SEA TURTLE CONSERVATION

BEACH MANAGEMENT AND HATCHERY PROGRAMMES

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AND
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A GOI – UNDP PROJECT MANUAL

Centre for Herpetology / Madras Crocodile Bank Trust, Tamil Nadu

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Contents

Pic courtesy: Kartik Shanker

Sea turtles have remarkable lifestyles, which makes them fascinating to both professional biologists and wildlife enthusiasts. Leatherbacks are amongst the deepest diving vertebrates, going down below 4,000 feet deep in search of jellyfish, their favourite food. Ridleys are known for their arribadas, when several thousand or hundred thousand turtles come ashore simultaneously to nest.

Sea turtles are air breathing vertebrates like birds and mammals but have returned to a near complete life in the water. Once they leave the beach as hatchlings, females will return to land only to nest and lay eggs; male sea turtles may never return to land at all.

Most sea turtles undertake long distance migrations, as hatchlings and juveniles during a long pelagic phase in the open ocean, and as adults between their feeding and breeding grounds. Loggerheads migrate over 12,000 km across the Pacific, from their developmental habitats in Baja California to their nesting grounds in Japan. Green turtles migrate from their feeding grounds in Brazil to nest on Ascension Island, a speck in the middle of the Atlantic. On the east coast of India, olive ridley turtles that nest in Orissa are known to migrate to Sri Lanka and perhaps, beyond. What's more, sea turtles return to the beaches where they were born (their natal beaches) to nest.

Sea turtles do not have parental care. The female turtle deposits the eggs on the beach and leaves the rest to nature. Nature worked pretty well for millions of years, but human related threats such as harvest of adults and eggs, incidental catch in fisheries, erosion, sand mining, beach armouring, lighting and predation by feral animals has had severe negative impacts on most turtle populations.

Since most nesting beaches in India are affected by factors that endanger nesting turtles, eggs and hatchlings, it is often necessary to have an appropriate conservation programme to safeguard these populations. However, it is important to first identify the source of the threat and evaluate the best approach to conservation. In this manual, we will deal with ways of reducing threats to eggs and hatchlings.

Pic courtesy : Kartik Shanker / Meera Anna Oommen

Protecting sea turtles on nesting beaches

Given the high densities of human populations along the Indian coast, nests are vulnerable to predation by humans and feral animals, mainly dogs. Hatchlings are also vulnerable to predation and are disoriented by beachfront lighting. Since it is often not possible to have complete protection for nesting beaches, *in situ* (on site) and *ex situ* (hatchery) approaches have to be adopted, depending on the nature of threat and the objective of the programme.

In general, eggs should be allowed to develop without disturbance as far as possible. It is only when the relative merits of moving eggs far outweighs leaving them on site that they should be moved. *Ex situ* conservation (with hatcheries) usually involves greater intervention, but offers additional value in terms of education and awareness.

Many state forest departments (West Bengal, Orissa, Goa, Gujarat and Andaman & Nicobar Islands) and NGOs (in Andhra Pradesh, Kerala, Maharashtra and Tamil Nadu) already run hatchery programmes.

Leatherback hatchlings

Pic courtesy: Kartik Shanker / Meera Anna Oommen

Practicalities of beach management and hatchery programmes

Both beach management and hatchery programmes have merits and demerits. Beach management programmes are often much harder to initiate and need the support of local communities, and those who make use of the beach, to succeed. Sometimes these programmes require as much effort and personnel as hatcheries, which offsets some of the supposed advantages. On the other hand, hatcheries can often have negative impact on populations because of their limitations. It is only when other options are ineffectual, and funds, personnel and suitable sites for a hatchery are available, should this option be considered.

Advantages of Hatcheries

1. A certain proportion of eggs is guaranteed protection from risks on the nesting beach, such as predation by feral dogs, crabs and other animals, extraction by people, beach erosion, flooding by high tides and so on.
2. The number of eggs protected and hatchlings released is documented, hence there is some known measure of ‘success’.
3. Involvement of volunteers and other personnel in conservation related action has a positive effect on spreading awareness.
4. The hatchery provides a physical focus for conservation activity related to the coast, which can be used for public education and awareness activities.
5. Hatchlings are available at a known time and place for use in education and awareness programmes.

Disadvantages of Hatcheries

1. Hatcheries are often relatively expensive as they require investment in fencing, nest enclosures, and personnel.
2. Hatcheries require trained personnel for collection, relocation and reburial of eggs, as well as to guard the hatchery against people and animals.
3. The personnel need to be trained.
4. Hatching success in hatcheries is regularly lower than in the wild.
5. Sex ratios in hatcheries may be skewed.
6. Improper methods of hatchling release leads to high rates of mortality, either while on the beach or at sea. For example, releasing hatchlings at the same site each day may create fish and sea bird feeding stations. Unattended, or inadequately constructed, hatcheries can be attacked by predators (including people), resulting in total or near total loss of eggs and hatchlings. Holding hatchlings for too long before release may lead to injuries or make them too lethargic to behave appropriately upon entering the sea.

Designing a conservation programme

Prior to initiating a conservation programme, the threat to populations and habitats have to be assessed. Conservation actions will depend on the nature and intensity of these threats. Basic biological data can be collected without much extra effort as part of ongoing conservation activities, and these often provide important information about the species. One must keep track of habitat quality and population trends to evaluate the success of the programme. Any conservation programme must include the following components.

Population size and trends – It is important to accurately determine whether populations are increasing or decreasing or stable. Hence, even if the main focus of a programme is conservation education, it is essential to keep records of details like the number of nests laid on a particular beach each season.

Assessment of habitat – The nesting habitat should be assessed periodically to evaluate threats such as sand mining, beach armouring and lighting.

Sources of mortality – These will essentially determine the main/priority actions to be taken towards conservation. For example, if the main threat is from fishery related mortality, conservation action will need to be directed towards reducing this by implementing no-fishing zones or the use of Turtle Excluder Devices for trawlers.

Research and Data management – Basic research often provides useful insights into the biology of a species, which can have important implications for conservation. Data should be collected systematically on nesting season, abundance (number of nests / beach / season), adult mortality (source and magnitude), clutch sizes and on hatching success *in-situ* and in the hatchery.

Public Awareness and Education – Public support is required for successful conservation, and hence education and awareness must form a central part of conservation programmes.

Involving Local Communities - It has become increasingly clear that successful conservation programmes need to involve local communities ie. the people who are most directly in contact with the animals in question. This involves:

- The identification of stake-holders
- Promoting bottom up as against top down management
- Integration of communities into conservation programmes
- Development of socio-economic alternatives for local communities

Most importantly, the communities must play a major role in the identification and development of alternatives, and participate in decisions about the use and conservation of their resources.

Pic courtesy: Kartik Shanker / Meera Anna Oommen

How to set up a hatchery

Location of the hatchery:

The best location for a hatchery is at a site that is as similar as possible to the habitat of the nesting site of the turtles. Hence, hatcheries should be located on the nesting beach, and if the beach is sufficiently long, several hatcheries should be established. This makes the transport of eggs less labour intensive, and makes it possible to transplant eggs into hatcheries relatively quickly. Several programmes have failed only because eggs had to be transported to hatcheries several kilometres away. One alternative that combines aspects of *in situ* and *ex situ* practices, is to simply transplant a clutch of eggs several metres up the beach from where the nest was originally laid.

Hatcheries also need to be located close to the nesting beach to minimize trauma during transportation of eggs to reduce the time between collection and relocation, to provide an opportunity for the hatchlings to imprint on their natal beach and to facilitate hatchling release. The hatchery should be located well above the high tide line, but not too far inland as to be in heavily shaded areas, or sand with a very high humus/organic soil content.

Pic courtesy: Kartik Shanker

The hatchery can be enclosed by chain link fence or wire mesh. Inexpensive wooden poles, cane and bamboo or slats can also be used. To prevent the entry of crabs and other burrowing predators, chicken wire mesh (or any small mesh material) can be buried to a depth of 0.5 metres along the inside of the fence. This measure is often essential to ensure the success of the hatchery.

Ideally, the hatchery should be located and oriented in such a manner to provide the greatest diversity of microhabitats for the nests. The shape of the hatchery often depends on local conditions. If the beach is narrow, then the hatchery perforce has to be rectangular with the long side parallel to the sea. Circular shapes provide the greatest area for a given perimeter, and hence a polygon provides more space to relocate nests especially if availability of perimeter fencing is a constraint.

To prevent infestation from fungus and bacteria, the hatchery should not be at the same site during two consecutive seasons**.**

Collection and Transport


Pic courtesy: Kartik Shanker / Meera Anna Oommen

Sea turtles are very sensitive and may return to the sea without nesting if they are disturbed while stranding or excavating the nest. During this period, workers should be very careful not to disturb the turtle with lights or movement. Once egg laying (oviposition) begins, the turtles goes into a 'nesting trance'. During oviposition, the turtle will usually not react even if she is handled gently, though some species (and individuals) are more sensitive than others. Collection of eggs, tagging and tissue sample collection can all be carried out during this time, or if possible, after she has finished laying eggs.

Ideally, eggs should be collected, transported and placed in the hatchery **within 2 hours after egg deposition.** Eggs collected within 8 - 10 hours (ie. same night as deposition) generally have a good chance of survival, if handled carefully. If eggs are collected more than 10 hours after laying, great care should be taken during collection, transport and relocation.

Only nests that are threatened by flooding, erosion or high levels of predation by humans and feral animals should be collected. Eggs can be collected in a plastic or cloth bag, either directly from beneath the turtle while she is laying, or dug out from the nest after she has laid and left the nest. The bags or buckets need to be clean and not contaminated. For smaller turtles like ridleys and hawksbills, eggs are fairly easy to locate. However, with larger turtles, although nests are easy to find, the eggs can be difficult to locate once the turtle has covered up the nest, and if the workers find a nesting turtle, it is best to collect the eggs during oviposition. Alternately, a small rope or coloured tape can be inserted into the nest so that it extends to the surface and once the turtle has completed nesting, the nest can be located by following the tape.

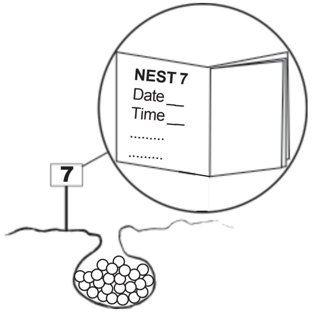
If eggs are trasnported and relocated more than 10 hours after laying, they should be handled very carefully and should not be rotated or jarred. This can be done by marking the eggs on top with a pencil and placing them in a rigid container (ie. bucket or tray, not a bag) with some moist sand from the nest to ensure that they do not move during transport.

Relocation

Each clutch should be relocated within the hatchery in a microhabitat as similar as possible to the natural nest. They should be buried at the same depth as the natural nest, which can vary depending on the species of turtle. The nest should be constructed in the shape of the natural nest ie. with a narrow neck and a flask shaped bottom. The eggs should be carefully placed in the nest and then covered first with moist and then dry sand on the very top. The latter should not contact the eggs. Nests should be relocated in low densities in the hatchery, with at least 1 metre between nests (and up to 2 metres if space permits) so that they do not affect each other during development and so that hatchery workers can move about without stepping on the nests.


Pic courtesy: Meera Anna Oommen

Each nest should be numbered and recorded in a data sheet or book (in particular the date of laying and number of eggs), so that the date of emergence can be estimated with accuracy, and for other research purposes. Data such as clutch size, nest location, date of collection need not be posted on the signboard near the nest. Rather, each nest should have a place marker with a number, and associated data can be entered in a data book. The marker can be a wooden stick (with or without a small signboard) placed beside the nest. Another aid to locate the nest is to use a coloured tape, extending just to or just below the surface. This is also a good way to mark nests *in situ*, without attracting the attention of egg collectors or curious passers by.



Nest enclosures in the hatchery

Some hatcheries use mesh enclosures for each nest to restrain hatchlings after they emerge to facilitate data collection and release. However, hatchlings should be released immediately after they emerge from the nest. So, unless the hatcheries are constantly manned, hatchlings may remain within the enclosure for extended periods, which can cause exhaustion or death, especially if there is bright sunlight. Chicken wire mesh should not be used for these nest enclosures. Hatchlings are easily cut by the wire when they put their flippers and heads through the mesh.


Pic courtesy: B.C. Choudhury

Thatch baskets work better, and also shade the nest towards the end of incubation, which can help to reduce mortality especially during summer. However, the nests should not be shaded too early during incubation, as this could affect sex ratios. In populated areas, thatch baskets can be stolen from the hatchery, and this can been countered by making a hole at the bottom of the basket, hence making them useless for any other purpose. If enclosures are used primarliy to restrain hatchlings for data collection and release, they only need to be placed during the end of incubation.


Pic courtesy: Kartik Shanker

Hatchling release

Hatchery personnel should anticipate hatching for each nest. Expected dates of hatchling emergence can be estimated from date of collection (and will vary depending on species and time of year), and can also be predicted by the 'caving in ' of sand surface above the nest when hatching begins. Hatchlings will usually begin to emerge from the nest two to three days after hatching begins. Hatchlings should be released into the sea in groups

immediately after emergence, but at different times of the night and at different points to prevent the creation of feeding stations (fish will learn that hatchlings are released at a particular point and may wait for them). Hatchlings should be allowed to crawl accross the beach to allow imprinting. However, it is best not to subject them to this if there is bright sun or hot sand.


Pic courtesy: Kartik Shanker

If and when immediate release is not possible, hatchlings should be kept in soft, damp cloth or sack in a cool and dark place. They should not be placed in buckets of water as they will engage in swim frenzy behaviour in the bucket and exhaust their yolk reserves. They need both the yolk reserves and swim frenzy behaviour to help them to swim past the breakers.

Don't retain the hatchlings in a container with water. Release them as soon after emergence as possible.


Olive ridley hatchling Pic courtesy: Kartik Shanker

How to run a beach management programme

Hatcheries are obviously not an ideal solution to the conservation of sea turtles since they involve substantial manipulation of natural events. They require considerable manpower and hatching success of nests may be much reduced. An alternative is to implement measures to protect the nests on the beach where they are laid. Some might suggest that one should simply remove all the people and associated predators, but this may be neither ethical nor possible. Alternative methods of beach management or *in-situ* protection include a variety of measures.

Beach patrols and disguising nests

The very presence of monitoring and surveillance personnel or even just researchers is often enough to deter egg collectors to some extent. This, of course, is if the collectors know that the collection of eggs is illegal, which is not the case in many areas. In this case, it is first necessary to acquaint them with the wildlife laws. All five species of sea turtles found in Indian waters are classified in Schedule 1 of the Indian Wild Life Protection Act (1972), which affords complete protection for the turtles and eggs. Offenders can be sentenced to imprisonment for a maximum of seven years.

Egg collectors can also be deterred by removing the evidence of nesting by wiping out the track and smoothing over the nesting site. Another method is to leave a lot of foot prints around nests and create poke marks with a 1 to 1.5 inches diameter stick. Egg collectors often use sticks to probe for nests and this makes it look like the eggs have already been taken. Nests can also be disguised from predators using masking scents (e.g. urine) but there is no evidence of how effective this is.

An alternative is to relocate the eggs to a site close to the original nest. In addition to being effective in thwarting egg collectors and predators, this does not require the infrastructure of a hatchery. Relocation protocols are the same as those for the hatchery as described above. The location of nests needs to be carefully determined using local landmarks. However, if beach front lighting is present, the hatchlings will be disoriented when they emerge, necessitating monitoring during the period of emergence as well.

Predator Control

Sometimes, the best way to deal with predators is to eliminate them. However, this is an option to be exercised only with semi-domestic, feral, introduced and widespread species. Elimination of native predators can negatively impact the coastal ecosystem. Further, this would be ineffective in many parts of the Indian mainland, where there is an endless supply of predators such as feral dogs. However, this is an alternative for isolated beaches such as in the Andaman and Nicobar Islands. Aversive conditioning (use of chemicals which create unpleasantness on consumption) have unfortunately not been shown to have great success, but could be useful if the right chemicals for particular predators are discovered.

Pic courtesy: B.C. Choudhury

Buried mesh and caging

Eggs need to be protected immediately after laying when they are most susceptible to predation. Again, after about 30 days, when the nest temperature reaches a certain level (due to the metabolic heat generated by the developing embryos), the predated eggs start to rot and smell. Predators (like dogs) which rely on smell will learn quickly to locate these nests. Of course, fresh nests are also susceptible to these predators. Hatchlings are obviously susceptible during emergence, especially if artificial lights are present that disorients them. In such cases, the nests need to be protected throughout incubation.

The placement of mesh or caging surrounding each individual nest is possible on beaches where the main threat is from predators such as dogs and pigs. The mesh should be buried deep enough to protect the egg from burrowing by predators. Mesh size should be big enough to allow hatchlings to crawl through after emergence, if the nests are not going to be monitored during that period.

Pic courtesy: Kartik Shanker

Data collection

The collection of accurate data is a very important part of any conservation programme. Information on the number of nesting turtles per season, or at least the number of nests (with eggs) on a given nesting beach provides information on population trends, though effort needs to be standardised between years and research teams. Data on nest depths determine hatchery relocation practice. Data on clutch sizes and hatching success can give important information about the reproductive biology of the species. In hatchery programmes, it is particularly important to determine hatching and emergence success so that one can evaluate if anything is drastically wrong, and then make appropriate modifications

Clutch size

Clutch size is the number of eggs laid into a nest. Turtles (especially leatherbacks) lay some abnormal eggs, including yolkless eggs (which are much smaller than usual) and multi-yolked eggs. Yolkless eggs are not counted, while multiyolked eggs are counted as single eggs. Clutch size must be determined at the time of oviposition. If the eggs are being collected for translocation to a hatchery, clutch size should definitely be determined at this time. If nests are left *in-situ*, it is useful to determine the clutch size for some proportion of these nests as well. Clutch size can also be estimated after emergence by counting egg shells and other nest contents (see below). If some of the eggs that are collected are not included in the hatchery nest (perhaps because of breakage) this information needs to be recorded.

Minimum data for each clutch

Turtle Species Tag number (if any)
Date and time laid (For nests laid before midnight, use the date of the following day; for nests laid after midnight, use that date)
Location / Nesting beach
Clutch size
Fate of clutch Predated / Collected / Left in situ / Relocated in hatchery

Data can also be collected on:

Nest location across beach	in relation to mean high tide line, dunes
Nest habitat	in grass, under vegetation, in sand
Nest depth top	depth from surface to first egg
Nest depth bottom	depth from surface to bottom of the chamber
Egg diametre	for 10 normal eggs
Egg weight	for 10 normal eggs

Measuring and weighing eggs

It is not strictly necessary to measure and weigh eggs, unless there is a specific rsearch objective. A minimum of ten eggs should be chosen at random from the clutch, and wiped free of sand. The greatest and least diameter for each egg should be measured and recorded. These can be averaged to obtain the diameter of each egg. The same eggs can also be weighed using a spring or electrical balance.

Excavation data

Collecting data on nest contents can help in identifying problems during incubation either in the hatchery or *in-situ.*

Nest contents can be categorised as:

S	= Shells	= Number of hatched out empty shells
E	= Emerged	= Hatchlings that have emerged from the nest
LIN	= Live in Nest	= Live Hatchlings still within the nest
DIN	= Dead in Nest	= Dead Hatchlings within the nest
DPE	= Dead hatchling in pipped egg	
LPE	= Live hatchling in pipped egg	
P	= Predated	= Open, partial / nearly complete shell with egg residue/ dead embryo

Unhatched eggs:

UD	= Unhatched, undeveloped eggs with no obvious embryo
UH	= Unhatched eggs with obvious small embryo
UHT	= Unhatched full term embryo

Pipping: The breaking / opening of the shell by the hatchling

Shells: The number of hatched shells (shells are also left from predation) is difficult to count, and the error often depends on the skill and experience of the worker. Only shells that are > 50 % of the egg must be counted; small fragments must not be counted. All workers (both new and experienced) should calibrate their error by comparing egg shell counts in nests where the clutch size is known (though this may be affected if there is predation inside the hatchery).

Undeveloped eggs: Some of these may be either infertile, but others may have a very small indiscernible embryo, which cannot be discerned without careful, detailed examination, and adequate equipment and training.

Calculating clutch size

Estimated Total clutch = components without shells + components with shells
(Clutch size or CS) **= (E + LIN + DIN) + (UD + UH + UHT + DPE + LPE) + P**

where
components without shells = number of hatched shells (S)
= Emerged (E) + Live in Nest (LIN) + Dead in Nest (DIN)
The other components have shells.
Predated eggs have a shell with egg residue or dead embryo

If the total number of hatchlings emerged is not known (i.e. if a few escaped and were not counted), **E = S – (LIN + DIN)**.

Calculating hatching & emergence success

If clutch size determined by counting hatchlings, then
Emergence success (%) = **(E / CS) x 100**
Hatching success (%) = **((E + LIN + DIN) / CS) x 100**

If clutch size is determined by counting egg shells, then
Emergence success (%) = **(S – (LIN + DIN)) / CS)) × 100**
Hatching success (%) = **(S / CS) x 100**

Total clutch size must include eggs that were lost between collection and relocation due to breakage or predation inside the hatchery.

Pic courtesy: Kartik Shankar

Education and Awareness

Hatchery and beach management programmes offer excellent opportunities for education and awareness. They allow wildlife enthusiasts and school and college students to participate in and contribute to conservation programmes, and help in giving them exposure to key conservation issues and to learn the basics of wildlife research.

Education

If funds are available, some material or handout with basic information should be provided to visitors to the hatchery or participants on turtle walks. During turtle walks, clear instructions (verbal or written) must be provided on behaviour, especially with regard to nesting turtles. A sufficient number of volunteers should be present to guide the group.

Hatchling release

Hatchling release is a particularly exciting activity for students and children, and really anyone. Hatchlings should be released at night or early in the morning, and should be allowed to crawl on the beach prior to entering the surf. Each participant can be assigned a few hatchlings to guard until they enter the surf and swim away. For large groups, one can cordon off a section of the beach, effectively keeping people behind parallel lines, in the middle of which the hatchlings crawl to the sea.

Pic courtesy: Kartik Shankar

Volunteers and participants

Volunteers and participants or new personnel must be acquainted with the particulars of sea turtle biology, conservation and management techniques. They should be encouraged to read general articles and manuals on sea turtles, and directed towards more literature and websites. They must be acquainted with the necessary techniques required for the conservation programme (see bibliography).

Community based conservation

It is ideal when the conservation programme can be run, or co-managed, by a local community. The youth of the fishing community should be encouraged to protect turtles and nests near their villages. This can work in tandem with other community programmes as well as synergistically with other turtle conservation programmes on the coast.

Pic courtesy: Kartik Shanker / Meera Anna Oommen

As Archie Carr once said:
"a sea turtle is a kind of turtle that never puts the same back foot into its egg hole twice in succession"

There are seven species belonging to two families, Dermochelyidae and Cheloniidae. Five species are found in Indian coastal waters; all species except the loggerhead nest on the mainland coast and islands. The olive ridley nests on both coasts (primarily the east coast) and Andaman and Nicobar Islands. The green turtle nests in Gujarat, Lakshadweep and the Andaman and Nicobar Islands, the hawksbill in Lakshadweep and Andaman and Nicobar Islands and the leatherback in the Andamans and Nicobar Islands. Loggerheads are rare in India and known from very few records, mainly in southern Tamil Nadu. All five species nest in Sri Lanka.

Life History

Reproduction: Males and females begin the reproductive cycle by migrating from their feeding grounds to breeding grounds. Feeding and breeding grounds may be separated by several thousand kilometers. Courtship and mating occur primarily in the offshore waters of the breeding ground; the male mounts the female, holding her with claws in his foreflipper and proceeds to mate. Both males and females may mate with several different individuals.

Several weeks after mating, the females come ashore to nest, mostly at night. They crawl above the high water mark, find a suitable nesting site, clear away the surface sand (making a body pit), and dig out a flask shaped nest with their hind flippers. This may be two to three feet deep depending on the size of the turtle. They lay about 100 – 150 eggs in the nest and fill it with sand; some species thump the nest with their body to compact their nest. (Once the turtle starts laying eggs, they go into a 'nesting trance' and are less easily disturbed during this stage) They then throw sand around the nest for camouflage and return to the sea. Most turtles nest more than once during a season, with roughly two weeks separating each nesting event. After they have completed nesting, they return to their feeding grounds until the next breeding migration, which may be a year or several years later.

Pic courtesy: Kartik Shanker

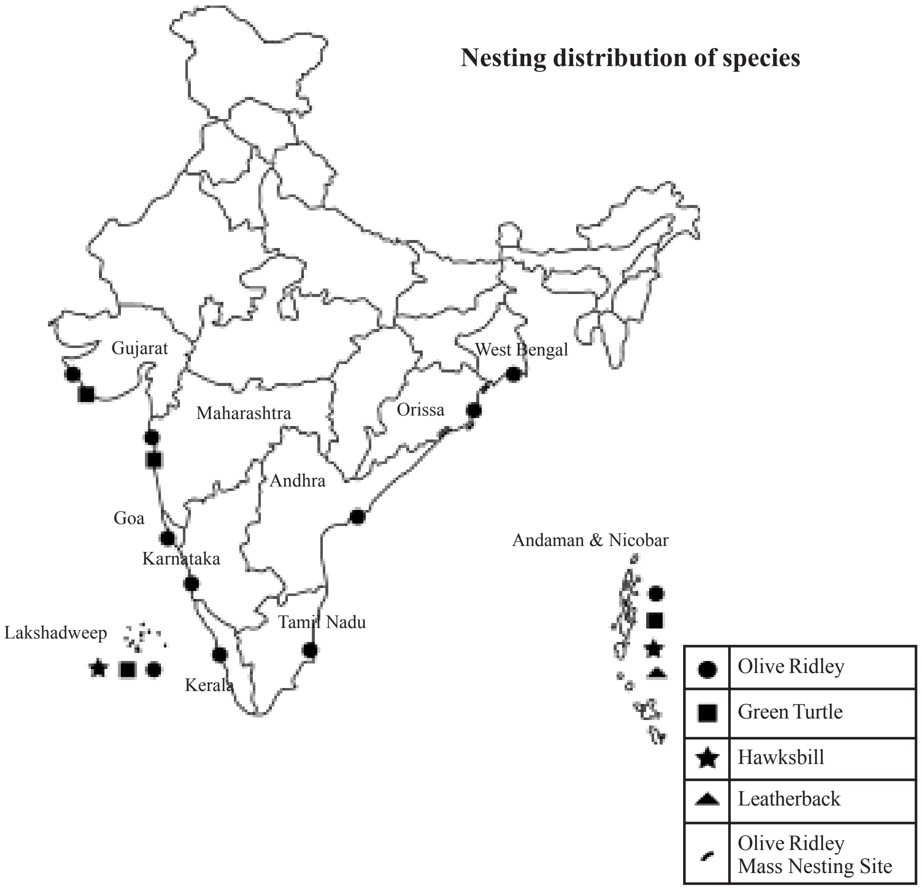
Development of hatchlings: The hatchlings develop in their nest over a period of 7 to 10 weeks. They hatch simultaneously over a period of a few days and then emerge from the nest together (to swamp predators) usually at night. Predators include crabs, birds, jackals, feral dogs, and many fish once they are in the sea. Once in the sea, the hatchlings spend the first couple of days of their lives in a "swimming frenzy" when they use stored energy reserves to get into the open sea. Beyond this, they spend many years in a variety of juvenile habitats until they join other adults at feeding areas. ***Less than one in a thousand hatchlings is believed to survive to adulthood.***

Temperature dependent Sex Determination: Lower temperatures produce males, higher temperatures produce females. The pivotal temperature (i.e. the temperature that produced equal numbers of males and females) varies among species and populations, although it is usually around 28–32°C. The sex of the hatchling is determined during the second trimester of development. Sex ratio is likely to vary over the course of a nesting season and also between nesting beaches.

Orientation and Navigation: Hatchling emergence is nocturnal to avoid predators and sunlight. Sea finding is visual; the hatchlings seek a "brighter horizon" which is usually the moon or starlight reflecting off the surface of the sea. They also use silhouettes of sand dune and trees to orient themselves away from land and towards the sea. As soon as they enter the sea, they orient themselves to wave direction, swimming against the direction of the waves. During this time, they also get imprinted on the earth's geogmagnetic field. Hatchlings and adults are sensitive to both magnetic field intensity and magnetic inclination angle, and therefore have a compass sense that enables them to migrate to their natal beaches as adults.

The Lost Year and beyond: Young turtles spend their lives in a variety of foraging habitats. The hatchlings are usually carried on trans oceanic gyres and currents. Sargassum driftlines (seaweed rafts) and FADs (Fish Aggregating Devices) have been found to be particularly important. Convergence fronts have also been found to be important foraging habitats for juveniles. Loggerheads are known to make trans-Pacific journeys (southern California to Japan) in the course of their development. For very long, this pelagic phase of their life was a complete mystery to biologists and was known as the 'lost year'. The juveniles and sub adults of some species spend many years in near- shore developmental habitats after the pelagic stage. Development to maturity may take 10 to 15 years in most turtles and maybe 30 years or more in the herbivorous green turtles

Nesting distribution of species

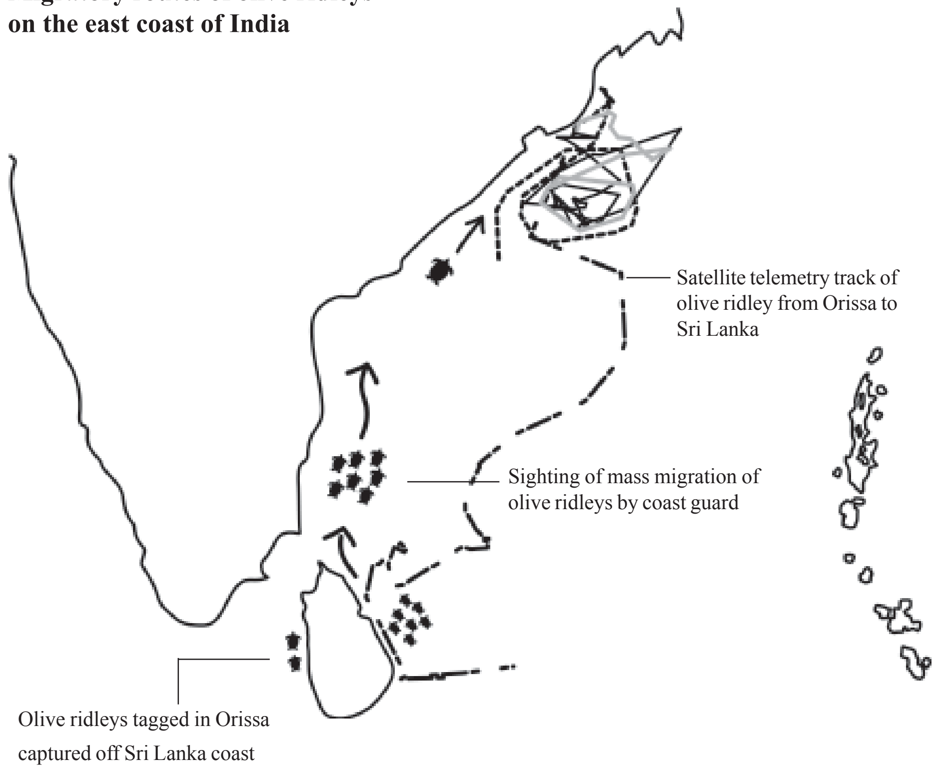


Philopatry: Sea turtles usually travel 100s to 1000s of kilometres from feeding to breeding ground. It has long been believed that sea turtles return to their natal beach (the beach where they were born) or group of beaches to lay eggs as adults. Recent genetic studies have substantiated this; some species (like green turtles) show greater precision in natal homing than others (like leatherbacks and olive ridleys).

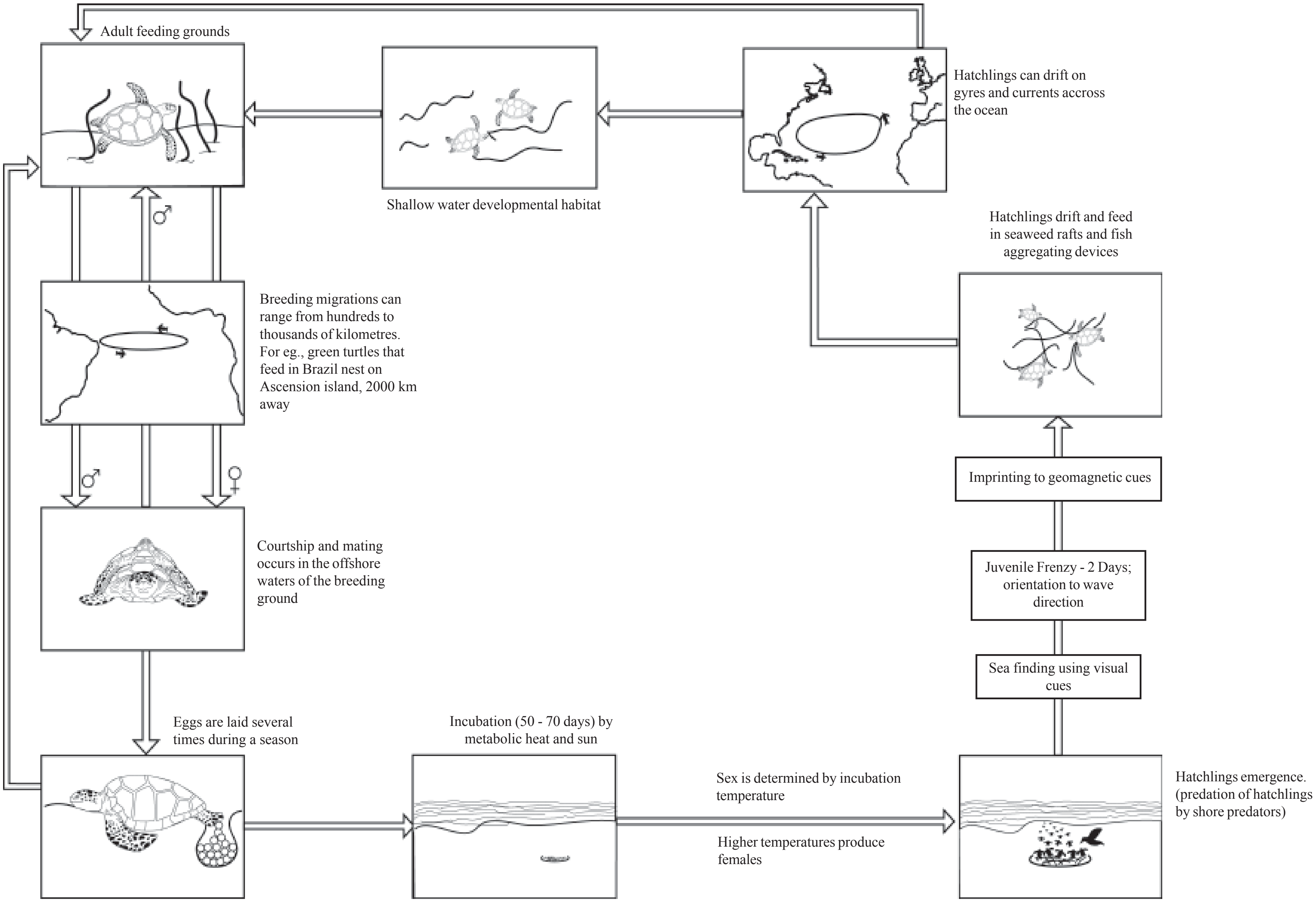
Nest Site Fidelity: Most turtles lay all their clutches within the same general area (0 to 10 kms) during the nesting season. In some cases, such as with olive ridley turtles in Orissa, they may travel larger distances (a few 100 km) for renesting. Some leatherbacks have nested on beaches separated by more than 700 km.

Beach selection is affected by accessibility of the beach as well as height and substrate. Different turtles prefer different types of beaches to nest. For example, olive ridleys and leatherbacks prefer wide beaches and sand bars at river mouths, while hawksbills and green turtles prefer small island beaches.

Migratory routes of olive ridleys on the east coast of India



Life Cycle



Adult feeding grounds
Shallow water developmental habitat
Hatchlings can drift on gyres and currents accross the ocean
Hatchlings drift and feed in seaweed rafts and fish aggregating devices
Breeding migrations can range from hundreds to thousands of kilometres. For eg., green turtles that feed in Brazil nest on Ascension island, 2000 km away
♂
♂
♀
Courtship and mating occurs in the offshore waters of the breeding ground
Imprinting to geomagnetic cues
Juvenile Frenzy - 2 Days; orientation to wave direction
Sea finding using visual cues
Eggs are laid several times during a season
Incubation (50 - 70 days) by metabolic heat and sun
Sex is determined by incubation temperature
Higher temperatures produce females
Hatchlings emergence. (predation of hatchlings by shore predators)

Threats to sea turtles

In many parts of the world and in India, sea turtle populations are affected by a wide variety of threats. Even under natural conditions, survival rates are low, and eggs and hatchlings are predated by small carnivorous mammals, birds, lizards and crabs. Once they are in the sea, a variety of predators plague them through their immature stages. Only large sharks, perhaps killer whales and humans predate adults. At a few sites, nesting turtles may be killed by large predators such as jaguars and tigers.

Human induced threats are increasingly problematic for turtle populations. These threats can be classified into direct and indirect threats.

Indirect threats:
- Loss of marine habitats
- Loss of nesting beaches (erosion, sand mining, beach armouring)
- Pollution
- Lighting (disorients both adults and hatchlings, mainly the latter)

Direct threats:
- Incidental catch in mechanized fisheries
- Consumption of adults – not common in much of India
- Egg depredation by feral animals and humans

In India, nearly 100,000 dead turtles have been counted on the coast of Orissa in the past decade, killed as incidental catch in trawl and gill nets. Several thousand turtles are also killed in fisheries along the coasts of Andhra Pradesh, Tamil Nadu and the Andaman and Nicobar Islands.

Some turtles trapped in trawl nets are not dead, but comatose, and if they are thrown back into the water immediately, they are likely to die. On the other hand, if they are kept on board the ship, they may recover. Turtle Excluder Devices (TED) can substantially reduce the mortality of turtles in trawl nets, without reducing fish catch.

Many other threats plague turtles along the Indian coast; the most signficant of these are threats to the habitat from unrestricted coastal development, and threats to the eggs and hatchlings from predators.

Pic courtesy: Bivash Pandav

Pic courtesy: Kartik Shanker

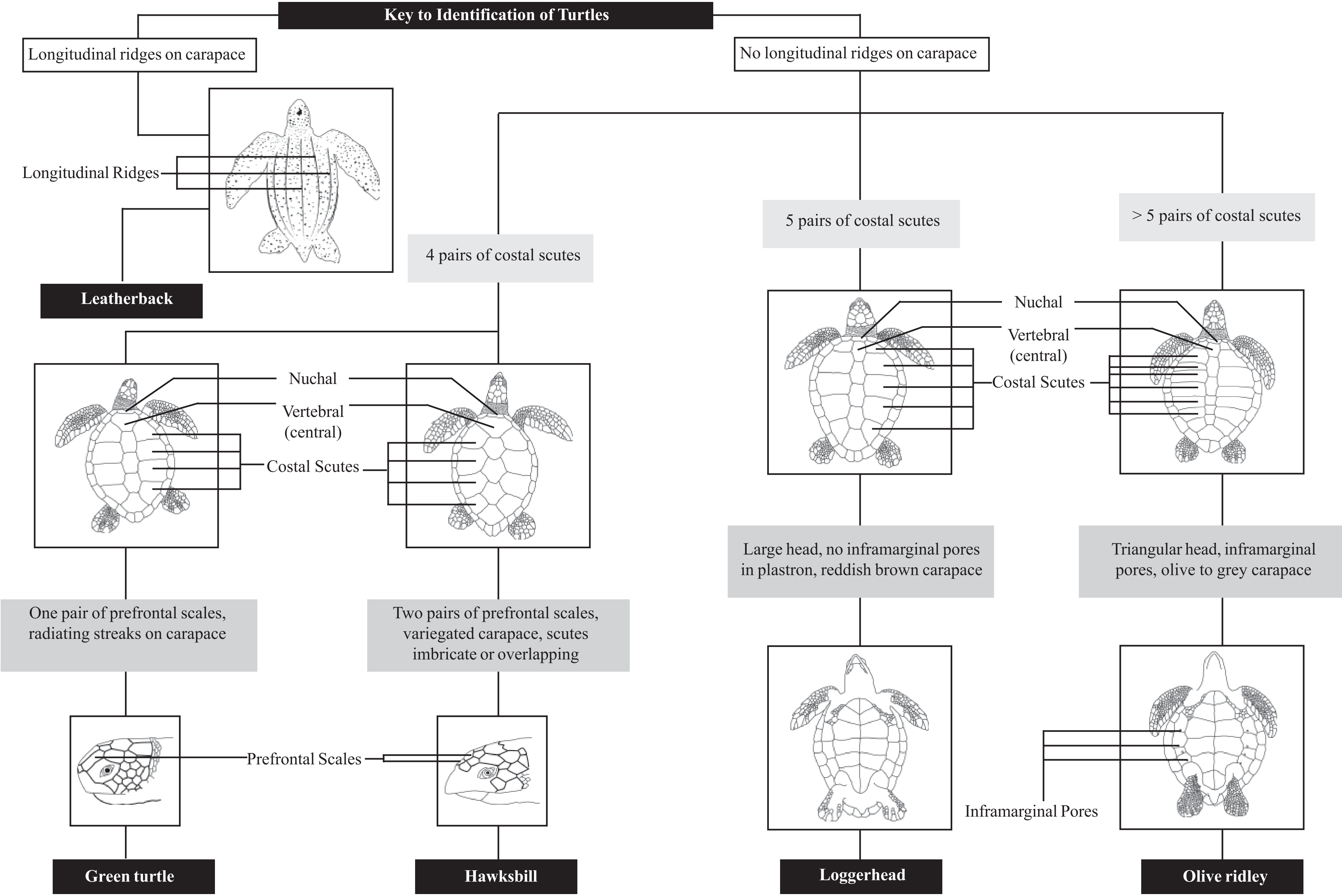
Identification of turtles

If a turtle or a carapace is seen, it can be identified from the features specified in the identification keye. Since there are only 5 species in Indian waters, identification is fairly straightforward when the turtle or carapace can be examined. Carapace lengths, number of costal scutes (see figure) and number of prefrontal scales are critical to the identification of the species. The shape of the central or vertebral scutes also provides clues to the identification. In loggerheads and ridleys, these scutes are narrow, and hence the first costal (lateral) scute comes into contact with the nuchal scute. In green and hawksbill turtles, the vertebrals are rhomboid, and the first costal does not touch the nuchal scute.

In case of doubt, a clear photograph of the carapace will also aid in identification.

In addition, there are flatback and Kemps ridley turtles, but these are highly unlikely to be found in Indian coastal waters. The distribution of nesting grounds and feeding grounds of sea turtle species can be a good aid to identification as well.

Hatchlings can be identified using the same characteristics as adults (number of costal scutes, etc) but one needs to be careful since coloration can vary considerably.



Key to Identification of Turtles
Longitudinal ridges on carapace
Longitudinal Ridges
Leatherback
No longitudinal ridges on carapace
4 pairs of costal scutes
Nuchal
Vertebral (central)
Costal Scutes
One pair of prefrontal scales, radiating streaks on carapace
Two pairs of prefrontal scales, variegated carapace, scutes imbricate or overlapping
Prefrontal Scales
Green turtle
Hawksbill
5 pairs of costal scutes
> 5 pairs of costal scutes
Nuchal
Vertebral (central)
Costal Scutes
Large head, no inframarginal pores in plastron, reddish brown carapace
Triangular head, inframarginal pores, olive to grey carapace
Inframarginal Pores
Loggerhead
Olive ridley

Leatherback

Scientific name	*Dermochelys coriacea*
Nest on	Tropical beaches worldwide
Occur in	All oceans, sub-arctic to tropical waters
Weight	500 kg
Carapace	
Length	140 - 170 cm
Shape	Elongate with seven prominent dorsal ridges; scutes always absent
Coloration	Mostly black with white spotting; pink or bluish spots on base of neck and flippers
Head	
Shape	Triangular; two maxillary cusps
Limbs	Forelimbs extremely long
Plastron	Relatively small and distensible
Period of nesting	Night
Clutch/Season	4 - 6
Re-nesting interval	9 - 10 days
Re-migration interval	2 - 3 years
Clutch size	80 - 100 eggs

Pic courtesy: Kartik Shanker

Green Turtle

Scientific name	*Chelonia mydas*
Nest on	Tropical beaches worldwide, mainland and remote islands
Occur in	Tropical and subtropical waters
Weight	250 kg
Carapace	
Length	90 - 120 cm
Shape	Broadly oval; margin scalloped but not serrated
Costal scutes	4 pairs
Coloration	Brown with radiating streaks in juveniles. Variable in adults
Head	
Shape	Anteriorly rounded
Prefrontal scales	1 pair
Limbs	Single claw on each flipper
Plastron	White in hatchlings, yellowish in adults
Other features	Vertebrals (centrals) large, so that first costal does not contact nuchal scute
Period of nesting	Night
Clutch/Season	4-6
Renesting interval	10 - 14 days
Remigration interval	3 - 5 years
Clutch size	100 - 120 eggs

Pic courtesy: Basudev Tripathy

Hawksbill

Scientific name	*Eretmochelys imbricata*
Nest on	Tropical beaches worldwide, mainly remote islands
Occur in	Tropical waters
Weight	150 kg
Carapace	
Length	80 - 100 cm
Shape	Oval, strongly serrated posterior margin, thick overlapping (imbricate) scutes
Costal scutes	4 pairs (ragged posterior border)
Coloration	Brown, boldly marked with amber and brown variegations
Head	
Shape	Narrow, straight bird like beak
Prefrontal scales	2 pairs
Limbs	Two claws on each flipper
Plastron	Light yellow to white
Period of nesting	Night/Day
Clutch/Season	3-5
Renesting interval	12 - 14 days
Remigration interval	2 - 5 years
Clutch size	120 - 150 eggs (upto 180 eggs)

Pic courtesy: Kartik Shanker

Loggerhead

Scientific name	*Caretta caretta*
Nest on	Temperate and subtropical beaches
Occur in	Temperate, sometimes subtropical and tropical waters
Weight	200 kg
Carapace	
Length	80 - 100 cm
Shape	Moderately broad, lightly serrated posterior margin in immatures, thickened area of carapace at base of 5th vertebral in adults
Costal scutes	5 pairs
Coloration	Generally unmarked reddish brown in subadults and adults
Head	
Shape	Large and broadly triangular
Prefrontal scales	2 pairs
Limbs	Two claws on each flipper
Plastron	Yellow to orange
Other features	Vertebrals (centrals) narrow, so that first costal contacts nuchal scute
Period of nesting	Night
Clutch/Season	3 - 5
Renesting interval	12 - 16 days
Remigration interval	2 - 3 years
Clutch size	100 - 120 eggs

Pic courtesy: Matthew Godfrey

Olive Ridley

Scientific name	*Lepidochelys olivacea*
Nest on	Tropical beaches worldwide
Occur in	Tropical waters
Weight	50 kg
Carapace	
Length	60 - 70 cm
Shape	Short and wide, carapace smooth but elevated, tectiform (tent shaped)
Costal scutes	5 – 9 pairs asymmetrical
Coloration	Mid to dark olive green
Head	
Shape	Large, triangular
Prefrontal scales	2 pairs
Limbs	Two claws on each flipper
Plastron	Pore near rear margin of infra marginals; Creamy yellow
Period of nesting	Night
Clutch/Season	1 - 3
Renisting interval	20 - 28 days
Remigration interval	1 - 2 years
Clutch size	100 - 120 eggs

Pic courtesy: Bivash Pandav

Other sea turtles of the world

Australian Flatback

Scientific name	*Natator depressa*
Distribution	Australia
Weight	200 kg
Period of nesting	Night/Day
Clutch/Season	2 - 4
Renisting interval	13 - 18 days
Remigration interval	~ 3 years
Clutch size	50 - 60 eggs

Kemps Ridley

Scientific name	*Lepidochelys kempii*
Distribution	Mexico
Weight	50 kg
Period of nesting	Day
Clutch/Season	1 - 3
Renisting interval	17 - 30 days
Remigration interval	1 -2 years
Clutch size	100 - 120 eggs

* - all values given above are approximate ranges and may vary substantially between individuals and populations

Identification of tracks and nests

Even though sea turtles can be identified by their tracks, this can be difficult even for experts (particularly with loggerheads, hawksbills and ridleys). Tracks can vary between populations and even between individual animals, and hence it is essential for field personnel to observe nesting turtles and note the characteristics of their tracks. Important features of a track are its width, body pit, and symmetry.

While some species (loggerheads, hawksbills and ridleys) make shallow body pits, green turtles and leatherbacks make large deep body pits. A symmetrical track is formed when the front flippers of the turtle move synchronously to pull the turtle forward, while an asymmetrical track is formed when the front flippers move alternately. Sometimes other animals (crocodiles, monitor lizards) leave tracks on the beach as well, but these can be easily distinguished.

If the hatching season has started, one must also be alert for hatchling tracks, which are, of course, small, but usually numerous as the hatchlings would have emerged and crawled to the sea simultaneously. One can follow hatchling tracks to a nest, which can be uncovered to examine nest contents and estimate hatching success.

Leatherback tracks

Olive ridley tracks

Pics courtesy: Kartik Shanker

A symmetrical track is formed when the front flippers of the turtle move synchronously to pull the turtle forward (left), while an asymmetrical track is formed when the front flippers move alternately (right).

Leatherback
Track: 150 – 200 cm wide, deep and broad, with symmetrical diagonal marks made by forelimbs, usually with a deep median groove from the long tail.

Beach type: wide beaches with steep slope, rock free deep water approach. In India, sites in the Andaman and Nicobar islands mainly. Main nesting sites are Galathea on the east coast and several beaches on the west coast of Great Nicobar.

Eggs: about 5 cm in diameter

Green
Track: 100 – 130 cm wide, deep, with symmetrical diagonal marks made by forelimbs, tail drag solid or broken line.

Beach type: large, open beaches to small cove beaches. Mainly Gujarat on the mainland. Lakshadweep islands and beaches in Andaman islands.

Eggs: about 4.5 cm in diameter

Hawksbill
Track: 70 - 85 cm wide, shallow, with asymmetrical (alternating) oblique marks made by forelimbs, tail marks present or absent. Often hard to distinguish from tracks of ridleys, but the two species nest in very different beach types.

Beach type: narrow beaches on islands or mainland shores, with reefs obstructing offshore approach, Lakshadweep islands, Andaman islands, and few beaches in Nicobar such as Indira Point at the southern tip of Great Nicobar (here turtles often have to crawl over reefs and rocks to reach the nesting beach). Hawksbills also often nest under overhanging vegetation (unlike ridleys which nest in open areas).

Eggs: about 3.5 cm in diameter

Loggerhead
Track: 70 – 90 cm wide, moderately deep, with asymmetrical diagonal marks made by forelimbs, tail drag mark usually absent.

Beach type: extensive mainland beaches or barrier islands. Not known to nest in India, but does nest in Sri Lanka.

Eggs: about 4 cm in diameter

Olive ridley
Track: 70 –80 cm wide, light, with asymmetrical, oblique marks made by forelimbs, tail drag mark lacking or inconspicuous.

Beach type: tropical mainland shores and barrier islands, often near river mouths. Throughout mainland; also Andaman and Nicobar and to a lesser extent, Lakshadweep islands.

Eggs: about 4 cm in diameter

In the Andaman and Nicobar islands, olive ridley and leatherback turtles often share nesting beaches, while hawksbill and green turtles share beaches.

Pic courtesy: Bivash Pandav

Field Equipment

Basic necessities

Data sheet or field notebook
Pen / Pencil
2 m tape
Watch or stopwatch
Bags for transport of eggs

Depending on the objective of the conservation or research programme, one may need:

Vernier Calipers (to measure eggs or hatchlings)
Weighing scales *
Tags and applicators
Scissors, forceps, and vials (with ethanol) for collecting and storing tissues
Permanent marker pens for vials and nest markers

- - calipers are cheap and can be purchased easily. Good weighing scales (or spring balances) are more expensive and purchase of these will depend on the availability of funds. Pesola spring balances are available from the Forestry Supplies Inc. and cost about Rs. 2000.00 each.

Nest data sheet

Turtle Species________________________Tag number (if any)________________

Date and time laid ____

Nesting site

Nest location along beach ____

Distance from HTL_____________ Distance from HTL, Dunes_____________

Nest depth top ________________ Nest depth bottom __________________

Clutch size

Egg diametre(cm) : (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

Egg weight(gm) : (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

Nest Contents / Excavation Data

E = Emerged =
S = Hatched out shells =
LIN = Live in Nest =
DIN = Dead in Nest =
LPE = Dead hatchling in pipped shell =
DPE = Dead hatchling in pipped shell =
Unhatched eggs:
UD = Undeveloped eggs with no obvious embryo =
UH = Unhatched eggs with obvious embryo =
UHT = Unhatched full term embryo =
P = Predated =

Hatchling SCL: (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

Hatchling Wt : (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

Nesting Beach Ground Survey (Extensive)

Date of Survey ________________________ Time start ______ Time End _______

Beach Name____________________________ **Beach Zone** ___________________

Observer ____

Length of beach zone (distance covered in survey): ____________________________

Number of Villages: ____

Lighting disturbance: ________________________________
Intensity ________________ Source ___________________

Assessment of threats:
Meat consumption ____________________
Poaching of eggs ___________________
Feral animals ___________________

Average width of nesting beach: ________________________

Beach is backed by (eg. Dunes, trees, habitation): _____________________________

Species: _______________________________

Estimates of nesting density (for each species): ___________________

Comments:

Nesting Beach Ground Survey (Intensive)

Daily Report

(Use a different form for each species)

Date of Survey _____________________ Time start ______ Time End _______

Beach Name/zone____

Observer ____

Weather:

Species:

S.No.	Nesting crawl (fresh/old)	Distance from High Tide line	Habitat (vegetation/sand/village)	Distance to village

Total Number of fresh nesting crawls:
Total Number of old nesting crawls:
Total Number of non nesting crawls:
Number of dead turtles:
Number of predated nests (by whom?):

Comments:

Mortality Survey Form

Date of Survey _____________________ Time start ______ Time End _______

Beach Name/zone____

Observer ____

Distance sampled:

S. No.	Sex	CCL	State of carcass	Injury/Remarks/Tags

Total number of dead turtles: **Males:**
Females:

Turtle encounter and nesting turtle data sheet

Name of observer ________________________
Institution ____________________

BEACH CHARACTERISTICS
Length________kms Width_________ m
Beach backed by a) vegetation, type_____b) road__c) village/town__ d) other____
Distance a) human ___ b) sand mining ___ c) lightning___ d) industry __ e)other___
Offshore (rocky, sandy, etc)

TURTLE
Time of encounter __________ Activity_________ Zone ___________
Primary tag number _____ Flipper______ Secondary tag number ______Flipper _____
Tag type ________________ Address _______________

Curved carapace length ________ Curved carapace width _______

EGG AND NEST DATA
# of eggs laid _________
egg data ______ a)diameter _____ b)weight ______

Position of clutch

In danger of	Fate of clutch
Inundation	relocated
Vegetation	predated
Rocks	poached
Trunks	insitu
Erosion	don’t know
Good position	

Nest dimensions
Depth of top egg ________ Depth of bottom ________

GENETIC SAMPLE COLLECTION

Blood _________ Tissue ________

GENERAL OBSERVATIONS

Sea turtle conservation programmes in India

Gujarat Forest Department
Contact: Director, Marine National Park, Jamnagar Marine (Gulf of Kachchh) WLS Pradarshan Ground, Jamnagar 361001. Gujarat.

Sahyadri Nisarga Mitra
Contact: Vishwas B.Katdare, Near Laxminarayan Temple, Chiplun, Dist. Ratangiri 415 605, Maharashtra. *Email: sahyadricpn@rediffmail.com*

Forest Department, Goa.
Contact: Range Forest Officer, Wildlife Division, Sea Turtle Study Centre, Tuye, Pernem. Goa.

Centre for Environment Education, Goa
Contact: Sujeet Kumar M. Dongre, CEE Goa State Office, c/o. State Institute of Education, Alto Porvorim, Bardez, Goa 403 521. *Email: ceegoa@ceeindia.org*

Theeram Prakruthi Samrakshana Samiti
Contact: Surendra Babu/Dinesh Babu, Iringal Beach, Kolaavipalam, Payyoli, Calicut, Kerala.

Students Sea Turtle Conservation Network, Madras
Contact: V. Arun, The School, Krishnamuthi Foundation of India, Besant Avenue, Chennai. *Phone: 044 24915845*

TREE (TRust for Environment Education)
Contact: Supraja Dharini, No. 63 First Avenue, Vettuvankeni, Chennai 600 041. *Email: treeindia2002@hotmail.com*

Forest Department, Andaman and Nicobar Islands
Contact: C/o Office of the Chief Wildlife Warden, Government of Andaman and Nicobar Islands, Post Office Haddo, Port Blair 744102, Andaman & Nicobar Islands

Green Mercy, Vishakapatnam
Contact: K.V. Ramana Murty, 8-77/1, Srinivasa NagarSimhachalam (Via), Vishakapatnam 530028. AP. *Email: green_mercy@yahoo.com*

Dolphin Nature Club, Vishakapatnam
Contact: Dolphin Nature Conservation Society, 54-12-26/2, Vidyanagar, HB Colony, Vishakapatnam 530022. AP.

Vishaka Society for Prevention of Cruelty to Animals (VSPCA)
Contact: Pradeep Kumar Nath, 26-15-200, Main Road, Vishakapatnam 530001, Andhra Pradesh

Sea turtle monitoring and research programmes

Orissa Forest Department
Contact: C.S. Kar, O/o PCCF & CWLW, Forest Department, Government of Orissa, Shahid Nagar, Bhubaneshwar. Orissa.

Gujarat Institute of Desert Ecology (Gujarat)
Contact: Dr. Wesley Sundarraj, Patwadi Naka, Bhuj, Kachchh 371001. Gujarat.*Email: jaws_wesley@hotmail.com*

Bombay Natural History Society (Maharashtra and Goa)
Contact: Varad Giri, Hornbill House, Shahid Bhagat Singh Marg, Mumbai 400023. Maharashtra. *Email:* *bnhs@bom4.vsnl.net.in*

Salim Ali Centre for Ornithology and Natural History (Tamil Nadu)
Contact: Dr. S. Bhupathy (*sb62in@yahoo.co.uk*), Anaikatty P.O., Coimbatore, 641108. Tamil Nadu. *Email: sacon@md3.vsnl.net.in*

Andaman and Nicobar Environmental Team
Madras Crocodile Bank Trust (Andaman and Nicobar Islands)
Contact: Harry Andrews / Kartik Shanker, Postbag 4, Mamallapuram 603104. Tamil Nadu. *Email: mcbtindia@vsnl.net*

Wildlife Institute of India (Orissa, Lakshadweep)
Contact: BC Choudhury (*bcc@wii.gov.in*), Bivash Pandav (*pandavb@wii.gov.in*), Post Box 18, Chandrabani, Dehradun 248001.

Some useful websites

http://www.seaturtle.org
http://www.kachhapa.org
http://www.euroturtle.org
http://www.turtles.org

Selected Bibliography and Further Reading:

Research and Management Techniques for the Conservation of Sea Turtles 1999.(Eds. K.L. Eckert, K.A. Bjorndal, F.A. Alberto Abreu-Grobois, M. Donnelly). IUCN/SSC Marine Turtle Specialist Group Special Publication No. 4

Sea turtles of the Indian subcontinent – in press (Eds. Kartik Shanker and BC Choudhury). Universities Press

Biology and Conservation of sea turtles 1995. (Ed K.A. Bjorndal). Smithsonian Institution Press. USA.

Biology of sea turtles 1997 (Eds. P.L. Lutz, J.A. Musick). CRC Press, USA.
Biology of sea turtles Vol. II 2002.(Eds P.L. Lutz, J.A. Musick, and J. Wyneken). CRC Press, USA

Sea Turtle Conservation: Research and Management Techniques. 2003. A GOI UNDP Project Manual. Madras Crocodile Bank Trust, Tamil Nadu. India.

Sea Turtle Conservation: Population Monitoring and Census. 2003. A GOI UNDP Project Manual. Madras Crocodile Bank Trust, Tamil Nadu. India.

Sea Turtle Conservation: Eco (turtle) friendly coastal development. 2003. A GOI UNDP Project Manual. Madras Crocodile Bank Trust, Tamil Nadu. India.

Many sea turtle populations are declining with each passing day. There is an urgent need to initiate conservation measures to safeguard these populations and their habitats. However, conservation planning and action are seriously hampered by lack of information on sea turtles and on field methods and research techniques.

This is the first in a series of four manuals, which have been designed to help forest officers, conservationists, NGOs and wildlife enthusiasts design and carry out sea turtle conservation and research programmes. The other manuals in the series are:
- Research and Management Techniques
- Population Census and Monitoring
- Eco (turtle) friendly coastal development

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