embryos. This environment does not exist if only fractions of the nest are incubated. Mixing portions from different nests is not the best choice either, given the different nature of each clutch, which may result in egg contamination. Eggs from different species should not be grouped together because the incubation times differ for each species.

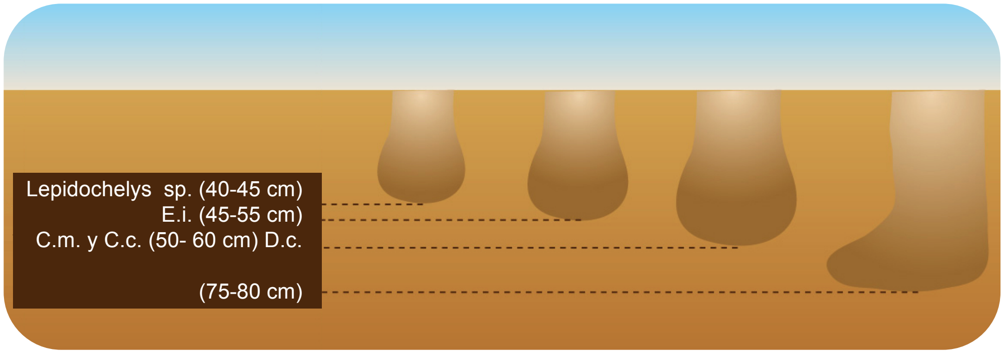


Figure 22. Shape and average depth of nest of different turtle species.

If eggs are received more than five hours after being collected or there is a need to move a nest several hours or even some weeks after it was laid on the beach (for example, a nest threatened by erosion), it is vital that the eggs are not turned or rotated in any direction. If it is possible a Styrofoam box can be used, as it is much more effective at avoiding egg rotation. If such a box is not available the following procedure may be used: 1) mark the top of each egg with a pencil (do not use markers that release chemicals or solvents); 2) always keep the mark to the top; 3) transfer the egg to a hard container such as a bucket. Never use plastic bags or sacks in these cases; 4) when placing the eggs in the nest, always keep the mark to the top; 5) conduct the relocation as expeditiously as possible; and 6) avoid exposing the eggs to sunlight.

Protecting eggs from predators

There are different ways to protect eggs threatened by predators that can be used on the beach or in the hatchery. The most common is a cylinder (cage) of galvanized wire mesh[6] (0.5 cm x 0.5 cm), 60-70 cm in diameter and 50-60 cm high. The mesh is placed directly over the nest and is buried about 10 cm into the sand. Since the hatchlings could be trapped upon emergence, this type of protection requires 24-hour surveillance as the hatching date approaches.

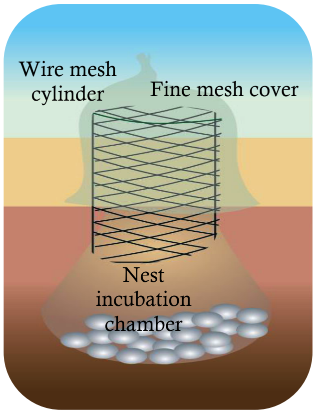


Figure 23. Protection for nests to prevent predation by insects and other animals.

The cylinder can be covered to prevent small mammals and birds from attacking the nest (Fig 24). If screen mesh is used, it is buried in the sand, completely covering the cylinder. This also prevents flies from laying their eggs in the nest and prevents their larvae from migrating towards the nest and attacking the hatchlings. It is known that flies are attracted by the mucus that covers the eggs during their first days in the sand or during the last days as the amniotic fluid flows from the eggs. The use of a fine screen mesh may also deter some types of coleopterans, acarids and roaches, among other insects.

An anchoring system will help to stop dogs, cats and some wild mammals from moving or tipping the cage over. Some beaches spread peppers over the nest on the first night to discourage predation by dogs.

[6] It has been suggested that non-metal material (plastic) be used to make cages to avoid possible interference with imprinting (Irwin *et al.*, 2004), but wire cages have been used for many years with no apparent ill-effect and offer some advantages over plastic.

CONSTRUCTION AND OPERATION OF THE HATCHERY

There are several types of hatcheries (open, semi-closed or closed) and these depend on the particular conditions of the beach. All hatcheries should be temporary structures, never being built with brick or concrete walls, since their location should be changed every season. The fence or walls of the hatchery should allow for proper air circulation and rainfall. Do not build a solid roof or partially cover the nests without scientific proof that shade is needed.

If the beach is long and the nests are distributed along its entire length, assess the logistical benefits of building more than one hatchery. Hatcheries should only be in operation until the last day of the season established for each project, so that the last nest hatches before the monitoring activities finish for the season.

The most common model is the closed hatchery (without a roof), wherein a space is enclosed on all four sides to prevent access by humans and animals (Fig 25). 24-hour surveillance is required, not only to dissuade predators and unwanted visitors, but also to release the hatchlings. The fence should be at least 1.2 m tall from the surface of the sand and be buried at least 30 cm in the sand. A common material used to build this type of hatchery is driftwood or bamboo, and screen mesh, netting or chain link fence can be used to enclose it. All materials should be galvanized steel, wood or aluminum to prevent corrosion. The hatchery should be built above the highest tide line and, if expecting a storm, it should be protected by a sand bag barrier, at least 50 cm high, in order to protect it from waves and unusually high tides.

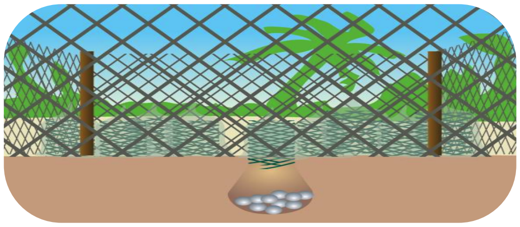


Figure 24. Diagram of a closed hatchery (no roof).

Selecting a Site

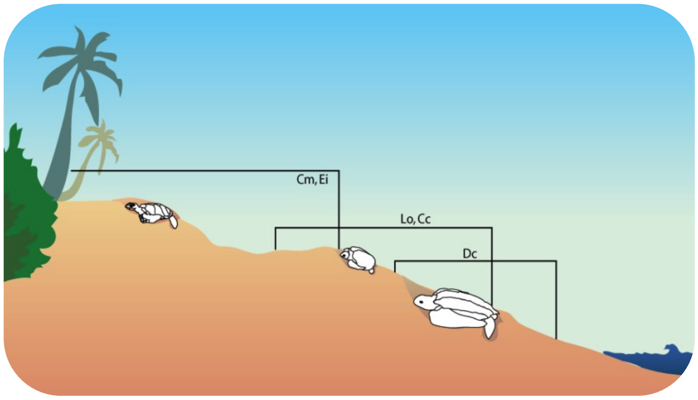


Figure 25. Generalized diagram of nesting sites selected by different species of sea turtles (Adapted from Márquez-M., 1996).

All sea turtle species select a particular site on the beach for nesting, which is usually above the high tide line, away from tree roots and safe from river erosion (Fig. 26). The hatchery should be located in an area with these same characteristics. In addition, the selected site should minimize relocation time and distance, thereby increasing the hatching success. Site selection will require a thorough study of the spatial distribution of the nests based on the background information of the beach, including: tide behavior, river mouth and natural drainage dynamics, impact of erosion and past nesting distribution during the rainy season. The sites that should not be selected to build a hatchery include: areas near canals, river mouths or lagoons; areas affected by tides or prone to erosion; areas with too much lighting or heavy foot traffic; industrial areas capable of releasing waste into the sea, or buildings with septic tanks.

Site selection should never be based on the researcher's convenience for surveillance or closeness to basic services. The hatchery is a tool used to help protect nests, improving their likelihood of survival and not to solve the logistical limitations of the people operating it.

When the hatchlings break the egg shell the amniotic fluid spills on to the sand. This fluid is an excellent growth medium for the development of micro-organisms such as fungi and bacteria, and attracts invertebrates like saprophagous flies, ants and roaches (Gautreau *et al*., 2007). Even after all shells are removed the fluids seep through the sand and permeate the hatchery. Therefore, it is not advisable to use the same site continuously due to the degradation of sand quality. Hatcheries should ideally be moved each season and previous sites should not be used again for at least two years. However, the rains in the area generally clean the sites from one year to the next, so it is not always necessary to change the hatchery site, especially if precautions have been taken by removing all the debris that remains in the nests after hatching, including the shells, **unhatched eggs** and dead hatchlings.

Nest Organization and Density Matrix

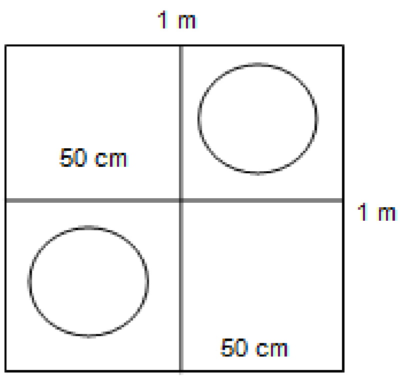
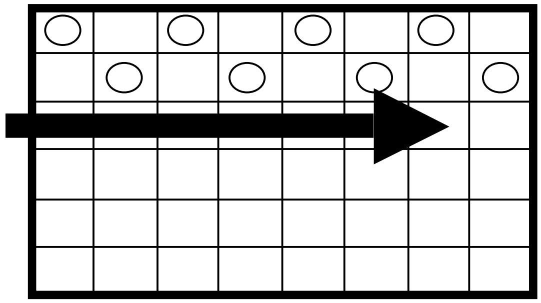


Figure 26. Example of a grid matrix for a hatchery.

The most common method for arranging nests in the hatchery is by using a matrix (a grid of columns and rows). These are outlined on the floor of the hatchery using light-colored string or rope. The grid is formed by marking spaces of 50cm, as observed in Figure 27. The rows are assigned a letter and the columns a number, or vice versa, so that each space has a code formed by the combination of a letter and a number. Once a code is assigned to each nest, the code can be recorded in the hatchery log without having to put all of the information on each nest using a label.

Nests are placed in every other space on the grid, leaving an empty space between them. Maximum recommended nest density is two nests/m^2 for species in the Cheloniidae family (Fig. 27), and one nest/m^2 for leatherbacks. Space and resources permitting, an "empty" row (without nests) can be left after every two rows, making it easier to walk around the hatchery (Fig. 28 A and B).

A



B.

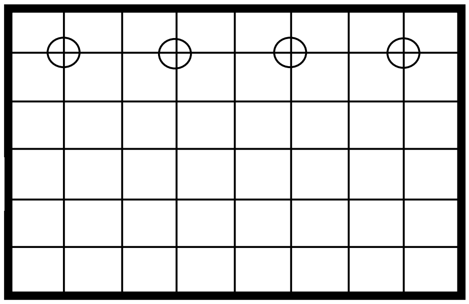


Figure 27. A) Nest distribution model for species of the Cheloniidae family, leaving every third row free of nests, space permitting. B) Leatherback distribution model.

The placement of all nests should begin from the front row towards the back; hawksbill and green turtle nests should be placed on the back row of the hatchery, closer to the vegetation, since these conditions more closely resemble the natural habitat for these species. A cylinder can then be placed over each nest, as described in the previous section for protection against predators. In addition to offering protection, the cylinder also facilitates collection of the hatchlings once they emerge, improves hatchery management and allows a precise calculation of the nest's hatching success. Data should be kept on the hatchery to verify its success. This topic is discussed below in the section on nest data and analysis.

Sand Humidity and Temperature

Sand humidity and temperature are very important factors for embryo development. A qualitative (visual) way to estimate correct humidity is to take some sand from the nest with your fingertips: if it falls off easily, it is too dry; if it stays on your hand forming small lumps, it has the necessary humidity, but if the sand is too compacted and releases water when squeezed, it is too wet. If necessary, dampen the sand with fresh water by using a clean plastic watering can.

To measure the amount of rain, install a rainfall gauge to be checked every 24 hours and record the values in the corresponding data log to be analyzed later.

Extreme precipitation events at the beach or in the higher part of the watershed may cause a rise in the water table that may flood the nests from the bottom. The level of the water table can be determined by inserting a measuring stick through a hole in the sand until reaching the water surface. It is important to know its depth and dynamics along the entire beach and throughout the nesting season, in order to assess the need to relocate nests according to their vulnerability to this factor. Climate change is causing changes in the frequency and intensity of extreme precipitation events and storms and, therefore, sea turtle conservation projects should consider this variable in their adaptation scheme.

It is important to monitor nest temperature as part of a hatchery management protocol, since the sex of sea turtles is determined by the temperature of the environment in which they are incubated. Relevant studies have shown the existence of a thermal balance point called the **pivotal temperature**. This is the temperature at which the same number of males and females are produced (Gulko & Eckert, 2004). During the second third of the incubation period, the embryos are influenced by temperature. All embryos developed during the second third in an environment where the temperature is higher than the pivotal temperature will result in a clutch that is mainly female. If lower than the pivotal temperature, the clutch will consist mainly of males. There are also minimum and maximum values that stunt egg development to the point of death, defined as below 24 °C and above 34 °C (Ackerman, 1997).

Temperatures can be monitored manually using a **thermocouple** or **thermosensor**, or any other adequately calibrated temperature measurement device. However, if you use a **datalogger**, this device can be programmed to record temperatures at pre-determined intervals; for example, every hour. The specific frequency of temperature readings will depend on the objectives of the project; however, one reading every hour is recommended. Temperature-measuring instruments should be placed in the hatchery, and also at various points along the entire beach, including the front, middle and back sections, to obtain control data. This characterization of the beach temperature profile is vital to infer the contribution of male and female hatchlings from the project beach to the population. In the face of global warming, it is essential to identify the sites that produce males, as these constitute important thermal refuges to maintain the reproductive capacity of the population. In addition, good knowledge of the thermal profile of the beach allows anticipation of what nests will be more vulnerable to over-heating, and may thus guide relocation when necessary. It is necessary to make temperature data for each beach available for regional analysis on the vulnerability of the population to global warming, enabling efficient and relevant corrective measures as necessary.

The main difference between thermosensors and dataloggers is that thermosensors provide an immediate reading, while dataloggers must be recovered after the nest hatches, and the information downloaded to a computer with the appropriate software.

All temperature-measuring instruments should be adequately calibrated for good operation. Write down the date, time, temperature at each site, equipment used, rainfall values and operator's name in the data logbook. The values, averages and standard deviations should be recorded.

Management of Incubation Temperature

It is important to remember that environmental conditions vary during a single nesting season, and between different seasons, causing a proportional change in hatchling sex, but usually with a bias toward females. During the season of clear skies and scarce rainfall (the "summer"), temperatures on some beaches reach levels lethal to turtles (**lethal temperatures**), causing high mortality. The nests may be protected by using shade from vegetation, or creating artificial shade. The basic objective of this intervention is to minimize embryo and hatchling mortality due to over-heating.

All beaches have an angle with respect to the solar emissions and at some point during the day, the shade from the coastal vegetation reaches the beach, but in the areas where deforestation has occurred and there is no shade, the nests are particularly vulnerable to over-heating. Recovering the original coastal tree line by reforesting with native species may be a measure to reduce *in situ* over-heating of nests in some areas of the beach. In the face of global warming this becomes especially important, to reduce embryo mortality from over-heating and ensure the production of males as well as females.

For beaches that have a hatchery, temperature monitoring should be conducted as described in the section above, to ensure that the thermal conditions in the hatchery are similar to those observed on the rest of the beach. If it is found that the hatchery has a problem with excessive heat, artificial shade may be installed (Fig 29). Shade can be provided using netting with a mesh size that will allow 25-50% shade; which will "soften" temperature increases or decrease. It is recommended to have 50% of the hatchery with shade and 50% without shade.

Figure 28. An example of a hatchery with partial shading

HANDLING AND RELEASE OF HATCHLINGS

Under natural conditions, depending on the species, the hatchlings usually emerge during the first hours of darkness when the temperature decreases; thus, the hatchlings have traveled a good distance offshore by daybreak, away from areas of higher predator density. In addition, they go through a very important process at this time, called **imprinting**. Any activity that involves retaining the hatchlings for more than one hour and/or impedes their immediate release into the water affects their capacity for returning and their capacity to avoid predators.

When hatchlings emerge in hatcheries, proper procedures for their handling and release should be followed. Once they emerge, they should be counted and handled using latex gloves or, if not available, hands washed with abundant soap and water. The hatchlings should be collected immediately after emerging, in a clean, usually plastic, container, and taken to places away from the hatchery (100-500 meters or more) for release, changing sites each time so that marine predators do not associate a specific location with a feeding ground. The hatchlings should be released as a group. The container to collect the hatchlings should be washed daily. The hatchlings should not be placed in water because they will swim instinctively, wasting energy they require to make their initial offshore swim. It is important to remember the need for imprinting, and therefore the hatchlings should be released above the high tide mark on the beach and left to reach the water by themselves. This will ensure that they have time to imprint on the parameters necessary to return to their natal beach.

The practices of leaving hatchlings in tanks or pools for purposes that range from educational activities to tourist attractions, release during the daytime, release directly into the sea, or handling by visitors, could affect their imprinting and their ability to survive and, therefore, should be avoided.

The entities that operate sites with hatchlings held in tanks rarely assess the presence and propagation of pathogens, use preventive medicine, or maintain a balanced diet and sanitary handling of the hatchlings. All of this undermines the survival of the hatchlings, especially when no criteria exist on the density (neonate per cubic meter of water) that these closed systems can effectively maintain. Hatchlings infected with pathogens may be asymptomatic and their release may mean propagation of these agents among the wild population, with the potential to cause a biological disaster. Keeping sea turtle hatchlings in artificial and poor quality environments has been broadly criticized, in particular when they are released after a period in captivity, ignoring their natural behavior and sequence of events that follow when they emerge under natural conditions.

The presence or advice of local wildlife experts is recommended, as well as comprehensive training for the staff responsible for manipulating eggs and hatchlings.

EVALUATION OF INCUBATION SUCCESS

It is necessary to assess the incubation success of the nests, whether these are incubated *in situ* or relocated to another site on the beach (*ex situ*), in order to understand the adequacy of the beach as an incubation system, the general health of the nesting population or the management methods used.

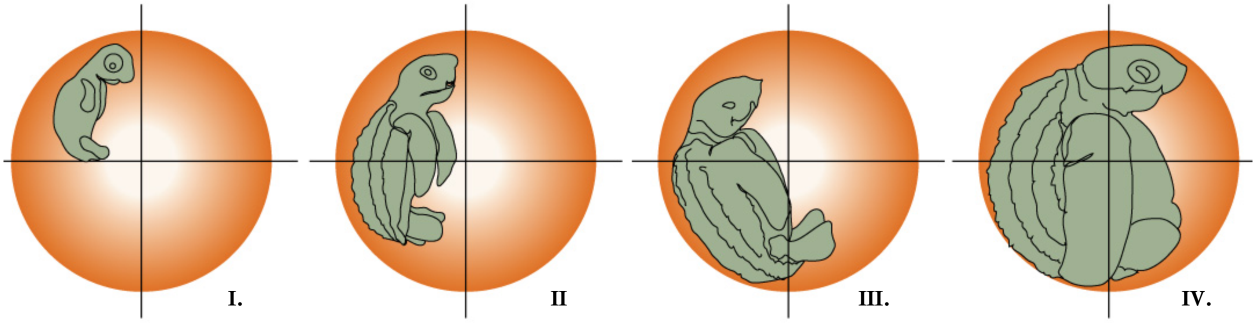
After a maximum of three days from first hatching, or once 50% of the hatchlings have emerged from the eggs in the nest, or 2-3 days after the estimated hatching date has passed and no hatchlings have emerged, the nests should be exhumed (**exhumation**) and their contents evaluated. In the latter case, this should be done carefully as the hatching may just be delayed. If that is the case, the nest should be immediately covered again with the same sand that was extracted.

The following information may be obtained from a nest having completed its incubation period (Annex 2):

- Nest identification number
- Species
- Date laid
- Date relocated
- Date of emergence
- Number of eggs in nest
- Hatchlings on surface:
    a. live
    b. dead
- Hatchlings inside the nest:
    a. live
    b. dead
- Empty egg shells (more than 50% of the egg)
- Eggs hatched with hatchlings in process of emergence (broken shell or "pipped"):
    a. live
    b. dead
- Unhatched eggs (unbroken shell):
    a. Without apparent embryo development
    b. With evident embryo development
- Predated eggs

Embryos from eggs with apparent embryonic development may be classified according to their stage of development; in three, four or more categories. An example is shown in Figure 30.

Stage I: Embryo fills up 25% of egg's amniotic cavity
Stage II: Embryo fills 26 to 50% of egg's amniotic cavity
Stage III: Embryo fills 51 to 75% of egg's amniotic cavity
Stage IV: Embryo fills 76 to 100% of egg's amniotic cavity



All hatchlings still in the process of hatching (leaving the egg), or **pipping**, as well as any embryos that are found still alive should be placed in a box with humid sand, closed with a lid and kept in the dark so that they may finish developing and can be released at a later date. All hatchlings released at a later date must be counted.

In particular, each embryo, hatchling or egg must be checked for the presence of fungi or bacteria, roots, ants or larvae, after establishing the corresponding stage of development for each egg, as well as the presence and form of any embryo malformation.

The parameters used to evaluate successful incubation are: number of hatchlings breaking out of the egg shell (hatching), number of hatchlings reaching the sea (release) and incubation period.

Either of the following two formulae may be used to determine percentage hatching success; since the value may be reported in several ways, it is advisable to present both formulae.

Hatching Success

$$\text{Hatching Success} = \frac{\text{\# EGG SHELLS}}{\text{TOTAL \# INCUBATED EGGS}} \times 100$$

$$\text{Hatching Success} = \frac{\text{\# EGG SHELLS + \# HATCHLINGS}}{\text{TOTAL \# INCUBATED EGGS}} \times 100$$

Where:
EGG SHELLS = Number of empty egg shells
HATCHLINGS = Hatchlings breaking the egg shell but not able to emerge completely (“pipped”) when the nest is excavated. The hatchlings may be alive or dead.
TOTAL # INCUBATED EGGS = Total number of eggs incubated in the nest. If unknown, it is the sum of egg shells, hatchlings, unhatched eggs (with or without apparent embryo development) and predated eggs.

Release Percentage

$$\text{Release Percentage} = \frac{\text{\# RELEASED HATCHLINGS}}{\text{TOTAL \# INCUBATED EGGS}} \times 100$$

Where:
RELEASED HATCHLINGS = Total number of hatchlings reaching the sea. These may be live hatchlings on the surface, live hatchlings inside the nest, live hatchlings ("pipped") and live embryos if recovered that may be released days later. If dealing with *in situ* nests and the total number of live hatchlings on the surface is unknown, the value is obtained by subtracting the number of dead hatchlings found on the surface and inside the nest from the total number of egg shells counted.

Incubation Period (reported in days)

$$\text{Incubation Period} = \text{DATE OF EMERGENCE} - \text{DATE LAID}$$

Where:
DATE OF EMERGENCE = The date of emergence of the first hatchling.
DATE LAID = The date when the female laid the eggs in the nest.

It is also important to report the total number of eggs incubated and the total number of hatchlings released, by species. These parameters will yield the total release percentage:

Percentage of Total Release

$$\text{Percentage of Total Release} = \frac{\text{\# HATCHLINGS RELEASED}}{\text{TOTAL \# INCUBATED EGGS}} \times 100$$

Nest excavation data should be recorded in the nesting log book and relate the nest to a specific female whenever possible; this allows various parameters, such as nesting frequency or reproductive output, to be determined for each turtle.

Using the environmental parameters recorded (e.g. incubation temperature, rainfall, distance to hatchery, etc), the reasons for certain results found upon excavation may be analyzed (e.g. a high number of Stage I embryos may correlate with high rainfall recorded during the early part of the incubation period).

In case there is a discrepancy between the number of eggs deposited and the total number of eggs counted at excavation, a decision should be made to make appropriate adjustments to the data and/or exclude those nests from subsequent statistical analyses.

OTHER MONITORING AND RESEARCH ACTIVITIES THAT COULD BE CONDUCTED AT NESTING BEACHES

1. Evaluation of dead turtles (e.g. turtles that are stranded, poached or predated) and necropsies.
2. Genetic studies.
3. Health assessments.
4. Satellite telemetry of nesting females to investigate migration routes, feeding grounds and habitat use.

To conduct these types of studies, or others, consult specific manuals relating to the topics.

Artificial nest:
Nest built by humans, whether in a hatchery, in the beach or an incubation box.

Asymmetrical track:
Imprint left on the sand surface where the marks of the front flippers are at different levels, showing that the turtle drags itself by moving each front flipper alternately.

Clutch:
Group of eggs laid by a female in a nest.

Clutch frequency:
The number of times a turtle lays eggs during a single season.

Corral:
Area on the beach separated and fenced, to deposit the nests that are collected from the beach in order to protect them from human and non-human predators, and incubating them until the emergence of the hatchlings. Synonym of hatchery.

Datalogger:
Temperature measuring device that can record and store data.

Double tagging:
Placement of two tags in different parts of the turtle (one on each flipper).

Egg laying:
When the turtle deposits eggs in the nest cavity it builds in the sand. Synonym of oviposition.

Evidence of previous tag:
Scar, hole or cut, usually in specific areas used for tagging, showing that the turtle was tagged before.

Excavation:
Action of removing sand from the nest chamber to a depth close to the eggs to confirm their presence.

Exhumation:
Action of taking out the contents of the nest to assess the results of incubation, or for clearing the nest.

False crawl:
Track left by a turtle that emerges onto the beach but does not nest (does not build a nest or does not lay eggs).

Hatchery:
Area on the beach separated and fenced, to deposit the nests that are collected from the beach in order to protect them from human and non-human predators, and incubating them until the emergence of the hatchlings. Synonym of corral.

Imprinting:
Action of memorizing the natal beach by hatchlings so that they are able to return to nest.

In situ:
The natural location of a nest in the beach.

Lethal temperatures:
High and low temperatures have been described for many turtle species; lethal levels are defined as temperatures at which the eggs are no longer viable and therefore will not hatch. The minimum temperature limit for eggs to hatch is 25°C and the maximum temperature limit for hatching is 35°C.

Neonate:
Turtle that has just hatched (hatchling).

Neophyte:
Female turtle nesting for the first time in her life. They are recognized by having no tags or evidence of previous tagging (tag scar).

Oviposition:
When the turtle deposits eggs in the nest cavity it builds in the sand. Synonym of egg laying.

Pipping:
Hatchlings that have broken the egg shell but have not completely emerged from it; a situation found when the nests are opened during exhumation. These hatchlings may be dead or alive.

Pivotal temperature:
The incubation temperature at which the sex ratio resulting from the nest is 1:1, i.e., 50% males and 50% females.

Poached nests:
Clutches of eggs taken illegally by humans.

Predated nests:
Clutches of eggs eaten by animals, whether domestic (dogs, pigs, cats) or wild (raccoons, foxes, etc.).

Remigrant:
Female returning to nest in subsequent seasons from which she has been tagged. They are recognized by having tags or the evidence of previous tagging (tag scar).

Renesting:
The action of a female nesting several times during the same season.

Saturation tagging:
Concept of tagging all nesting turtles on a specified beach.

Symmetrical track:
Imprint left on the sand surface where the marks of the front flippers are at the same level, showing that the turtle drags itself by moving both front flippers at the same time.

Thermocouple (thermosensor):
Temperature measuring device.

Tracks:
Marks left by the turtle on the sand as it moves up and down the beach.

Unhatched eggs:
Eggs that have not been broken by the hatchling. May contain an evident embryo or not.

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Annex 1.
Examples of Forms for Nest Surveys and Nesting Females

Suggested format for morning nest surveys:

Beach		Date	Observer	
Start Time		End Time		
Location (marker or post)	Species	Nest or False Crawl	Nest Poached or Predated	Comments

Suggested format for each nesting female observed:

Beach	
Date	
Observer	
Location (marker or post)	
Description (zone)	
Species	
Activity	
Time A	
Time B	
Time C	
Total Eggs Laid	
Nest Fate	
Nest Identification Number	
Tag Number and Location	
New, Old or Replacement Tags	
Previous Tag Scars	
Carapace Measurements	
Comments	

Definition of Fields:
Location: Record number of beach marker or post.
Description: Describe the nesting area ((e.g, inter-tidal zone or in vegetation)
Activity: What the turtle is doing when first encountered
Time A: Time when first encountered
Time B: Time the eggs are taken from the nest to be relocated
Time C: Time at which the eggs are relocated
Nest or False Crawl: Record if the track is a nest or a false crawl
Nest Fate: Record if the nest remains *in situ*, or if it is relocated elsewhere
Nest Identification Number: If the nest is marked and a number assigned for monitoring and later evaluation of the incubation success
Tag Number and Location: Record tag number and location on turtle (e.g. left or right flipper)

New, Old or Replacement Tags: New (if tags are applied), Old (if the turtle has tags when encountered) or Replacement (if tags are removed and replaced)
Previous Tags Scars: Record type and location of any previous tag scars
Carapace measurements: Measurements (e.g. curved carapace length)
Comments: Record presence of any scars, deformities, parasites, tumors, etc.

Annex 2.
Suggested Format to Evaluate Incubation Success

<table>
<tr><th rowspan="3">NEST</th><th rowspan="3">SP</th><th rowspan="3">DL</th><th rowspan="3">DE</th><th rowspan="3">ED</th><th colspan="2">HS</th><th colspan="2">HIN</th><th rowspan="3">SHELLS</th><th colspan="2">HTCH</th><th colspan="5">EMBRYOS</th><th rowspan="3">UH</th><th rowspan="3">PE</th><th rowspan="3">OBSERVER</th><th rowspan="3">COMMENTS</th></tr>
<tr><th rowspan="2">L</th><th rowspan="2">D</th><th rowspan="2">L</th><th rowspan="2">D</th><th rowspan="2">L</th><th rowspan="2">D</th><th rowspan="2">I</th><th rowspan="2">II</th><th rowspan="2">III</th><th colspan="2">IV</th></tr>
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</table>

Definition of Fields:
NEST: Nest Identification Number
SP: Species
DL: Date laid
DE: Date of emergence
ED: Number of eggs in the nest (deposited)
HS-L: Hatchlings on surface - alive
HS-D: Hatchlings on surface - dead
HIN-L: Hatchlings in nest - alive
HIN-D: Hatchlings in nest - dead
SHELLS: Egg shells (more than 50% of the egg)
HTCH-L: Hatched eggs with hatchlings in process of emergence – “Pipped” (alive)
HTCH-D: Hatched eggs with hatchlings in process of emergence – “Pipped” (dead)
EMBRYOS: Unhatched eggs (closed), with evident embryo development and its stage (I – III). For Stage IV, record if dead or alive.
UH: Unhatched eggs (closed), with no apparent embryo development
PE: Predated eggs