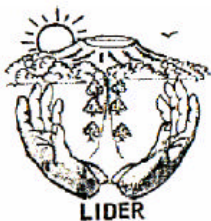

Frontier Nicaragua Environmental Research

Report 4

Sea Turtle Monitoring Methods Manual

Playa El Carbón, Reserva Natural Volcán Cosiguina
Chinandega, Nicaragua



FRONTIER



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2009

Frontier Nicaragua Environmental Research

Report 4

**Sea Turtle Monitoring
Methods Manual**

Couchman, O., Wulffeld, E., Muurmans, M., Steer, M. & Fanning, E. (eds.)

LIDER Foundation
UNAN-León
Nicaragua

Society for
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Universidad Nacional Autonoma de Nicaragua (UNAN)-León

UNAN is the largest university in Leon, established as a centre for learning and research in the arts and the physical, natural, earth, marine, medical and human sciences. The University is surveying and mapping the flora and fauna of Nicaragua and is conducting research into the maintenance and improvement of the environment and the sustainable exploitation of Nicaragua's natural resources.

Fundación LIDER (Luchadores Integrados al Desarrollo de la Región)

LIDER is a non governmental organisation responsible for Reserva Natural Volcan Cosiguina and has been working in the Reserva Natural Volcan Cosiguina to establish and facilitate an effective management system for this area.

The Society for Environmental Exploration (SEE)

SEE is a non-profit company limited by guarantee, formed in 1989. The society's objectives are to advance field research into environmental issues and implement practical projects contributing to the conservation of natural resources. Projects organized by SEE are joint initiatives developed in collaboration with national research agencies in co-operating countries.

Frontier Nicaragua Forest Research Programme (NRF FRP)

The Society for Environmental Exploration has been conducting research into environmental issues since January 2004 under the title of Frontier Nicaragua. Biological field surveys were conducted in the Volcan Cosiguina Nature Reserve in collaboration with UNAN León and Fundación LIDER

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1. Introduction

Sea turtle fossils date back to 110 million years and formed the ancestors of today's seven species in our oceans (Hirayama 1998; Naro-Maciel *et al.* 2008). All sea turtle species play an important role in the marine ecosystems by controlling prey species and providing food for larger predators and they act as nutrient transporters between sea and land (WWF 2007). Without the presence of sea turtles, the health and sustainability of marine as well as coastal ecosystems would be widely affected (*ibid.*).

All sea turtle species are protected under the CITES appendix 1 agreement, which means that trade in any sea turtle product is illegal (CITES 2008), but fisheries by-catch, hunting, habitat destruction, and other environmental factors have severely reduced the marine turtle populations (WWF 2003). As a consequence, three of the seven existing species of marine turtle are critically endangered with extinction, two are endangered, one vulnerable and the due to insufficient information the status of the seventh species remains unknown (IUCN 2008). Conservation efforts all over the world are trying to secure stable populations through raising awareness, influencing international treaties and policies, reducing bycatch and actively protecting nesting beaches. It is vital for turtle conservation to work with local communities and develop an understanding of the risks of poaching turtles for meat, eggs or trade. Non-consumptive uses such as ecotourism and employment in turtle conservation can help local communities and promote conservation at the same time (WWF 2003).

Frontier Nicaragua has been working at the nesting beach Playa Carbón at Reserva Nacional Volcan Cosiguina since 2004. The project aims to monitor and enhance the nesting success of sea turtles and prioritises the patrolling of nesting beaches with critically endangered species. The work is of great importance for international sea turtle conservation and will push Nicaragua forward in biodiversity conservation. Nicaragua is developing an important role within the conservation of sea turtles due to the vital nesting sites the country holds on the Pacific and Caribbean coasts.

An alliance of projects nationally and internationally is the only way to secure populations. Through international tagging schemes of critically endangered sea turtles we can develop our understanding of the necessary conservation tactics.

Although not described within this report, the Frontier Nicaragua sea turtle monitoring project at Playa Carbón also includes projects with the local community, as it is believed to have a vital role in effectively implementing conservation strategies.

2. Biology

Central America has a high concentration of seaturtle species. Of the seven extant species, five are present in these waters: leatherbacks, green and hawksbill turtles nest on both Pacific (PC) and Caribbean coasts (CC), whereas the loggerhead and olive ridley only nest on the Pacific coast (WWF 2007). The most common turtle along the pacific coast of Nicaragua is the olive ridley; indeed, Nicaragua is one of the only

nine areas world-wide where olive ridleys take part in mass nesting behaviour, known as *arribadas* (Hope 2002). The flatback turtle (*Natator depressus*) only nests in Australia and the Kemp's ridley (*Lepidochelys kempii*) only nests in the Gulf of Mexico (WWF 2007). The species in Central American waters and their associated status are described below (WWF 2007; Marine Conservation Society 2009; IUCN 2008)

Leatherback turtle (*Dermochelys coriacea*)

Status: Critically endangered

Nesting season: March-June (CC) November-January (PC)

Main diet: Soft-bodied cnidarians, such as jellyfish

Average weight: 500 kg. Largest of all the sea turtles

Average carapace length: 150 cm

Main threats: Meat and egg hunters

Green turtle (*Chelonia mydas*)

Status: Endangered

Nesting season: July-September (CC) October-December (PC)

Main diet: Vegetarian (important role in exchanging nutrients between nutrient rich ecosystems within the ocean to nutrient poor ecosystems).

Average weight: 150 kg

Average carapace length: 100 cm

Main threats: Meat and egg hunters

Hawksbill turtle (*Eretmochelys imbricata*)

Status: Critically endangered

Nesting season: March-August (CC) July-September (PC)

Main diet: Mainly sponges

Average weight: 50 kg

Average carapace length: 88 cm

Main threats: Shell and egg hunters

Loggerhead turtle (*Caretta caretta*)

Status: Endangered

Nesting season: May-August (PC)

Main diet: Molluscs and crustaceans

Average weight: 115 kg

Average carapace length: 92 cm

Main threats: Fishery bycatch, tourism development at nesting beaches

Olive Ridley turtle (*Lepidochelys olivacea*)

Status: Vulnerable

Nesting season: August-October (PC)

Diet: Algae, molluscs and shrimps

Average weight: 45 kg

Average carapace length: 70 cm

Main threats: Meat and egg hunters

3. Threats

The threats causing the sea turtle decline, are similar across the species, but the rate of decline is greater for some populations than others. The main nesting beach of leatherbacks in the Eastern Pacific, Playa Grande in Costa Rica has seen a decrease in the leatherback population from 1367 nesting females in 1988 to 117 nesting females in 1998, which is believed to be caused by mortality, mainly fishery bycatch (Spotila *et al.* 2000) however, illegal egg harvest is mentioned in other studies as being the main cause of decline (Tomillo *et al.* 2008). In Nicaragua the estimated annual harvest of hawksbills along the east coast has declined 92% between the late 1960s to early 1970s and the mid-1990s, but the hawksbill population is still in decline in the majority of the Caribbean waters (Meylan 1999). The main threats to marine turtles along the south east coast of Nicaragua has similarly been identified as fishery bycatch, egg poaching and killing of nesting females (Lagueux and Campbell 2005).

An overview of human threats and natural threats to sea turtles are given below (based on Kemp *et al.* 2000; Marine Conservation Society 2009):

3.1 Human threats

Bycatch and longline fishing

Longline fishing is a technique where many kilometres of a single fishing line with fishhooks is released into the water to be trawled in days later. Longlines used in the tuna and swordfish fishery kills high numbers of leatherback and loggerhead turtles each year due to bycatch. These two species in particular are attracted to the baited hooks, because they feed in areas of high planktonic concentrations where the highest densities of pelagic fish are also found. Other species as the Kemp's ridley turtle are more vulnerable to trawling nets used in shrimp fishing and has suffered from population decline due to bycatch in this industry. The annual number of turtles killed as bycatch is unknown but estimates range up to 300,000 and the bycatch in fishing nets include not only sea turtles, but also dolphins and sharks and seabirds. In Central America more than 80,000 turtles are captured each year, mainly hawksbills and green turtles.

With the introduction of the Turtle Excluder Device (TED) developed for shrimp nets bycatch is lessened due to larger animals being able to escape the net. Implementation of the TED nets has had a difficult journey through legislation and gathering support in the fishing community but is one of the actions now in place to reduce threats to the marine life.

Sea turtle meat and products

Trade in sea turtle products has formerly been a major cause for the rapid decline of sea turtle species. The hawksbill especially has been in great demand due to its distinctive tortoiseshell markings. Although CITES now ban all trade on turtle products, illegal trade is still occurring and some countries, such as Cuba and Dominica are proposing to reopen international trade.

Turtle eggs and meat has been a popular food item in coastal communities for centuries due to the high yield of good quality meat as well as the ease with which

turtles can be caught. Overconsumption and especially unsustainable egg harvest pose a major threat to turtle populations because of their slow development into maturity. It is feared that although adult turtle populations might not decline rapidly for many decades, the numbers of hatchlings and juveniles are being depleted leaving no sub-adults to carry on the generations.

Development on beaches

Nesting beaches are disappearing due to the development of hotels, resorts, marinas and other structures particularly associated with coastal tourism. New buildings replace vegetation, decrease the size of the nesting beach and result in more use of artificial lighting. House and street light can interrupt or deter nesting females from successful laying and hatchlings become disorientated when crawling for the sea. Recreational use of beaches, especially through driving and placement of sun beds also cause a disturbance to the turtles which can result in failed nesting or

Domesticated animals

Domesticated animals such as dogs, and cats, which have access to the beach are a threat to sea turtles by consuming eggs and hatchlings and possibly deterring nesting females by leaving a scent of predator.

Pollution

Pollution of seas and nesting beaches has a critical impact on the sea turtles. Stomach contents in turtles have revealed plastic bags, bottles, fishing line among other items in quantities that impair nutrition or even leads to starvation. Stranded turtles have been found with toxic concentrations of heavy metals in kidneys and liver and even before hatchlings break free of their shell they are exposed to pollutants through carcinogenic molecules found in the shells.

Human-induced climate change

Climate change poses a threat to sea turtles in several ways. Predicted sea level rise due to climate change will lead to loss of nesting habitat, especially where coastal development prevents the turtles from moving inland. Additionally, important food sources for the turtles, found in coral reefs and seagrass beds, are under threat from sea level rise, temperature change and more numerous storms.

Marine turtles also face disruption in the sex development of the hatchlings. As eggs incubated at hotter temperatures produce females and cooler temperatures produce males, a rise in sand temperature at nesting beaches could severely affect the natural sex ratio, unless the turtles change their nesting season according to the temperature change.

3.2 Natural threats

Land and vegetation

Erosion can change landscapes over night. If nesting beaches are exposed to erosion it can lead to destruction of nests and lack of space for turtles. Vegetation may, in some cases, cause a threat to nests if roots penetrate eggs or trap hatchlings.

Natural predators

Adult sea turtles face few threats from natural predators, mostly large sharks. Hatchlings and eggs however, experience high mortality due to fishes, racoons, crabs and sea birds.

Disease (fibropapillomas)

Skin tumours which can blind or obstruct movement and breathing are found in all sea turtle species, but mostly in green turtles. Studies are being conducted as to why this virus is rapidly spreading and if it is linked with the pollution of the seas. (Aguirre and Lutz 2004)

4. Seaturtle Monitoring Program

4.1 Aim

Frontier Nicaragua's work at the nesting beach, Playa El Carbón since 2004 has provided the experience and knowledge needed to set up a successful sea turtle hatchery conservation programme. Our aim is to determine an increase or decrease of population size in the nesting species, while at the same time increase the hatchling success through beach controlling and hatchery management. By collecting data through continuous nesting seasons the programme allow us to compare reliable consistent data and monitor the population trend in the area.

4.2 Equipment and clothing

Torch with red filter	Dark clothing
Notebooks with datasheets	Closed toed shoes
2 pencils	Raincoat
Tagging pliers	
Tags	
Alcohol	
Measuring tape (50/100 m and 5 m)	
Gloves	
Untreated plastic bags	
GPS (not essential)	

4.3 Dividing the beach into sectors

Setting out beach transects is a good way to determine which area has the highest density of nests. This can decide the place of the hatchery as well as areas in need of higher vigilance.

Every 100 meters a marker post is placed to facilitate quick recording of location when gathering data. Starting at 0.1 km on the stretch of beach, marker posts from 1 to 10 indicate distance or as far as monitoring is manageable. (see section 4.6 on how to use markers).

4.4 Beach patrolling

Patrol groups should never be larger than six people. Large groups are harder to control whilst working with a turtle and there is a much higher risk of disturbing the animal. Make sure the group is aware of the etiquette when working with a turtle along with the health and safety regulations, such as wearing closed toe shoes. The pace on the beach is slow to avoid accidents. It is vital that the lead researcher is at the front to spot signs of turtle activity. When a track is spotted, the researcher will leave the group at the high tide line and investigate the situation, returning to the team with the plan of action. If the turtle is found choosing her nesting spot the team must stay at least 5 meters away so not to scare the animal. This is when the turtle is most sensitive to disruptions. When the researcher believes the turtle has nearly completed digging her nest the group can join in from behind the turtle, never walking directly in front of her.

Only the researcher in charge is allowed to use light during the patrol as too much light will deter turtles from nesting. The use of video-equipment and cameras is strongly discouraged as the flash of the camera or the white light on the video-camera is disturbing for the turtle and could scare her back to sea.

4.5 Approaching a turtle

Sea turtles are sensitive animals. When choosing a nesting site they can easily get scared. Delaying their nesting process can lead to dangerous consequences for the turtle including death. Their sight and hearing is very primitive but they can easily detect vibrations while on the beach, making it important to keep patrol groups small. Furthermore, their sense of smell is very well developed and therefore the use of insect repellent or strong odours while working around a turtle will not only disturb the nesting process but may also pose a health risk to the animals due to chemicals such as DEET contained in products.

Always approach a turtle from behind to minimise disturbance. Never stand in front of her unless checking her tags as she returns to sea on a false crawl (i.e. without nesting). Their tails and cloacae are very sensitive and therefore must never be touched. Whilst waiting for the turtle to lay it is advised to kneel down behind her. During this period keep activity to a minimum, as the priority is for her to lay her eggs successfully. Measuring and tagging will be done after the turtle has laid.

4.6 Location of nest

The sea turtle species nest at different levels of the beach. To record the location, you can use the sector markers as well as a zone description. The recorded locations are wherever the turtle lays her eggs, not where she enters the beach.

Zone descriptions are shown below:

Low Tide (L)

Nest placed on the low tide zone on the beach

High Tide (H)

Nest placed on the high tide zone on the beach

Vegetation (V)

Nest placed in vegetation or dunes on the beach

With sector markers you can either record distance to nearest northern marker or, if you are working on a beach extending far inland, record the distance to the two nearest sector markers which provides you with a more precise recording of the nest's location within the zones (figure 1).

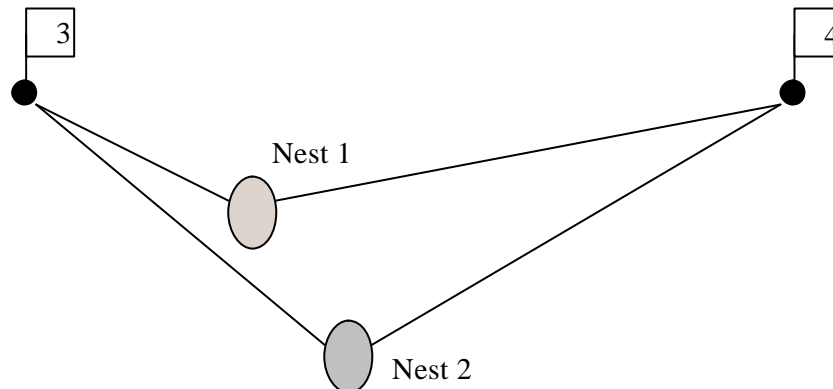


Figure 1. Illustration of nest location recording

If available, GPS can be used for nest recordings but accuracy must be noted and the technique considered sufficient reliable or not.

4.7 Nest information

Relocated (R) or in situ (IS) need to be recorded under NEST on the datasheet. In situ means you either are not able to find the eggs due to the turtle camouflaging the nest or the nest is located close to the hatchery thus provided with sufficient protection and not in need of relocation. Preferably the position of the in situ nest needs to be measured in order to excavate the nest at a later stage. When the turtle does not nest, FC (False Crawl) is noted.

4.8 Nesting process

The nesting process of every species of sea turtle can be divided into 7 activities. The activity of the turtle needs to be recorded when the patrol team discover the turtle.

1. Beaching (B)

When the turtle comes out of the sea looking for a place to nest.

2. *Making bed (MB)*

Digging a body pit. Using both front and hind flippers to dig herself in before creating her nest cavity. The length of time differs between species, with a leatherback taking up to 45 minutes.

3. *Digging nest (D)*

Digging the nest carefully with hind flippers. Nest depths and widths differ again between different species.

4. *Laying eggs (L)*

Laying fertile and infertile eggs. The number of eggs varies between species. With leatherback species laying an average of 70-80 fertile eggs and 20-30 infertile eggs and the olive ridley laying between 80-100 fertile eggs and no infertile eggs.

5. *Covering up (CU)*

After the turtle has finished laying she will use her hind flippers to start pressing down sand on the eggs. This activity needs to be imitated in a relocated nest after putting the eggs in. The activity will compact the sand and therefore prevent rain entering the nest.

6. *Camouflaging (C)*

Camouflaging nest area with front and hind flippers. Sand is thrown over the whole area as the turtle turns. Length of time differs again between species and individual turtles. Green turtles can camouflage for up to 2 hours! This is also dependent on the level of human interference. When the turtle is being disturbed, she will hurry to sea.

7. *Returning to sea (R)*

After finishing the camouflaging process the turtle returns to the sea.

4.9 Counting / collecting eggs

This section focuses on egg collection for the purpose of relocation to a hatchery, but the precautions during egg handling are just as relevant if the aim is to simply count the eggs. Egg relocation can be a valuable conservation tool in areas of high poaching or erosion but should always be used as a last option after exhausting other conservation methods. Inevitably there are risks associated with moving eggs from their natural conditions.

By bag

Collecting eggs by bag has several advantages; the eggs are being handled less, which decreases the risk of cross contamination and it keeps the turtle's fluids with the eggs, maintaining a more natural process which could influence the hatching success.

The moment oviposition begins is often hard to judge, therefore make sure your team is prepared. While the turtle is digging her nest, the egg counter/collector sits ready behind the turtle with the re-location bags (non-chemical, doubled up to prevent breaking of bag) and wearing gloves. Nest depth should be recorded at the start of the laying process. The turtle gives a single sign as she is about to lay; she moves one or both of her hind flippers to gently cover the nest. At this moment the plastic bag needs

to be slid in below (not touching tail and cloaca). A hand can be used to lead the eggs from cloaca into the bag. If any eggs fall next to the bag, they can be carefully fished out while the turtle is laying, but this should be avoided whenever possible. The bag needs to be pulled out when the last egg has been laid. You will know when she has finished as she will start to move. During oviposition the turtle is completely still.

Some turtle species lay infertile eggs (smaller and yolkless) together with the fertile ones. It is important to collect these infertile eggs as well as they have an important role in the survival of the fertile eggs in providing space for gas exchange and protection against predators.

By hand

When a turtle is found during or after laying her eggs, the eggs can be collected by hand. Whilst wearing gloves the eggs are carefully placed in a plastic bag. Nest depth can still be taken just after turtle has finished laying.

4.10 Tagging sea turtles

Only when the egg laying is complete, can tagging take place. A metal tagging scheme is a relatively cheap option compared to expensive micro-chipping techniques or the use of satellite transmitters, and standard tags can be obtained from various suppliers. There are two different sized tags; the large tag is designed for the leatherback only, due to their size, while the second, smaller tag is for the smaller species of hawksbill, olive ridley, green turtle and loggerhead. Each metal tag has two letters followed by four numbers. Older tags usually have six numbers. Each turtle will be tagged on the left and the right flipper, starting with the lowest number tag on the left flipper. Before putting in a tag, clean the area of the flipper with alcohol or benadine. The tags should be cleaned with alcohol before leaving for patrol. The tag should be placed far enough into the flipper to reduce the chance of it falling out but with enough space for movement and growth (1 cm gap will be sufficient). Leatherbacks are tagged on their hind flippers while the other species are tagged on their front flippers next to the primary scale. It is advisable to give training in tagging to those responsible.

When a new tag is used, the tag number will not be boxed on the data sheet. Any tags read on a re-emerging turtle should have a box drawn around the tag number on the data sheet. This way information on the number of new nesting females and returning nesting females can be recorded.

Tags provide us with information not only on the individual turtle but also on the species and their migration routes. The tag carries a message that requests tags to be returned if found (dead turtles in fishing nets or washed up). A small reward will be given to the person who sends the tag back. This allows us to understand the risks turtles face.

4.11 Measuring sea turtles carapace

As with tagging, measurements take place after egg laying to avoid causing any distress during laying. Using a tape measure (preferably not a role-tape measure), the length and width of the turtle are measured. Before measuring, the sand is cleaned off the turtle's carapace to get an accurate reading. Measurements are taken twice. If there is a difference of more than 5 cm, a third measurement is taken.

The width is always measured from the widest part of the carapace. The length measurement is taken along the centre of the carapace starting where the carapace meets the skin behind the turtles head all the way to the notch of the carapace. When dealing with leatherbacks you must measure to the end of the caudal projection.

The width is filled in under WCC (Width Curved Carapace) and length under LCC (Length Curved Carapace). Take into mind that the olive ridley WCC is normally wider than the LCC.

4.12 Recording turtle injuries

Injury data provides us with information on the threats the sea turtles face in the ocean. On the data sheet under comments is an outline of a turtle with numbers that correspond to parts of the turtle. For example, if an injury is identified on the front right flipper the researcher will try and detect a reason, it will be recorded as: Injury #2 (shark attack).

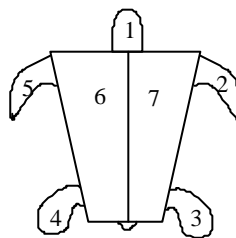


Figure 2: Turtle structure to reference injuries

4.13 Old tag holes (OTH) / Old tag notches (OTN)

Regularly you will come across turtles with holes or scarring in their flippers due to lost tags. They are defined as either a rip, which is known as OTN or a puncture where the tag has opened up and left a hole, known as OTH. Recording this data is important in showing us which turtles have been counted before.

4.14 Comments

Any other distinctive features of the turtle will be recorded under comments, such as injuries, fibropapillomas or fishing hooks.

4.15 Datasheet recording

Table 1. Example of data sheet

RECORDER	Maggie	Maggie	Maggie	
TIME	21.30	02.25	03.12	
DATE	21-08	21.08	21.08	
DISTANCE TO SECTOR MARKERS	50 m to sector 3 68 m to sector 4	51 m to sector 1 47 m to sector 2	80 m to sector 9 85 m to sector 10	
ZONE	H	B	H	
SPECIES	Leatherback	Leatherback	Olive ridley	
LEFT TAG	VA3404	796753	VA3408	
RIGHT TAG	VA3407	796754	VA3409	
CARAPACE LENGTH	156	162	70	
CARAPACE WIDTH	111	115	75	
ACTIVITY	MB	P	B	
NEST	R	IS	FC	
NEST DEPTH	76	68	-	
OLD TAG HOLE	# 3	-	-	
OLD TAG NOTCH	-	-	-	
EGGS	83	76	-	
INFERTILE EGGS	32	23	-	
COMMENTS	Injury #2 (shark)	Half missing #4		

5 Hatchery management

Hatcheries are the last option of conservation tools that are only used in areas with high poaching rates or erosion. It is always best to avoid removing eggs from a natural environment. Locating all the eggs in one area has positive and negative results. If not conducted correctly, hatchling success can be worse than on the beach. The interference and relocating of the eggs is artificial and leaving eggs in situ would be the ideal. Re-locating eggs to hatcheries must be used as a last option.

5.1 Location

Location is vital to create a successful hatchery. The following factors must be taken into mind when deciding:

Different area every year

Due to build up of bacteria, crabs and insects inside used hatcheries it is important to regularly change location. Make sure to relocate at least for the following two seasons. Areas prone to erosion must be avoided.

Partially shaded

As sex ratios are depended on temperature the hatchery must have areas which are not fully exposed to the sun. Shaded areas within the hatchery are an important factor.

On peak nesting sector

Choose the location at the busiest nesting area of the beach. Relocating the eggs over large distances will have an affect on the eggs due to a difference in the size of sand grains, sand moisture and temperature. Also it is always better to avoid carrying eggs over large distances as there is higher risk of accidents.

Root removal

The nesting area has to be cleared from roots or plants on the surface before putting eggs inside the hatchery. Choosing a location with no natural vegetation would be preferable. Roots have to be removed as they can perforate the eggs or strangle the hatchlings.

Size

Decide on the maximum number of nests which can fit inside the hatchery. When the hatchery is full, nests can be relocated on the beach or a secondary hatchery.

Secure

It is necessary to make the hatchery as secure as possible. By guarding the area 24 hours per day 7 days a week, the eggs will be safe from poaching and predators. It is a common occurrence for hatcheries to be targeted by poachers.

5.2 Mixed species hatchery or single species hatchery

When relocating the eggs into a mixed species hatchery it is important to keep in mind the different nest shapes and depths for the different species. Keep a recommended

distance between the nests of 50 cm which is important due to the variety of nesting behaviour of each species. Leatherbacks usually lay their eggs at low tide, therefore their eggs should be placed on the ocean side of the hatchery. In contrast, the green turtle builds its nest close to the beach border, which should be reflected when relocating to the hatchery.

A	B	C	D	E	F
Olive Ridley		Olive Ridley		Olive Ridley	
	Green		Green		Green
Hawksbill		Hawksbill		Hawksbill	
	Loggerhead		Loggerhead		Loggerhead
Leatherback		Leatherback		Leatherback	

Figure 3: An example of a mixed species hatchery

5.3 Relocation

- Gloves (untreated plastic gloves, rubber) to rule out cross contamination from hands to eggs.
- Bags from untreated plastic to catch/transport eggs.
- Long centimetre stick to measure nest depth.

To minimise disturbance to the turtle, do not touch, measure or tag the turtle before or during laying as they might abort the process. Sitting behind the turtle with a small group is not disturbing as long as movement around her is kept to a minimum. Sea turtle's hearing is not very developed but they can feel the vibrations of movements.

It is important not to transport the eggs longer than eight hours, as development begins to set in after this time period. Preferably eggs should be relocated within three hours.

For transport to the relocation area or hatchery keep the following in mind:

- Do not mix nests of several turtles in one bag
- Do not put the bags of eggs on top of each other whilst transporting, due to the high pressure.
- Use large enough bags to allow space and the division of pressure
- When transporting by horse, allow no trotting or galloping to minimise movement

- When transporting by hand, place eggs in rucksack instead of carrying in hand to minimising movement.

5.4 Placing eggs in hatchery

Depending on the species the depths and shape of the nest are going to differ. Ideally the measurements taken from the original nest should match the measurements in the relocated nest. The depth of the original nest and the width of the hind flipper will match nest depth and width of the mouth. For leatherback sea turtles the infertile eggs will be placed on top of the fertile eggs.

In the next figure average nest depths and widths are given which can be referred to when original nest depth/width data is missing.

Table 2. Average nest depths for Central American turtles

	Depth	Bottom of nest	Mouth
Olive Ridley	45-50 cm	20-25 cm	15-20 cm
Leatherback	65-75 cm	30-35 cm	20-25 cm
Hawksbill	40-50 cm	25-30 cm	15-20 cm
Loggerhead	55-65 cm	30-35 cm	15-20 cm
Green turtle	45-60 cm	20-25 cm	20-25 cm

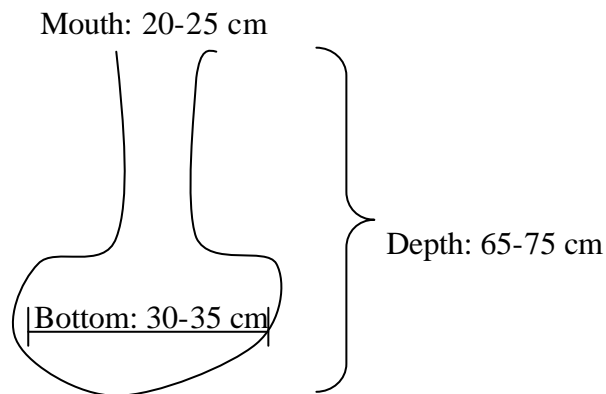


Figure 3. Example of a leatherback nest

Once the eggs are placed in the nest, every 5 cm of sand needs to be pressed down before another layer is being added until completely covered. This mimics the natural behaviour of the nesting female and helps to protect the eggs against rain.

The nest is identified with a piece of non-toxic flagging tape. This tape must be marked with:

1. number corresponding to the datasheet
2. tag number of the turtle
3. date the eggs were laid
4. number of eggs.

Record on a hatchery datasheet:

1. date re-located
2. approximate date of hatching
3. excavation due date
4. location in the hatchery

5.5 Nest excavations

The approximate incubation time for all sea turtle eggs is 60 days. If the eggs have not hatched by their due date, the nest will be excavated five days after the due date. This gives the eggs enough time to hatch if developing slower. When a nest has hatched, excavations take place five days later. This gap gives time for final eggs to hatch but soon enough to release any weaker hatchlings that are at risk left in the nest.

Hatchling success rates are vital to understand the hopes for hatcheries as a conservation tool. To collect the data you must tally the contents of the nest. Count broken egg shells as hatched. All un-hatched eggs are opened to collect data on possible reasons for its failure to hatch. Obvious causes as infestation of maggots can be noted as well as the development stage e.g. unfertilised, embryo smaller than yolk, embryo larger than yolk, hatchling died, hatchling alive.

5.6 Releasing hatchlings

Hatchlings are never released directly into the sea and during release, do not use the same area of beach each time, so to avoid attracting predators. Varying location of release lowers risk. When nests hatch together, hatchlings can be released together as safety is in numbers.

5.7 Hatchery management

Preferably only one person will be in charge of the hatcheries data collection, allowing standardisation of the methods (for data sheet see Appendix).

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