SEA TURTLE CONSERVATION

RESEARCH AND MANAGEMENT TECHNIQUES

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Available from:
Wildlife Institute of India, PO Box 18, Chandrabani, Dehradun 248001, India.
Phone: 0135 2640111 to 115 Fax: 0135 2640117
Email: undpturtle@wii.gov.in

Produced by:
Centre for Herpetology / Madras Crocodile Bank Trust,
Post Bag 4, Mamallapuram 603104. Tamil Nadu. India.

Design & Execution:

ECOTONE
#3, South Boag Road, T. Nagar, Chennai - 600 017
Phone: 044 2431 5934
Saravanakumar (sarak@vsnl.com)

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A GOI – UNDP PROJECT MANUAL

Centre for Herpetology / Madras Crocodile Bank Trust, Tamil Nadu

Series Editor:
Kartik Shanker
Centre for Herpetology, Madras Crocodile Bank Trust, Tamil Nadu.

Authors:
Harry V. Andrews (mcbtindia@vsnl.net)
Centre for Herpetology, Madras Crocodile Bank Trust, Tamil Nadu.

Bivash Pandav (pandavb@wii.gov.in)
Wildlife Institute of India, Dehradun.

Kartik Shanker (kartikshanker@vsnl.net)
Centre for Herpetology, Madras Crocodile Bank Trust, Tamil Nadu.

Technical Advisors:
Brendan Godley
School of Biological Sciences, University of Exeter,Exeter, UK.

Matthew H. Godfrey
Wildlife Resources Commission, North Carolina, USA.

Jeanne A. Mortimer
Department of Zoology, University of Florida, Gainesville, USA.

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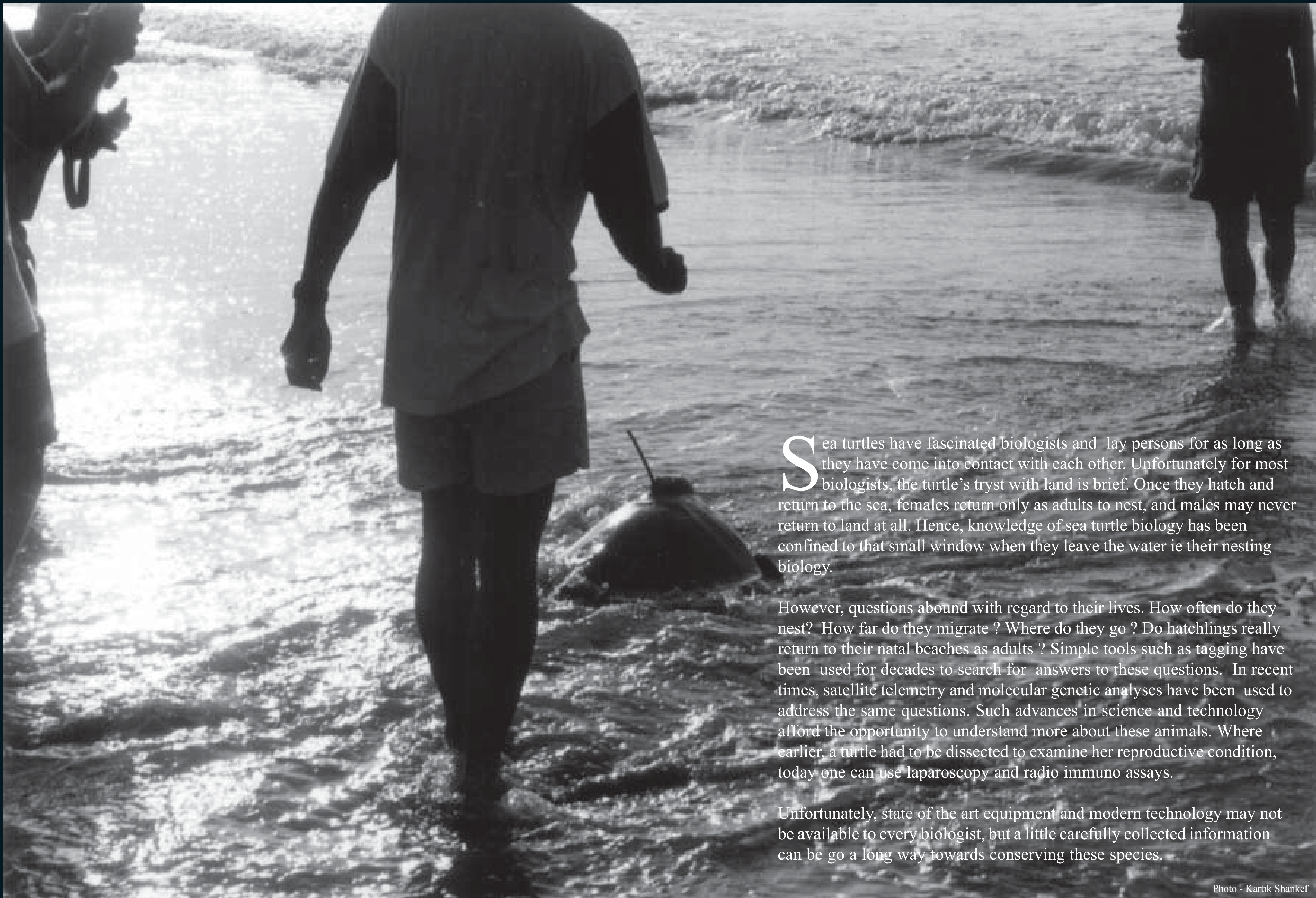
Contents



Sea turtles have fascinated biologists and lay persons for as long as they have come into contact with each other. Unfortunately for most biologists, the turtle's tryst with land is brief. Once they hatch and return to the sea, females return only as adults to nest, and males may never return to land at all. Hence, knowledge of sea turtle biology has been confined to that small window when they leave the water ie their nesting biology.

However, questions abound with regard to their lives. How often do they nest? How far do they migrate ? Where do they go ? Do hatchlings really return to their natal beaches as adults ? Simple tools such as tagging have been used for decades to search for answers to these questions. In recent times, satellite telemetry and molecular genetic analyses have been used to address the same questions. Such advances in science and technology afford the opportunity to understand more about these animals. Where earlier, a turtle had to be dissected to examine her reproductive condition, today one can use laparoscopy and radio immuno assays.

Unfortunately, state of the art equipment and modern technology may not be available to every biologist, but a little carefully collected information can be go a long way towards conserving these species.

Photo - Kartik Shanker

The need for research on sea turtles

Sea turtles are clearly in need of conservation today. However, without data that provides knowledge of their biology, it is very hard to frame appropriate management strategies. Intensive research often needs extensive infrastructure and funding which may or may not be available to all field biologists. Fortunately, even the simplest of monitoring programs can collect basic data on various aspects of their biology, which could be crucial to their conservation.

Lack of knowledge about their biology has been a particular impediment to the conservation of sea turtles. For many years, conservationists incubated sea turtle eggs in styrofoam boxes to increase hatching success. But because the boxes were usually cooler than the nesting beach, and the sex of the hatchlings is determined by incubation temperature, these activities had been producing and releasing only males. Other sea turtle conservation programs involved 'headstarting' or maintaining hatchlings in captivity for months or years and releasing them when they were larger, so that their early mortality would be reduced. Unfortunately, this failed to take into account the imprinting of the turtles on their natal beach which might affect their ability to remigrate to these beaches as adults. There is little evidence that headstarting, though labour and cost intensive, has had any significant effect on the conservation of sea turtles. Hence, the knowledge of an animal's biology is crucial to conserving it. Here, we provide details on techniques such as tagging, measuring and tissue sampling, and brief descriptions of other aspects of sea turtle research. The manual also provides the basic tools to identify sea turtle species, their tracks and collect basic information about their biology.

Photo -Bivash Pandav

Designing a research programme

A good research project comprises both planning and execution. First, the research question has to be framed in the context of existing knowledge, research and areas of interest. Second, the data required to answer the question must be identified. Finally, the data has to be collected, standardised and analysed carefully. An estimate of error is particularly important, as this helps us determine how precise our conclusions are.

Literature survey
Both the historical perspective of a research topic as well as the current status of knowledge on the subject are particularly relevant to any research question. When placed in context, it becomes clear as to whether the research topic aims to fill lacunae in current information or address gaps in theory. Will this provide information that is completely new for the species ? Or will it merely inform about a particular population ? Does the answer to the research question have any relevance to the conservation of the species ?

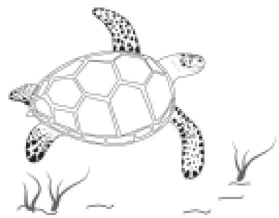
Research Questions and hypotheses
Once the general idea has been placed in the context of existing literature, a specific research question or set of questions has to be framed. This is followed by rephrasing the question as a statistical hypothesis or statement that can be tested using data.

Sample size
Once a question is framed in a statistical context, it is important to have sufficient data to accept or reject the hypothesis with some measure of (statistical) confidence. The sample size required to achieve this will vary, but one must take this into consideration when planning the experiment and data collection.

Feasibility
Many research questions are of great interest to biologists, but some are not feasible for a variety of reasons. Feasibility is often a function of funds, and may influence sample size. For eg., the number of islands visited, frequency of visits, or number of satellite transmitters deployed, is a function of manpower, time and money. Hence, the research design should seek to answer questions given available resources. Variables that address the question must be identified, and data collected on these particular variables. It is also important to assess the error in the measurement of these variables.

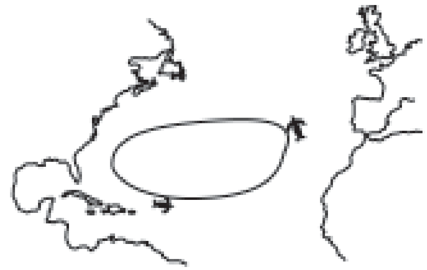
Review
Finally, a research proposal should be reviewed by peers and colleagues, in this instance, other sea turtle biologists who have some expertise in the area of research.

Life history of sea turtles



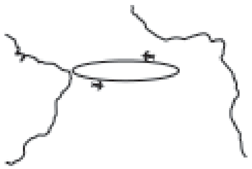
Adult feeding grounds

Shallow water developmental habitat for juveniles



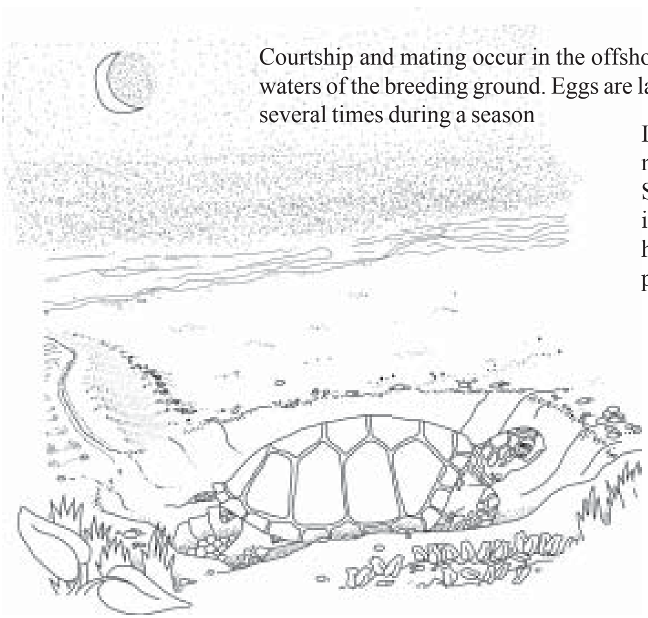
Hatchlings spend many years drifting on gyres and currents across the ocean

Hatchlings drift and feed in seaweed rafts and fish aggregating devices



Breeding migrations can range from hundreds to thousands of kilometers. for eg. green turtles that feed in Brazil nest on Ascension island, 2000km away

Once in the water, hatchlings orient to wave direction. They swim continuously in a 'juvenile frenzy' for the first few days, which enables them to reach the open sea. They also imprint to geomagnetic cues



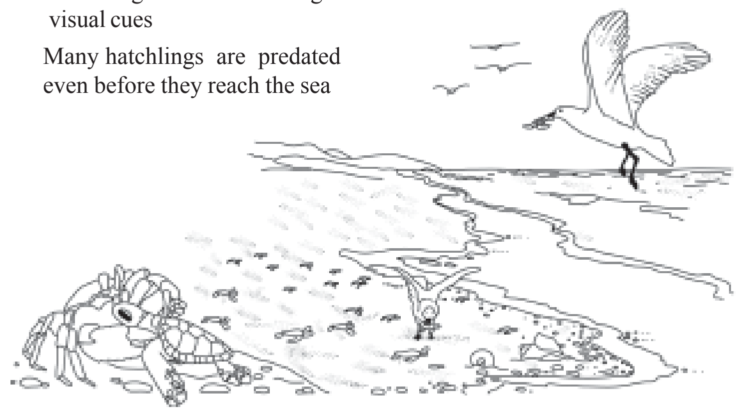
Courtship and mating occur in the offshore waters of the breeding ground. Eggs are laid several times during a season

Incubation is regulated by metabolic heat and sun. Sex is determined by incubation temperature; higher temperatures produce females

Hatchling emerge after 50- 70 days of incubation

Hatchlings find the sea using visual cues

Many hatchlings are predated even before they reach the sea



Illustrations adapted from "Sea turtle colouring book", by Francine Jacobs. *Original illustrations by* Mary Beath. 1981. Centre for Environmental Education, Washington DC, USA.

Photo - Kartik Shanker

Studying Nesting Turtles

For most land lubbers, their contact with these amazing reptiles is brief. Once the hatchlings leave their natal beaches, they return to land only to nest as adults. Males may never return at all, except in some instances where they have been known to bask. Consequently, most research has been confined to that brief window in their life cycle when they do come ashore. However brief the encounter has been, the questions that these turtles have thrown up are endless. How often does a turtle nest within a season ? Do they nest each year ? How far do they migrate within and between nesting seasons, and where do they go ?

Nesting Biology

Males and females begin the reproductive cycle by migrating from their feeding grounds to the breeding ground. Feeding and breeding grounds may be separated by several thousand kilometers. Courtship and mating occur 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, 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.

Green Turtle *(Chelonia mydas)*

Period of Nesting:	Night
Clutch /Season	4 - 6
Re - nesting interval	10 - 14 days
Remigration interval	3 -5 years
Clutch size	100 - 120 eggs

Leather Back *(Dermochelys coriacea)*

Period of Nesting:	Night
Clutch /Season	4 - 6
Re - nesting interval	9 - 10 days
Remigration interval	2 -3 years
Clutch size	80 - 100 eggs

Hawksbill *(Eretmochelys imbricata)*

Period of Nesting:	Night/ Day
Clutch /Season	3 - 5
Re - nesting interval	12 - 14 days
Remigration interval	2 -5 years
Clutch size	120 - 150 eggs

Loggerhead *(Caretta caretta)*

Period of Nesting:	Night
Clutch /Season	3 - 5
Re - nesting interval	12 - 16 days
Remigration interval	2 -3 years
Clutch size	100 - 120 eggs

Olive ridley *(Lepidochelys olivacea)*

Period of Nesting:	Night
Clutch /Season	1 - 3
Re - nesting interval	20 - 28 days
Remigration interval	1 - 2 years
Clutch size	100 - 120 eggs

Photo -Bivash Pandav

ridleys thump the nest with their body to compact the sand. 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.

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.

Tagging sea turtles

Historically, sea turtle tagging has proved to be a valuable source of information on various aspects of sea turtle biology including reproductive biology, growth, population sizes and migration. This involves marking animals with metal tags to recognise them when they return to the same beaches to nest, and hoping that others who encounter these animals in distant shores will return the tags or the information. Often, however, large numbers of tags have to be applied over many years before any useful results can be obtained. The study design also has to be suitable. If, for example, individual turtles nest at several adjacent beaches, tagging and monitoring at a single beach would probably not provide adequate data to estimate inter-nesting intervals,

clutches per season, and so on. Considering that tags are also expensive, one must consider very carefully whether the money and effort to be spent on tagging are worthwhile. Finally, given that tagging causes a certain amount of disturbance and discomfort to sea turtles, it should be clear that the information obtained from a tagging programme is, in the long run, likely to provide commensurate benefits – either to our general knowledge of turtle biology or (ideally) to the turtle population itself.

Tagging is particularly useful to study animals at the nesting beach. Identifying an animal uniquely enables us to estimate the number of clutches laid each season. If this is known, beach surveys that only include nest counts can be used to estimate the number of nesting females. Tagging also provides information on time intervals between nesting (inter-nesting interval) and distance between nesting sites (site fidelity). Most turtles generally lay within the same area (0 to 10 kms) each time they nest. 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.

When tags are returned from other areas by field biologists or fishers, it helps in identifying migration routes and foraging grounds of turtles tagged in breeding areas and vice versa. However, long distance returns of tags are usually very low compared to the number of tags applied.

In India, the Wildlife Institute of India tagged about 1700 olive ridley mating pairs (both males and females) in the offshore waters of Orissa. The program also tagged more than 10,000 nesting females between 1997 and 1999 at Gahirmatha, Devi River mouth and Rushikulya. Both males and females were recaptured within a season and between seasons. Ridleys that were tagged at one site were later encountered nesting at other sites, the distance between nesting sites varying from 35 to 320 km for individual turtles. There have been only 24 long distance returns of tags from the 15,000 turtles tagged in Orissa. All of these have been from Sri Lanka and southern Tamil Nadu. Here, metal tagging has provided some evidence that the turtles that nest in Orissa do migrate to the coastal waters of Sri Lanka and southern Tamil Nadu.

Photo - Bivash Pandav

External tags

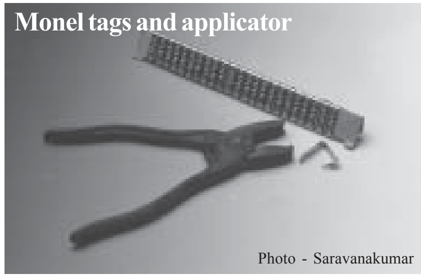

Monel tags and applicator

Photo - Saravanakumar

Most commonly, external flipper tags have been plastic or metal. A primary consideration is the longevity of the tag. Tag retention can depend on a variety of factors including the species of turtle, size class, geographical location, and where and how and by whom it is applied. Metal tags used on turtles are usually made of Titanium (Stockbrands Company, Australia) or metal alloys such as Monel or Inconel (National Band and Tag Company, Kentucky, USA; http://www.nationalband.com). Metal tags require a special applicator for attachment, which is sold along with the tags. Generally, Titanium and Inconel tags are much more durable than Monel, but are also more expensive. Monel tags have highly variable rates of corrosion, showing great wear within a few years in some situations, while lasting decades in others. Tags are of variable sizes, but for adult sea turtles (barring leatherbacks) National Band and Tag Co. 1005-681 is a useful tag size, and is available in both Monel and Inconel. Monel tags cost about US $200.00 per 1000 while inconel tags cost about US $800.00 per 1000.

In India, several tens of thousands of turtles have been tagged in Orissa using these Monel tags, and have been recovered in successive years in good condition. In some cases, tags have been retained for more than 20 years.

Applying the tag

The main difficulty with tagging is faulty application. The tag has to be placed correctly in the applicator, with the hole in the tag aligned with a groove in the applicator. When the applicator is squeezed, the tag pierces the flipper, and passes through the hole in the opposite end of the tag, where it bends over and locks (like a stapler pin). The initial force of squeezing the applicator only results in the tag piercing the flipper, and additional force has to be applied for locking, which is distinctive. All users should practice this first to ensure that tags are locked on application, and should also check each time they tag a turtle.


Tag in applicator

Photo - Saravanakumar

Ideally, sea turtles should be double tagged (once on each flipper) to minimize the

problem of tag loss. If a turtle is given a single tag, and that tag is lost, it will lose its identity. A double tagged turtle, however, can lose one of its tags, and still be recognized by the researcher. In fact, the researcher can replace the lost tag, thus further extending the length of time the turtle will be identifiable in future encounters. Double tagging also helps to measure the rate of tag loss, which is important for population studies.

Tag numbers and message

The size of the tag will dictate the length of the number and the message. The numbering must be unique to prevent confusion between tagging programs. It is up to the research program to find a unique combination of letters and numbers that are not being used elsewhere. Currently, a tagging database has been created where one can check which alphanumeric codes are already in use.

Photo - Saravanakumar

The message on the tag must be concise ('WRITE TO': or 'RETURN/SEND TO:') and the mailing address must be valid for at least a few years beyond the life of the project. Usually, tags are found by fishermen who come across them when they intentionally or accidentally catch the tagged turtles. Most fishermen will not return the tag unless they are aware of its significance. Sometimes they are not concerned, but very often they may believe that they will get into trouble, for catching a tagged animal, and hence dispose of the tag as quickly as possible.If they are inclined to return the tag, often they will pass it on to local conservation groups. Hence it is important to spread information about the tagging programme in areas where it is suspected that these turtles might nest or forage. A decision also needs to be made with regard to whether the return of the tag will be rewarded. Rather than monetary rewards, it is suggested that posters, t-shirts and other such gifts serve the dual purpose of rewarding the finder and spreading awareness. Also, some thought should be given to the longevity of the project. If the tagging program is short, and the tag offers a reward, there may arise a situation several years later when a person returning a found tag seeks a reward but the original project is no longer in operation.

Tag position on the turtle

External tags should be applied to the front flippers of sea turtles at a proximate location ie. along the trailing edge near the junction with the body. Tags can also be attached to the hind flippers, and in fact, it may be preferable to tag leatherbacks on the rear flipper.

If the tag is attached to the front flipper of the leatherback, the lock should end up on the dorsal side to prevent the tag from abrading the body of the turtle. Tagging can be slightly traumatic or painful for the animal, but a properly applied tag is probably no more painful than ear piercing in humans. During nesting animals should be tagged immediately after oviposition. Olive ridleys can usually be tagged during or after oviposition, but other species are best tagged after. Some turtles (like leatherbacks and hawksbills) may abandon the nest if tagged during laying, and though they will return later to complete nesting, it is best to avoid disturbing them. Studies have shown that there are no adverse effects of tagging on either renesting or survival (although there is a concern that contaminated tagging equipment may spread disease). Tagging can be preceded by the application of an antiseptic and topical anaesthetic.

Applying the tag

Photo - Kartik Shankar

In all cases, it is useful to check all four flippers for tags, in case you come across a turtle that has been tagged by a different program in a different location using a slightly different method.

Tagging Database

Since many programmes the world over tag sea turtles, there is some danger of using the same or similar tag codes. Furthermore, while most tags do carry a return address on them, information that reaches sea turtle field biologists (from perhaps local fishers) often includes only the tag number and not associated information on its origin, even if it was present on the tag. Hence, a tag inventory has been established at the Archie Carr Centre for Sea Turtle Research (ACCSTR), University of Florida, Gainesville to keep a record of all tags used in sea turtle tagging programmes. This database can be accessed at **http://accstr.ufl.edu/taginv.html.** Tagging programmes should register their tag numbers and codes in this database. Field biologists who encounter or recieve information on unidentified tags can search the database to locate the origin of the tag and provide the information to the tagging programme.

PIT Tags

Passive Internal Transponder (PIT) tags are small inert transponders sealed in glass which passively transmit a unique identification number to a handheld scanner or reader at close range (approx. 1ft). PIT tags are generally about 10 – 20 mm long and 2 – 3mm thick. These can be injected into the turtle in the shoulder or under the scales or between the digits of the front or hind flipper. The disadvantages of PIT tags are their greater cost, the cost of readers, problems associated with charging batteries in remote field stations, and the inability of personnel (either at the same or distant beaches, or at foraging grounds) to recognize tagged animals without the scanner/reader. PIT tags can also sometimes migrate, if implanted too deep inside the animal's body. Generally, PIT tags have been found to be the most reliable with the best tag return rate, especially for leatherbacks, which have a particularly high rate of external tag loss. If PIT tags are used, it is best to also apply external tags, as this will lessen the possibility of total tag loss, can provide valuable information about the rate of retention of both PIT and external tags, and will enable other researchers and fishermen who capture the turtle to provide information about subsequent encounters with the turtle.

PIT tag scanner

Photo - Saravanakumar

PIT tag applicator

Photo - Saravanakumar

PIT tags are available from Avid, California, USA (http://www.avidmicrochip.com), Destron-Fearing, Minnesota, USA and Trovan Ltd, Koln, Germany. PIT tags are currently made in two transmitting frequencies (125 Hz and 400 Hz), but the latter are slowly being phased out. Tags and scanners made by different companies are not always compatible. PIT tags cost about US $6.00 per tag and scanners cost up to US $1000.00

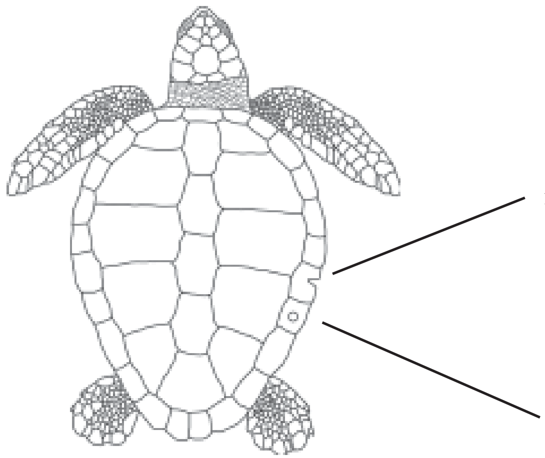
Location

There is a lot of variation in the tagging sites used by different researchers when they apply PIT tags, and so care must be taken when scanning a turtle for a possible PIT tag. Some attempts to standardize PIT tag sites have been made (e.g. for leatherbacks, injecting the PIT tag into the turtle's right shoulder muscle), although not everyone follows these standards.

Notching of scutes

The notching of a marginal scute or a combination of scutes has been attempted in an effort to identify year classes of hatchlings at rookeries. But, as the turtle grows older, these marks are often hard to distinguish from natural injuries. This, combined with the low rate of survivorship between the hatchling and adult stage, makes notching an unreliable marking technique. A better technique is to drill holes in the marginal scute. Such drill holes seem to be retained for many years and can be a useful way to mark juveniles and adults. These can be drilled in combinations to uniquely mark individual turtles, or simply to identify members as belonging to a group of marked turtles.

In the absence of tags, notching/drilling has been useful in some field programmes. Adult green sea turtles notched during late 1979 were identified during the 1998 nesting season in the Andaman Islands. Olive ridley and green turtles were notched each time they nested during the 1998-99 season in the Andaman and Nicobar islands. During the subsequent season, if any marked turtles were encountered, notching was carried out on a different marginal scute. While this did not provide information on individual turtles, some information on the number of nests per season, and inter-nesting intervals was obtained. However, such data is usually not robust and cannot provide precise data on population parameters.



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

Photo -Bivash Pandav

Examining Turtle Nests

Information on nests is important for conservation and research. 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 *in-situ*, it is useful to determine the clutch size for some proportion of nests. 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. If the balance is not accurate enough to weigh single eggs, groups of eggs can be weighed together and averaged.

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 should 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**

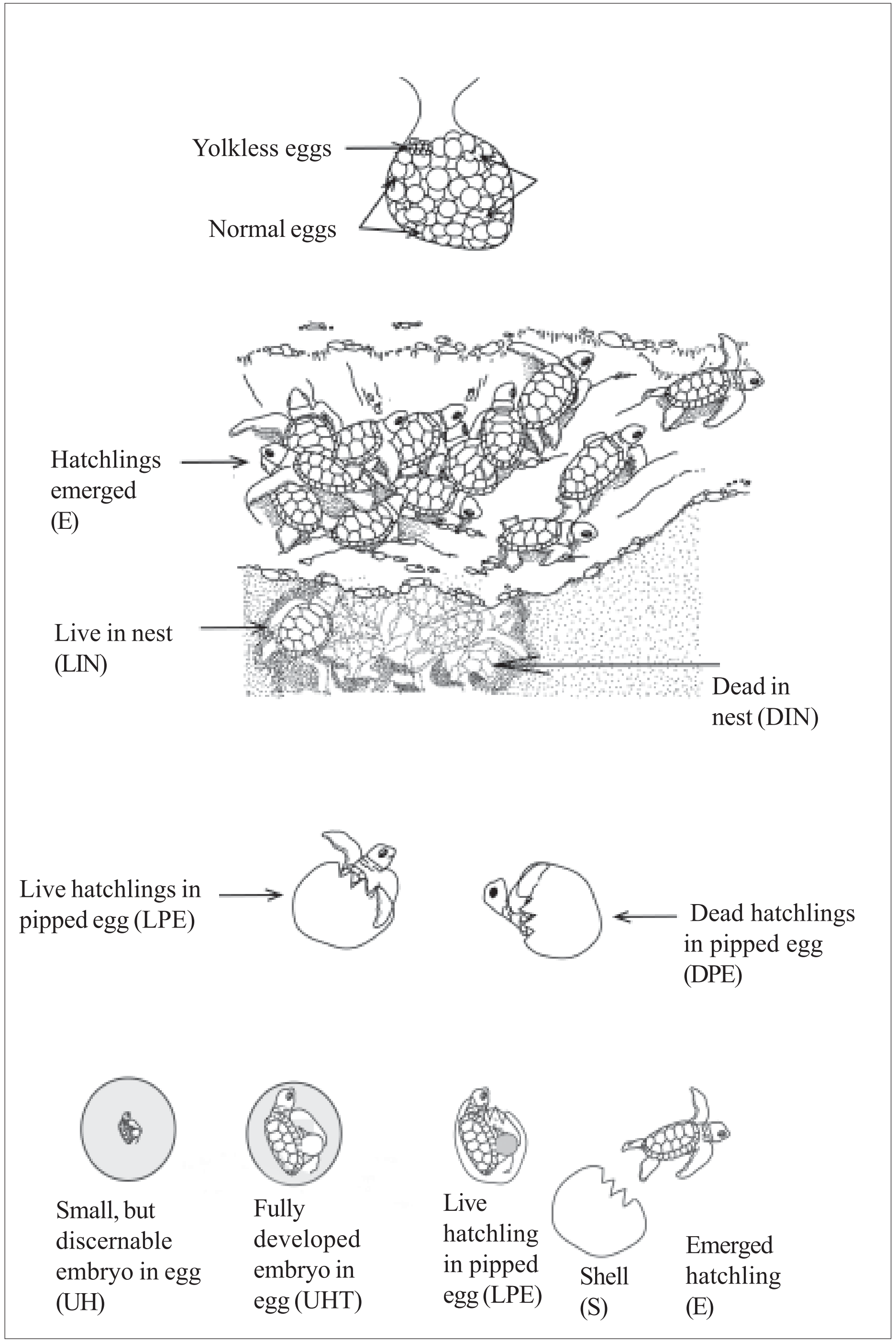
where
- **components without shells = number of hatched shells (S)**
= Emerged (E) + Live in Nest (LIN) + Dead in Nest (DIN)
- the other components have shells.
- predated eggs have a shell with egg residue or dead embryo

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.



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)

Photo - Kartik Shanker

Studying Hatchlings

Mortality is highest during the early phase of a turtle's life. It is important to understand the factors that affect egg and hatchling survival, especially on land, when they are most vulnerable to anthropogenic factors. Even under natural conditions, only one in a thousand hatchlings is believed to survive to adulthood.

The hatchlings develop in their nest over a period of 7 to 10 weeks. They hatch over a few days and then emerge from the nest together (to swamp predators) usually at night. Predators include crabs, birds, jackals, feral animals on land, and many fish once they are in the sea. Once in the sea, the hatchlings spend the first couple of days in a "juvenile frenzy" when they use stored energy reserves to get to the open sea. Beyond this, they spend many years in a variety of habitats until they join other adults at feeding areas.

Temperature dependent Sex Determination: Lower temperatures produce males, higher temperatures produce females. The pivotal temperature 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.

Orientation and Navigation: Hatchling emergence is nocturnal to avoid predators and sunlight. Sea finding is visual and the hatchlings seek a "brighter horizon", usually the moon or starlight reflecting off the surface of the sea. They also use silhouettes of sand dunes and trees to orient themselves towards the sea. As soon as they enter the sea, they find the open sea by 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 inclination angle in order to navigate.

The Lost Years: Hatchlings spend their lives in a variety of foraging habitats. Sargassum driftlines (seaweed rafts) and FADs (Fish Aggregating Devices) have been found to be particularly important. The hatchlings are usually carried on trans oceanic gyres and currents. Convergence fronts have also been found to be important foraging habitats for juveniles. 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.

Estimating hatchling sex ratios

Primary sex ratio: The sex ratio at birth in a population is an important and interesting demographic parameter. To determine this, the relationship between temperature and sex determination has to be established for a particular population. This can be done by experimentally maintaining nests at particular incubation temperature and sexing a proportion of the hatchlings. In India, the pivotal temperature is known only for the olive ridley population in Orissa (~29.2 °c).

Estimating the hatchling sex ratio of the population needs to take three factors into consideration. Spatial variation in nesting results in nests being laid in beaches or zones with different temperature profiles, which will result in different sex ratios. Temporal variation in nesting results in nests at different times of the year being subjected to different temperatures. Finally, frequency of nesting in different places at different times needs to be taken into consideration. The population under consideration itself may need to be defined, and genetic data may be required to achieve this. Sand temperatures cannot be directly converted into sex ratios since pivotal temperatures are usually derived from lab studies at constant temperatures, unlike field conditions. Moreover, the effect of metabolic heating needs to be taken into consideration. Also, interclutch variations in pivotal temperature may complicate the estimation of sex ratio.

Incubation times and sex ratio: If temperature data are not available and hatchlings cannot be sexed, incubation times can be used as a surrogate to estimate hatchling sex ratios for populations. Though this cannot be applied to individual nests, it is a useful technique for particular beaches or populations. Here the relationship between temperature and incubation (higher temperatures lead to shorter incubation times) is defined from known data. Hence, accurate data on incubation times yields rough values of temperature of incubation. The sex ratio can then be derived from the temperature profile for the beach for a particular season.

Sexing hatchlings

All the procedures available for sexing hatchlings involve dissection of the animals and examination of the gonads. Though experiments involving radioimmunoassays have been carried out, there are no conclusive results that support non invasive methods of sexing hatchlings. This can be translated to sex ratio if the pivotal temperature is known.

Photo -Bivash Pandav

Tracing Migratory Routes

Sea turtles often migrate thousands of kilometers across international waters. Current knowledge of sea turtle life history suggests that individual turtles occupy a series of different habitats during the course of their life cycles. Various modern techniques are now being used to track sea turtles to study their long range migrations

Tagging provides information about migration only as far as the sites of tagging and tag recovery, hence allowing inferences about the beginning and perhaps, the end points of the migration. For details of the migratory route, and behaviour during migration, one has to turn to a more advanced technique, namely telemetry. Radio telemetry is a widely used technique in wildlife studies, and has been used with limited results to study turtles within the breeding area. This involves placing a transmitter on the turtle and tracking it with a receiver. However, once a sea turtle begins its (often) long journey to its foraging area, it is impossible to track and follow these turtles. Satellite telemetry solves this problem as the transmitter signal is received by a satellite, and the animals can be tracked wherever they go. This data can be used to trace the precise migratory route of the turtle, and collect associated information such as swim speed and travel rate. Transmitters can be fitted with equipment to provide information on water temperature and activity of the turtle.

Satellite Telemetry

Transmitters, also called PTTs (Platform transmitter terminals) are attached to the animal whose long distance movements are to be studied. Once they are turned on, the transmitters send high frequency signals which are received by polar orbiting weather satellites. ARGOS, a French company, has equipment on board these satellites for tracking animal movements. The transmissions are first decoded to identify the transmitter, each of which has a unique code and then the position of the transmitter is calculated. The data are then downloaded by ARGOS. Once the data are received, the latitudes and longitudes can be plotted on a map and the migratory routes of the animals can be traced. The data are classified by ARGOS depending on the quality of the data received by the satellite. LC 1, 2 and 3 are the best quality points and have an error radius of approximately1000m, 350m, and 150m respectively.

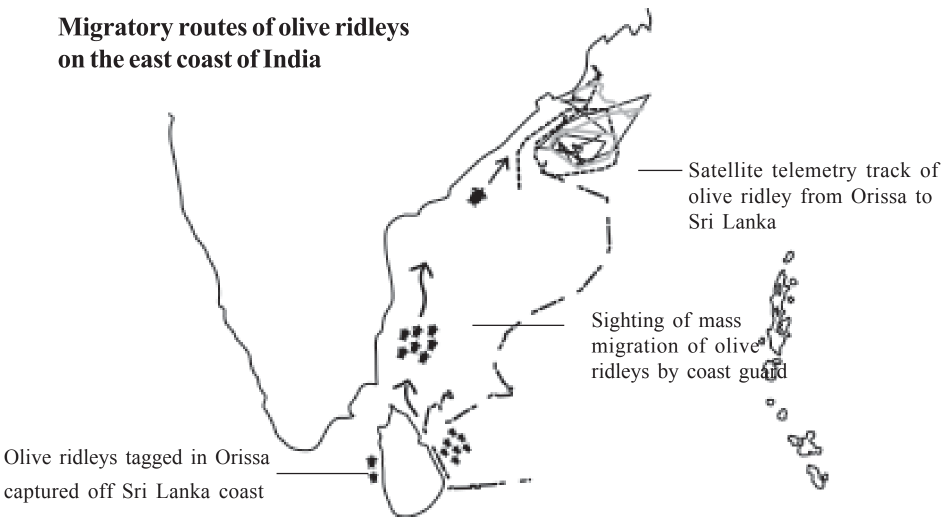
For marine turtles, the transmitters also have a salt water switch which is turned on when the turtle is under water. The PTT sends transmissions only when the salt water switch is turned off ie. when the turtle surfaces. Transmitter specifications that need to be selected include repetition rates and duty cycles, which determine how often the transmitter will come on and how long it will stay on. This is to gain the maximum useful information out of the transmitter given the lifespan of the battery.

In hardshelled turtles, the transmitters are attached to the carapace of the turtles using Epoxy or fiberglass. In leatherbacks, the transmitters can be attached to the carapace directly using orthopaedic bioabsorbable mini-anchor screws, or by a harness. This is an expensive technique and can cost upto US $2000.00 for the transmitter and US $2000.00 fot the data for each turtle.

For more information, check:

ARGOS - http://www.cls.fr, SIRTRACK - http://sirtrack.landcare.cri.nz, TELONICS - http://www.telonics.com, WILDLIFE COMPUTERS - http://www.wildlifecomputers.com A tracking tool is also available at http://www.seaturtle.org. In India, a satellite telemetry exercise was carried out in Orissa in April, 2001 (see http://www.wii.gov.in). A training video is available from the Wildlife Institute of India, Dehradun.

Migratory routes of olive ridleys on the east coast of India



Attaching Satellite Transmitters to Turtles

(a UNDP Project carried out by Wildlife Institute of India, Orissa Forest Department and Smithsonian Institution)

The carapace of the turtle is first cleaned with alcohol 1

The bottom of the transmitter is cleaned with alcohol 2

Using a special gun, the two part epoxy is applied to the bottom of the transmitter 3

The epoxy is then applied to the carapace of the turtle 4

The transmitter is then pushed onto the back of the turtle and the epoxy is smoothened around the transmitter 5

Photos - BC Choudhury

The exercise was followed closely by the local village community and two of the transmitters were turned on by the children from the community

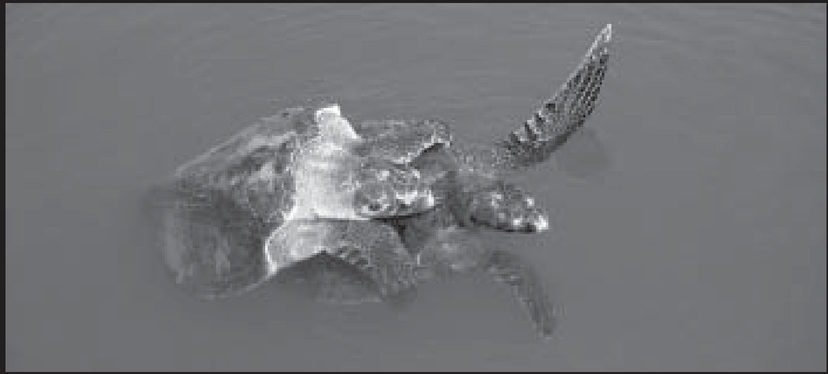


Photo -Bivash Pandav

Studying Behaviour and Evolution

For many years, sea turtle biologists have grappled with questions such as: Are black turtles and green turtles separate species ? How closely related are olive and kemps ridleys ? From which rookery do a group of foraging turtles derive ? Do clutches have multiple paternity ? And do turtles return to their natal beaches to nest ?

Sea turtles have long been believed to nest on their natal beaches ie. the beaches where they were born. For many years, this remained mere speculation. Firstly, the hatchlings grow from a few centimeters in size to adults that are many times larger, ranging from the 80 cm ridleys to the 180 cm leatherbacks. Tags that would successfully last through till adulthood (which could take ten or more years) are not available. Secondly, considering that only one in a thousand hatchlings survives till adulthood, the number of tags that would need to be applied to get significant results would be astronomical. Finally, research would have to be carried out for decades to demonstrate natal homing through tagging.

However, in the early 1990s, a technique became available that could succesfully address the question of natal homing in turtles - molecular genetic analysis. In simple terms, if turtles did not return to their natal beaches, the genetic markers of the populations would mingle. If however, turtles were faithful to their natal beaches, then markers in different populations would be distinct. In the first landmark study, scientists showed that the green turtles that foraged off the coast of Brazil had a mix of genetic haplotypes, but the haplotypes of the nesting beaches in Tortuguero, Costa Rica to the north and the Ascencion Island in the middle of the Atlantic were completely different. Hence the turtles were feeding together, but returning to their natal beaches to nest.

Genetic Analysis and Tissue sampling

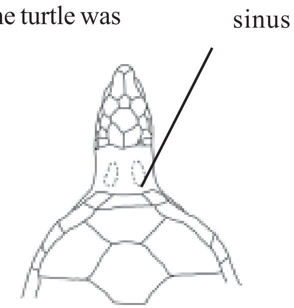
Quantity: Earlier, a large quantity of DNA was required for analysis, and hence blood

sampling was essential. However, current techniques, which are mostly PCR (Polymerase Chain Reaction) based, require very small quantities, as can be obtained from small biopsies of tissue or skin. Blood may still be required for other studies eg. hormonal studies.

Contamination: The most important aspect of sampling for genetic studies is avoidance of contamination. Equipment such as needles, forceps and scissors should be washed and cleaned thoroughly before re-use. Vials should be sterilized before use and sealed completely (with parafilm) after use. Vials should be labeled using permanent markers.

When to collect: Often, genetic sampling is done opportunistically ie. during other field projects. It is wise to collect and store samples, because the opportunity to collect a sample may not always present itself. However, first ensure that proper permits are acquired before collecting samples. Samples can be stored almost indefinitely, and hence genetic analysis can be carried out at a later date when funds are available.

What data to record: Some basic data need to be recorded for each sample. These include: species of turtle, date, location where turtle was encountered, whether it is known to be an adult or juvenile, male or female, and whether the turtle was sampled at the nesting beach or its foraging ground.



Collecting and storing blood

Where? Blood can be collected from the dorsal cervical sinus, which is located bilaterally in the neck close to the dorsal surface, about 1/2 to 1/3 way to the back of the head from the carapace. Either a syringe and needle or a vacuum tube with needle (vacuutainer) can be used. For hatchlings and young juveniles, an insulin syringe with a flexible 26-29 guage needle (12.7 mm) is used. For adult turtles (except leatherbacks) a 21 gauge needle (2.5-3.8 cm) can be used. For leatherbacks, 7.5 cm 18 gauge needles are required. In leatherbacks, blood can also be collected from a sinus in the rear flipper. It is also advisable to sterilize the skin prior to inserting the needle.

How? The turtle should be restrained so that the neck is stretched and lower than the body which helps fill the sinuses. With nesting turtles, this is easily achieved during oviposition by scooping out sand from below the head. The needle is inserted about 1 cm from the dorsal cervical midline on either side of the line's midpoint. The needle should be inserted perpendicular to the surface to a depth of 1 – 3cm, till there is a spurt of blood, at which point, some suction can be applied to collect blood. The depth of insertion may need to be adjusted till the sinus is located, but the needle should not be rotated. The location of the sinus varies between individuals and it may be necessary to insert the needle a few times. If a few attempts are unsuccessful, the other side of the neck can be tried. 1 – 2 ml of blood can be collected from adults, while 0.1 to 0.5 ml only should be collected from hatchlings.


Storage vials and parafilm

Photo - Saravanakumar

Storage: Small blood samples can be dried on glass slides or filter paper, but these methods should only be used as backup. Blood can be stored in EDTA vacuutainers or in lysis buffer (100 mM Tris-HCl, pH 8; 100 mM EDTA, pH 8; 10 mM NaCl; 1-2 % sodium dodecyl sulphate, SDS). The blood: buffer ratio should be 1:5 to 1:10.

Collecting and storing tissue

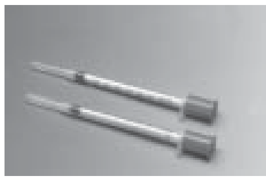
How? Tissue can be collected from live or dead animals. In either case, precautions must be taken to avoid contamination.A tiny piece of tissue can be taken from the flipper using a razor blade (single edge blades or double edged blades broken in half). The advantage of using razor blades is that they are easily available, reasonably sterile, and can be disposed after each sample, thus reducing the chances of cross contaminating samples. Razor blades must not be discarded in the field. Under field conditions, they can be stored in an empty plastic bottle till they can be disposed properly and permanently.

Storage: The samples can be stored in a 1 or 2 ml cryovial. Tissue samples can be stored in absolute or 95 % ethanol (alcohol). Tissue can also be stored in saturated salt (NaCl) solution with 20 % DMSO (dimethyl sulfoxide). Salt solution is preferred because it is not volatile or inflammable and better for transport of material. (In the absence of the above, at a pinch, tissue can be stored in any alcohol, or salt, or salt solution, all of which are usually available in abundance in field stations).

Genetic analysis

Genetic analysis can be carried out in laboratories which are suitably equipped. Primarily, mitochondrial DNA sequencing analysis is used for phylogenetic and phylogeographic studies, while microsatellite analysis is used for population genetic and paternity studies. In India, genetic studies on sea turtles have been carried by the Wildlife Institute of Dehradun, India in collaboration with Centre for Cellular and Molecular Biology, Hyderabad.


Vacuutainers


1ml insulin syringe


Photos - Saravanakumar

2 ml syringe with 22 gauge needle


Photo -Bivash Pandav

Measuring Sea Turtles

Sea turtles are measured for a number of reasons, to relate body size to reproductive output, to determine minimum size at reproduction, and to monitor nesting female size at a rookery. Changes in nesting female size can for example be indicative of either a declining population or in some cases, an expanding population. At foraging grounds, they are measured to determine size classes of turtles, which in turn can provide important information about the demography of a population. Mark recapture studies in which turtles are captured, marked and released, then later recaptured, can provide estimates of population size. Repeated measurements of tagged turtles during mark recapture studies can provide estimates of growth rates.

As with all other data, measurements need to be as precise ie. free of error, as possible. Error can creep into the measurements in many ways. Different personnel may take measurements differently. They may measure the turtle from different points. Different tape measures can vary substantially from each other. The same tape measure can deteriorate over time (and stretch) and thus result in erroneous measurements.


Photo -Bivash Pandav

Hence, tapes and calipers should be calibrated regularly. Error should be measured by taking repeated measurements of the same animals (by the same and different personnel). Though straight line measurements are more precise, calipers of the required size are unwieldy for field travel and use.

Photo -Bivash Pandav

Flexible, fiberglass tape measures are better than metal or cotton tapes, because they are flexible and do not stretch. The tape measure should be longer than the carapace, so that the reported length is the result of a single measurement. If any irregularity (such as deformity in the shell of the turtle) affects the measurement, it should be noted, and the measurements should not be used in the analysis.

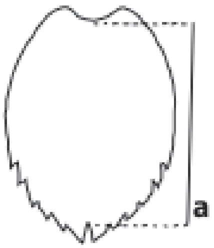
Carapace measurements of hardshelled turtles

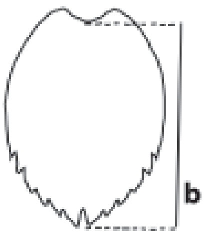
Though carapaces have been measured from different points both anteriorly and posteriorly, we will present two common methods of measurement here. It is also important that the type of measurement used be reported in any publication.

(a) Minimum carapace length is measured from the anterior point at midline (at the point where the nuchal scute meets the turtle's neck) to the posterior notch at midline between the supracaudals.

(b) The "notch to tip carapace length" is also measured from the anterior point at midline to the posterior tip of the supracaudal. If the supracaudals are asymmetrical, then the measurement should be to the longer one.

Generally, in Straight Carapace Length (SCL) measurements, SCL-min is preferred, but SCL-nt can also be recorded for comparison with other data sets. SCL-min may not be useful if there is substantial variation in the shape and length of the notch between the supracaudals. Either way, the measurement should be specified on the data sheet. Curved





Carapace Length (CCL) is measured using the same points on the turtle's shell.

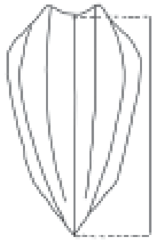
Carapace Width is measured at the widest part of the shell. Both Straight Carapace Width (SCW) and Curved Carapace Width (CCW) should be measured with the turtle resting naturally on its plastron.

Tail Length

Total tail length is the distance from the midline of the posterior edge of the plastron to the tip of the tail following the curvature of the tail. Post cloacal tail length is the distance from the mid cloacal opening to the tip of the tail. Both measurements are taken using a flexible tape measure. Since tail length is a secondary sexual characteristic in turtles, the ratio of TTL to PTL is greater in mature males than in mature females, and can also be greater in immature males that are beginning to show sexual characteristics

Linear measurements of Leatherback turtles

Both SCL and CCL are measured from the nuchal notch (anterior edge of carapace at midline) to the posterior tip of the caudal peduncle. CCL should not be measured along the crest of the ridge, but alongside the ridge, just adjacent to the apex of the central keel. Carapace widths are measured at the widest point.



Hatchling turtles

Hatchlings should be measured as described above, using calipers. Care should be taken not to distort the shell of the hatchling, which is very flexible.

Weighing animals

Though body mass is an important variable, it is often difficult to weigh adult turtles. When weighing adult females on the nesting beach, it is important to record whether the weight was taken before or after the turtle laid her eggs. A portable tripod with a pulley can be constructed to weigh turtles.

Hatchlings can be weighed using a spring balance. Depending on the accuracy of the scale available, it may be better to weigh groups of hatchlings together and determine the average weight.

Some Other Areas of Research

Today, new tools and technology ar e available, opening up many avenues of research. For example, GIS and Remote sensing can be used to study nesting and foraging habitats and anthropogenic impacts on these habitats. Listed below are but a few other traditional areas of research on sea turtles, and there are many more.

Reproductive cycles and Endocrinology

Various techniques such as hormone radioimmunoassay, laparascopy and ultrasonography can be used to study reproductive cycles and endocrinology in sea turtles. However, these methods require equipment, expertise and training. Useful data can also be obtained from autopsies of dead turtles.The state of the ovaries can be a fund of information on the reproductive stage and status of the turtle.

Diet studies

Diet sampling and diet component analysis are an important aspect of studying nutrition and foraging Combined with information on growth rates, these can offer important insights into the nutritional ecology of sea turtles.

Orientation and Navigation

Studies have been carried out on visual stimuli and sea finding of hatchling sea turtles. What wavelengths and intensities of light are they most sensitive to ? How do landward silhouettes affect sea finding ability ? This information can help design turtle friendly beachfront lighting. Experiments have also been conducted on the sensitivity of hatchling turtles to geomagnetic stimuli, to understand their ability to navigate.

Diseases

Studying diseases is an important component of the health of sea turtle populations. Given the high rates of organic and inorganic pollutants in many waters that sea turtles inhabit, they could be susceptible to a wide range of diseases. Fibropapilloma, in particular, affects many sea turtle populations, and has been the focus of research in recent times. Fecal samples and blood samples are used to study parasites and pathogens. Serodiagnostic tests have been conventionally used to study blood borne pathogens, but today, many molecular diagnostic tests are also available.

Field Equipment

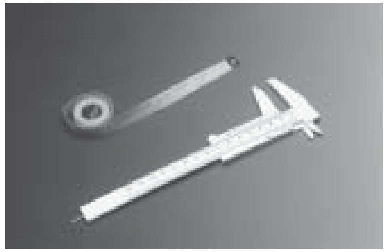
Basic necessities

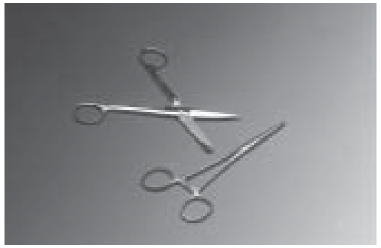
Data sheet or field notebook
Pen / Pencil
2 m tape
Watch or stopwatch
Bags for transport of eggs

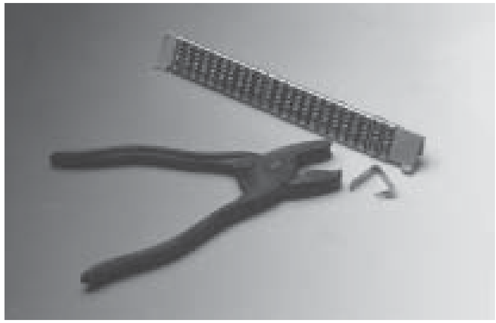
Depending on the objective of the conservation or research programme, one may need:

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.







Photos - Saravanakumar

Some Useful Data Sheets

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____

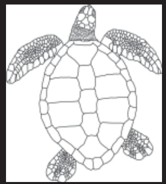
Observer ____

Distance sampled:

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

Total number of dead turtles:

Males:
Females:



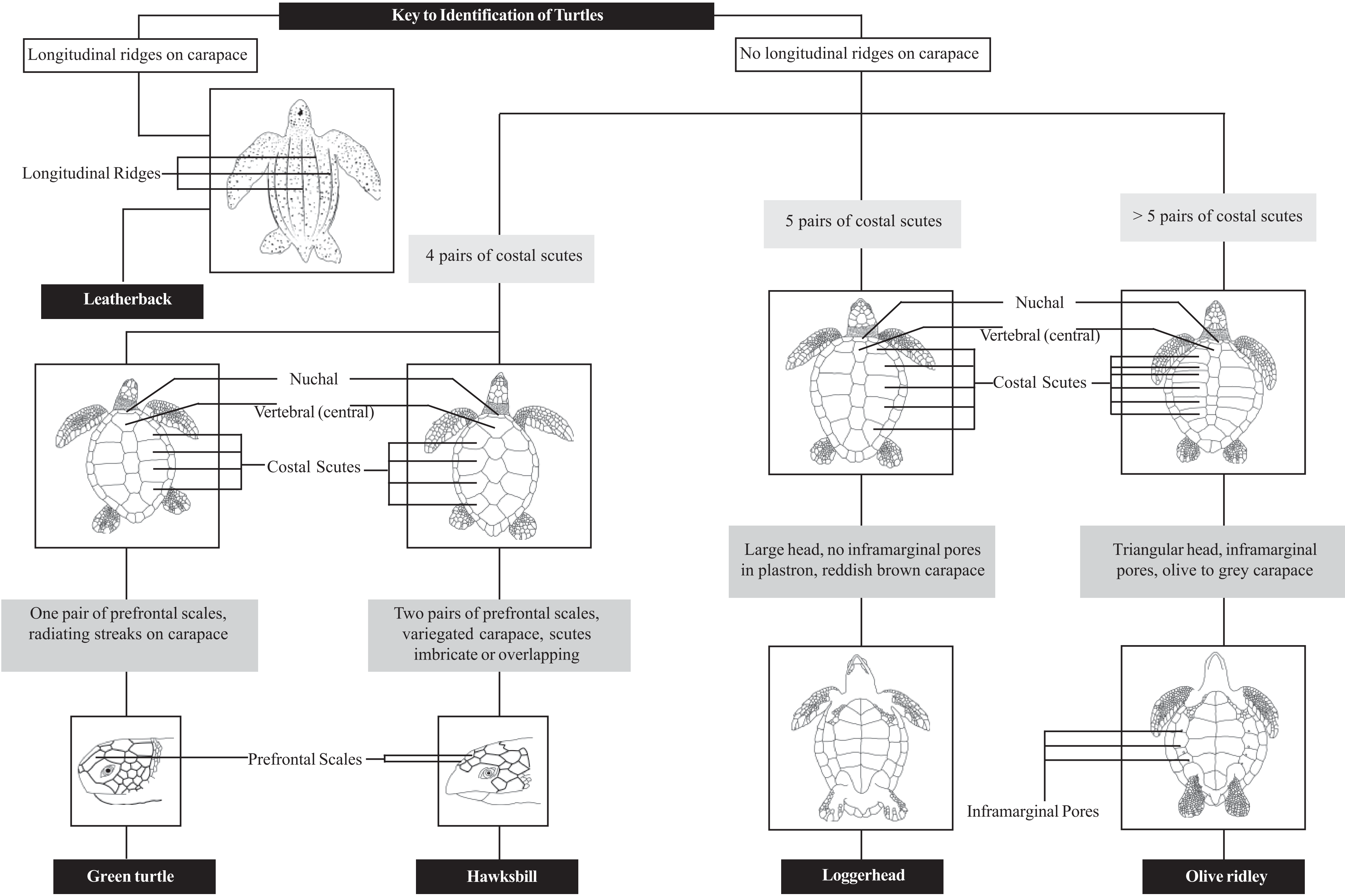
Identification of turtles

If a turtle or a carapace is seen, it can be identified from the features specified in the identification key. 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
5 pairs of costal scutes
> 5 pairs of costal scutes
Nuchal
Vertebral (central)
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
Large head, no inframarginal pores in plastron, reddish brown carapace
Triangular head, inframarginal pores, olive to grey carapace
Prefrontal Scales
Inframarginal Pores
Green turtle
Hawksbill
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

Carapace elongate with seven prominent dorsal ridges; scutes always absent . Mostly black with white spotting; pink or bluish spots on base of neck and flippers. **Head**- Triangular; two maxillary cusps **. Limbs** - Forelimbs extremely long. **Plastron** Relatively small and distensible

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

Carapace broadly oval; margin scalloped but not serrated. Costal scutes 4 pairs.Brown with radiating streaks in juveniles. Variable in adults. **Head -** 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

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

Carapace oval, strongly serrated posterior margin, thick overlapping(imbricate) scutes Costal scutes 4 pairs (ragged posterior border)Brown, boldly marked with amber and brown variegations. **Head-** Narrow, straight bird like beak. Prefrontal scales2 pairs. **Limbs -** Two claws on each flipper. **Plastron** - Light yellow to white.

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

Carapace moderately broad, lightly serrated posterior margin in immatures, thickened area of carapace at base of 5th vertebral in adults. Costal scutes 5 pairs. Generally unmarked reddish brown in subadults and adults **. Head-** 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

Olive Ridley

Scientific name *Lepidochelys olivacea*
Nest on Tropical beaches worldwide
Occur in Tropical waters
Weight 50 kg
Carapace length 60 - 70 cm

Carapace short and wide, carapace smooth but elevated, tectiform (tent shaped) Costal scutes - 5 – 9 pairs asymmetrical.Mid to dark olive green. **Head-** Shape Large, triangular. Prefrontal scales 2 pairs. **Limbs -**Two claws on each flipper.

PlastronPore near rear margin of infra marginals; Creamy yellow.

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
Renesting 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
Renesting 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

Photo - 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, in Lakshadweep islands, Andaman and Nicobar islands. Hawksbills also often nest under overhanging vegetation.
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

Sea turtle research resources

Journals

Most journals of wildlife, ecology and herpetology will carry articles on sea turtles and internet searches (http://www.google.com) are the best method of finding the latest information. Recent publications are included in the Marine Turtle Newsletter and a bibiography is available at the ACCSTR website (http://accstr.ufl.edu) There are also journals and newsletters specifically dedicated to sea turtles.

Marine Turtle Newsletter (http://www.seaturtle.org/mtn)

The Marine Turtle Newsletter is published quarterly in two languages (English and Spanish) and distributed free of charge to over 2000 readers in more than 110 nations. The aim of the newsletter is to provide a forum for exchange of information about all aspects of marine turtle biology and conservation.

Kachhapa (http://kachhapa.org)

Kachhapa, the newsletter, was initiated to provide a forum for exchange of information on sea turtle biology and conservation, in the Indian subcontinent, Indian Ocean region, and southeast Asia. Kachhapa comes out twice a year. Kachhapa articles are peer reviewed, and it also includes notes, letters and announcements. Kachhapa reaches more than 1000 readers in south Asia and internationally.

Other journals to look out for include Chelonian Conservation and Biology, Hamadryad and other herpetology and marine biology journals.

Internet

Seaturtle.org (http://www.seaturtle.org)

This is the world's premier online resource for seaturtles. It includes a global directory of sea turtle biologists and conservationists, supports the Marine Turtle Newsletter and the Annual Symposium on Sea Turtle Biology and Conservation. It also includes a satellite tracking tool, GIS and maptool, image library and many other useful resources.

ACCSTR (http://accstr.ufl.edu)

The Archie Carr Centre for Sea Turtle Research website provides many important resources including a sea turtle bibliography, a tag inventory, and sequence database for genetic studies.

Kachhapa.org (http://www.kachhapa.org)

This is a portal for sea turtle conservation in south Asia. The website supports Kachhapa, the newsletter, and has a directory of sea turtle biologists in the region. It includes the latest news, announcements, images and updates on Operation Kachhapa activities.

CTurtle is an email discussion group which has hundreds of subscribers from around the world, including most sea turtle biologists and conservationists. For details and subscription see ACCSTR website.

Sea turtle research programmes in India

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 (Andaman and Nicobar Islands)
Contact: Harry Andrews, Post Box- 1, Jungli Ghat P. O., Port Blair- 744103. Andaman and Nicobar islands. *Email: mcbtindia@vsnl.net*

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.

Selected Bibliography and Further Reading

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Lohmann, K. J. 1992. How sea turtles navigate. *Scientific American,* 266(1): 100-106.

Shanker, K. 2002. Tracking turtles through time and space. *Resonance*, June 2002: 53-66.

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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 second 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:

- Beach Management and Hatchery programmes
- Population Census and Monitoring
- Eco (turtle) Friendly Coastal Development

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