SEA TURTLE CONSERVATION

POPULATION CENSUS AND MONITORING

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A GOI – UNDP PROJECT MANUAL

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Contents

Census and monitoring of turtle nesting beaches

Many populations of sea turtles are clearly in need of urgent conservation actions today. However, without appropriate knowledge of their biology, it is very hard to frame effective management strategies. Intensive research often needs extensive infrastructure, capacity building and funding, which is often not available to field biologists. However, even the simplest of monitoring programs can collect data on various aspects of basic biology. The most important data that we need for conservation are with regard to the status of populations.

How many individuals comprise a population? What is the age structure of the population (are there many young animals or many old animals)? What are the trends over time – is the population increasing, stable, or decreasing? Since this is impossible to calculate precisely for sea turtles (given our limited knowledge of various aspects of their biology such as their remigration intervals, sex ratios, numbers of animals in the age classes before reaching reproductive age, etc.), we often use surrogates or indices such as number of nests/ nesters per year. Even a simple index such as this can be hard to quantify unless the study design is carefully planned.

One of the most important questions for conservation is with regard to trends: is the population increasing, decreasing or stable? To answer this question, reliable data on the population size (or index) are required for a number of successive years. Given the amount of year-to-year variation, the long time to maturity, and the long life spans of sea turtles, it is necessary to gather systematic data for decades. These data should be comparable in that they should have been collected by the same method (and hence be comparable in regard to considerations such as error and bias) and even better, the data should have an associated measure of error, so that one can not only judge whether differences are due to errors in measurement or actual changes in population size, but also to verify if perceived trends are significant or not.

Population trends in sea turtles are particularly hard to pin down because of the yearly variation in nesting populations. Some sea turtles like ridleys nest annually or once in two or three years. On the other hand, the remigration interval for leatherbacks and green turtles can be three or four years or even as much as 11 years. This means that the proportion of the total population that is nesting each year can vary substantially. Hence, yearly variations in nesting population size may not be a good index of population dynamics unless data are collected for a sufficiently long period – which is usually decades.

Because nesting females are the only part of the population that are readily accessible – they crawl out on to nesting beaches where they can be counted or their tracks can be counted – nearly all estimates of population size in sea turtles are based on nesting beaches. This means that we are ignoring the situation with all the members of the population that are not reproducing, all of the males (regardless of age) and those reproductive females that do not nest during the period when we carry out our beach surveys. Hence, population estimates are based on a relatively small part of the total population.

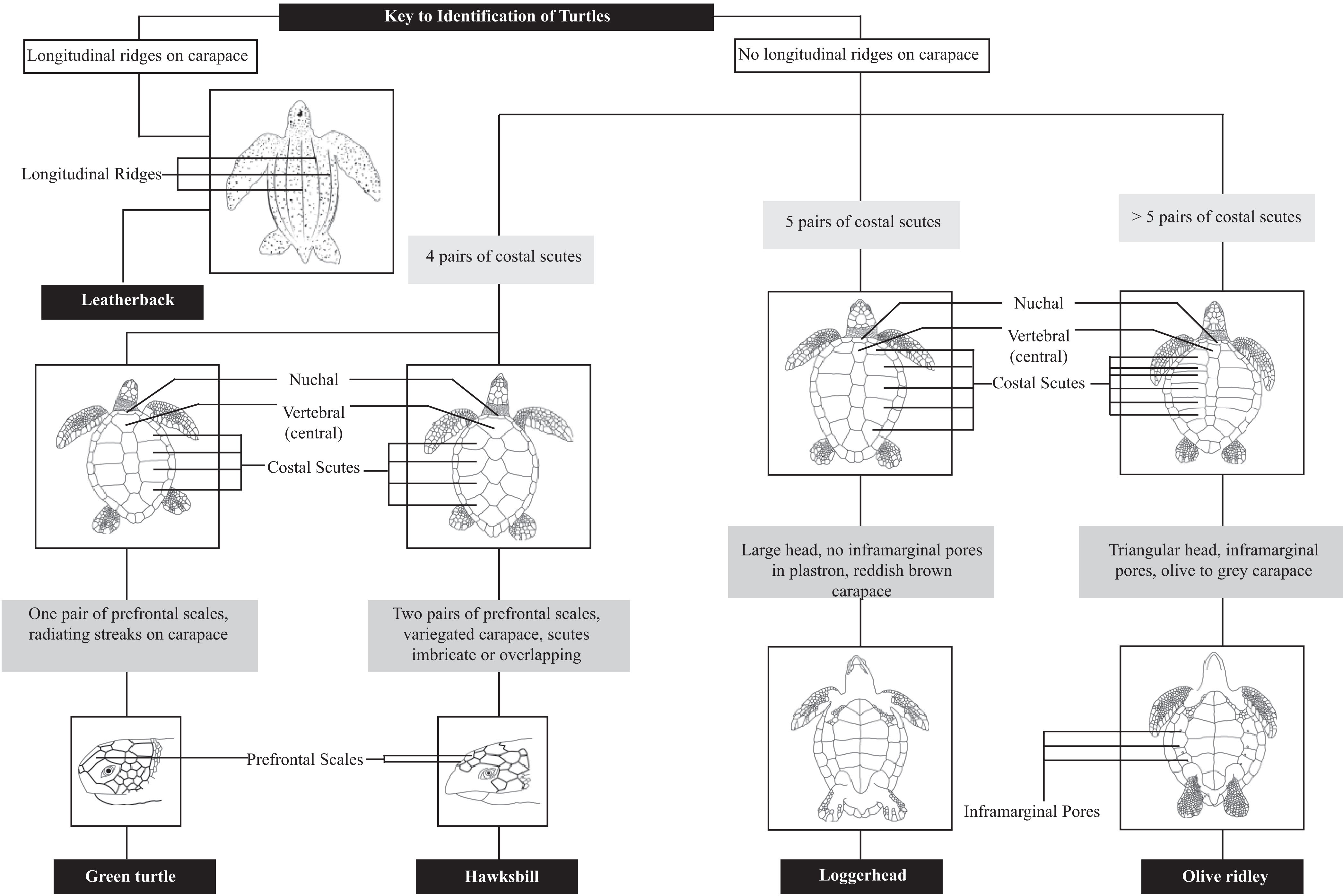
Even with these caveats, good information on population sizes is critical to conserving and managing wild populations. In this manual, we discuss basic methods used for monitoring sea turtles:

- Identification of sea turtles and their tracks
- Population surveys on nesting beaches
- Counting turtles during arribadas
- Habitat Surveys
- Market Surveys
- Assessing threats

What is a population ?

For sexually reproducing animals, it is defined as a 'set of organisms capable of freely interbreeding with each other under natural conditions.' It is generally understood to be a group of individuals belonging to the same species occupying a geographically delimited area. In genetic terms, one can define a population as a group of individuals amongst which there is gene flow on an ecological time scale ie. within a few generations. Most importantly, it is necessary to be consistent in the use of term.

Photo - Bivash Pandav


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

Identification of sea turtles and tracks

Adults and hatchlings

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 and number of prefrontal scales are critical to the identification of the species. 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.
Incase of doubt, a clear photograph of carapace and head should be taken.

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.

Tracks

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. Track identification should be confirmed by checking for remains of hatchlings, egg shell sizes, and other more concrete evidence.

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.

Photos: Kartik Shanker

Symmetrical track

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.

Asymmetrical track

Leatherback

Dermochelys coriacea

Nest on	Tropical beaches world wide
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
Remigration interval	2 - 3 years
Clutch size	80 - 100 eggs

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

Photo - Kartik Shanker

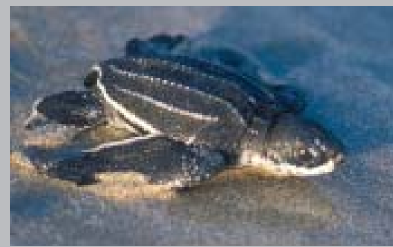


Photo - Kartik Shanker / Meera Anna Oommen

Photo - Kartik Shanker

Green Turtle

Chelonia mydas

Nest on — Tropical beaches world wide, 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

Re-nesting interval — 10 - 14 days

Remigration interval — 3 - 5 years

Clutch size — 100 - 120 eggs

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

Photo - Basudev Tripathy

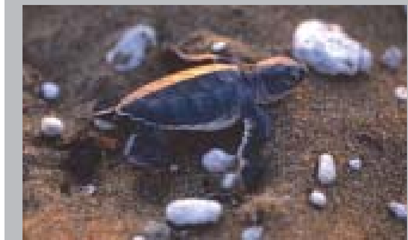


Photo - Brendan Godley

Photo -Brendan Godley

Hawksbill

Eretmochelys imbricata

Photo - Kartik Shanker

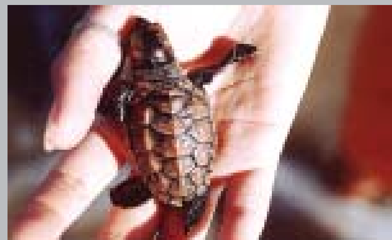


Photo - Paula Baldassin

Photo - Johan Chevalier

Nest on — Tropical beaches worldwide, mainly remote islands

Occur in — Tropical waters

Weight — 150 kg

Carapace

Length — 80 - 100 cm

Shape — Oval, strongly serrated poste rior margin, thick over lapping (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

Re-nesting interval — 12 - 14 days

Remigration interval — 2 - 5 years

Clutch size — 120 - 150 eggs (upto 180 eggs)

Other features — Vertebrals (centrals) large, so that first costal does not contact nuchal scute

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

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
Re-nesting interval	12 - 16 days
Remigration interval	2 - 3 years
Clutch size	100 - 120 eggs

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

Photo - Mathew Godfrey

Photo - Paula Baldassin

Photo - Alan Rees

Olive ridley

Lepidochelys olivacea

Photo - Bivash Pandav

Photo - Kartik Shanker

Photo - Kartik Shanker

Nest on	Tropical beaches world wide
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
Other features	Vertebrals (centrals) narrow, so that first costal contacts nuchal scute
Period of nesting	Night
Clutch/Season	1 - 3
Re-nesting interval	20 - 28 days
Remigration interval	1 - 2 years
Clutch size	100 - 120 eggs

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

Other sea turtles of the world

Photo - Michael Coyne

Kemps Ridley

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

** - the animal in the picture is a juvenile kemp's ridley turtle. Adults ressemble olive ridleys.*

Photo - Grupo de Tortugas Marinas

Black Turtle

Scientific name	*Chelonia sp.*
Distribution	East pacific ocean
Weight	70 kg (upto 120 kg)
Period of nesting	Night
Clutch size	75 - 85

The east pacific green turtle or black turtle is considered as a species (*Chelonia agassizii*) by some turtle biologists, but genetic studies indicate that it is a part of the global green turtle population.

Photo - Kellie Pendoley

Australian Flatback

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

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

Nesting versus non nesting emergences

(False crawl versus successful nesting crawl)

Sea turtles emerge frequently on nesting beaches and return without laying eggs, sometimes having constructed several nests. Scoring non nesting crawls as nests can give a false account of nesting density. The best way to identify a nesting crawl is to locate the nest and eggs. This may not always possible and other signs can be used to identify nesting crawls that were successful.

It requires considerable experience to determine a successful nesting crawl from the spoor, and given the importance of distinguishing them from false crawls, personnel should expend considerable effort on first familiarising themselves with the species and its nesting habits and field signs (track and nests) by direct observation of the nesting process.

Field signs of a nesting crawl

Backstop – an approximately 45 °c incline made in the sand as sand is pushed back with the rear flippers during the excavation of the primary body pit (not distinctive in smaller species)

Crawl – tracks made by the sea turtle (not evidence of succesful nesting)

Egg chamber – cavity into which the turtle deposits the eggs (not evidence of succesful nesting)

Escarpment – perimeter of the secondary body pit where the front flippers have cut away a small cliff into the surrounding sand (not always distinctive)

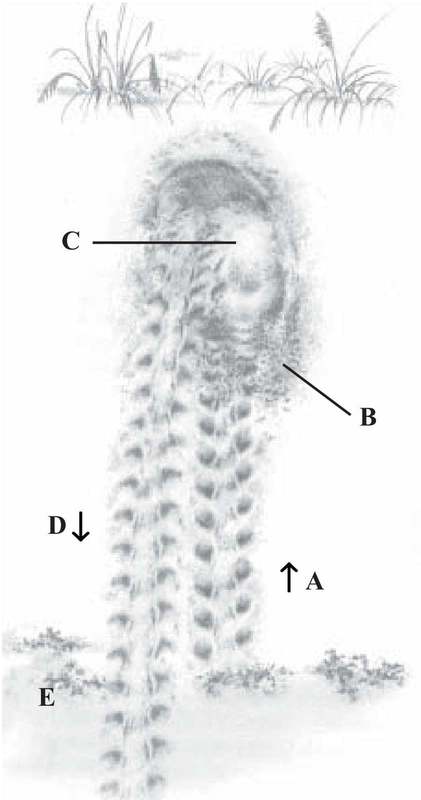
Body pit – excavation made by the turtle prior to digging the egg chamber. Ridleys make practically no body pit at all , while loggerheads and hawksbills make very shallow body pits, that may be difficult to detect. Green turtles and leatherbacks usually make deep body pits.

Successful nesting crawl

Observing the direction in which sand was pushed will help identify the up track (track leading to the nest) and down track (track left while turtle returned to the sea). In ridleys, the flipper mark is comma shaped, and the direction of the tail of the comma indicates the direction in which the turtle moved.

One can follow the crawl to the nest to look for the above signs of nesting. Ridleys and Hawksbills do not create large body pits, but the backstop may be evident if the sand has not been disturbed. Even it if is present, this is not certain proof that there was a succesful nesting. The nesting area is usually a smoothed out expanse of sand resulting from the throwing of sand by the front flippers following egg laying. This needs considerable experience to be able to detect with an acceptable degree of certainty.

Stages of successful nesting, with emerging crawl (A); sand misted or thrown back over the emerging track (B); a secondary body pit and escarpment, with sand thrown in the vicinity (C); and returning crawl (D). (E) marks the high tide line.



Illustrations adapted from `Research and Management Techniques for the Conservation of Sea Turtles'. IUCN/ SSC Marine Turtle Speacialist Group Publication No. 4.

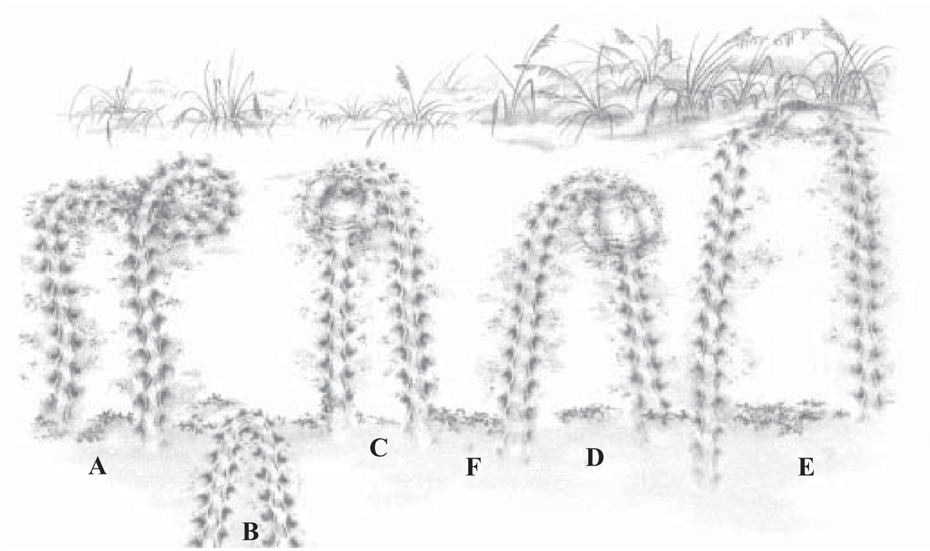
False crawl

These can be determined from the following signs:

- Very little or no sand disturbed apart from the crawl itself
- Considerable sand disturbed but with the crawl exiting from the disturbed area.
- Considerable sand disturbed and an uncovered egg chamber

In ridleys, false crawls can usually be determined from the complete absence of a nesting area,or from half or fully excavated nest chambers that have not been covered.

In addition, one may encounter depredated nests. These will usually be surrounded by eggshells and partially consumed eggs and must be counted as successful nesting crawls.



Examples of false crawls (non-nesting emergences) include extensive wandering with no body pitting or digging (A); U-shaped crawl to the high tide line (B); considerable sand disturbance and evidence of body pitting and digging and no evidence of covering (D); and considerable sand disturbance, evidence of body pitting and digging with a smooth-walled egg chamber and no evidence of covering (C). (E) marks the site of a crawl where the relative lengths of the emerging and returning crawls are the same. (F) marks the high tide line.

Photo - Bivash Pandav

Population surveys

Nesting beach surveys are most widely used for monitoring sea turtle populations. Surveys may be conducted on a single day (a ‘snapshot’ of a nesting beach) or may be intensive long term structured monitoring of sites during the whole nesting season for several decades. Since methodologies vary widely, it is often difficult to compare surveys conducted at different sites, or even surveys of the same site carried out by different methods at different points in time. Hence, it is of utmost importance to use a standardised method that is clearly understood by anyone who reads the reports and that is repeatable and comparable.

Nesting surveys often begin with beach assessments, which identify potential nesting sites, seasons and the species nesting. Often, preliminary beach surveys can be combined with preliminary nesting assessments, as long as the survey is carried out during the nesting season (if this information is available).

Preliminary Surveys of Extensive Coastlines

Often, information is needed for hundreds of kilometres of coastline. Obviously, the entire coast cannot be monitored on a daily basis. Surveys of such extensive coastlines are best conducted by covering the entire coast at least once, and often it is effective to partition the coast into sectors and sample them at different levels according to their importance and accessibility. For example, the coast can be divided into 50 km sectors and a random stretch of 10 km could be evaluated for each sector. For a finer scale of resolution, one could sample 2 out of each 10 km. In both these cases, 20 % of the coastline is covered. The proportion of coastline that needs to sampled to get a clear picture of nesting along a coast will vary between sites.

Often, this depends on the logistics and accessibility. If transport is available, and the beach is accessible from the road, one can motor to different sectors and sample them by foot. If driving on the beach is possible (by cycle or motorcycle), the entire coast can be covered fairly quickly. Combined with interviews, the surveys of extensive coastlines seek to identify:

1. What proportion of the coastline comprises potential nesting habitat
2. Locations with occurrence of sea turtle nesting
3. Species of sea turtles nesting
4. Seasonality of sea turtle nesting
5. Relative intensity of sea turtle nesting
6. Index beaches for intensive monitoring
7. Potential threats to habitats, eggs, hatchlings and adult turtles
8. Potential beaches for conservation activities
9. Potential conservation activities and partners

While # 1 and # 6-9 can be evaluated at any time, only surveys conducted during the nesting season can evaluate # 2–5 from direct observation, and surveys conducted outside the nesting season will depend on interviews with locals for information on these questions.

The proportion of nesting habitat along a coast can be assessed from satellite imagery, aerial photographs, or up to date maps, and although it is preferable to do initial planning before field work, these resources may not be available or accessible. In any case, ground surveys should be conducted, for they give the most reliable results. First, what constitutes a potential nesting beach needs to be defined. Once this is clear, the extent of these beaches can be measured at either coarse or fine resolution.

Data sheet for extensive nesting beach survey

Date of Survey ________________________ Time start ______ Time End_______

Beach Name____________________________ **Beach Zone** __________________

Observer ____

Length of beach (distance covered in survey): ____________________________

Average width of nesting beach: ________________________

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

Number of Villages: ____________________________

Assessment of threats:
Direct
Incidental catch: _____________________
Meat consumption _____________________
Poaching of eggs _____________________
Feral animals ____________________
Indirect
Plantations: _____________________
Sand mining: _____________________
Beach armouring: _____________________
Other: ____ ________________

Lighting disturbance: ________________________________
Intensity ________________ Source ___________________

Species: _______________________________
Nesting season: _________________________________
Estimates of nesting density (for each species): ___________________

Comments:

Intensive surveys of nesting beaches

Often, the results of preliminary or extensive surveys provide some indication to important nesting sites and the species nesting. However, more data are needed to obtain reliable estimates of population size and trends. Intensive surveys can be carried out during an entire nesting season to quantify the amount of nesting at a beach. If only a part of the nesting season is monitored, it necessary to have clear and standardized methods for deciding when to start and stop monitoring. Since it may not be able to survey the entire coastline throughout the season, it might be necessary to choose a few sites to represent the entire coast.

The sites used for intensive surveys can serve as index beaches that can be used to estimate total sea turtle nesting effort over a larger region. Long term monitoring of these index beaches will also provide much needed information on population trends. Index beaches may either be important nesting beaches which support a large proportion of a region's nesting, or they may be representative of nesting in the region. For systematic and regular monitoring, they must be of a length that can be surveyed daily, and be accessible to project staff.

Frequency of surveys

Daily versus periodic surveys

Daily surveys (whether conducted at night or day) during the nesting season can obviously provide the most detailed information on species, nesting activity and nest density from both direct observations of nesting females as well as from track and nest counts (that is indirect counts based on spoor). But, periodic surveys that are conducted less frequently (weekly, fortnightly, monthly) can also provide useful data. Both daily and periodic surveys, however, must be careful not to double-count tracks. To this end, tracks can be raked out or otherwise marked to ensure that they are counted only once.

Surveys that are carried out at periodic intervals must attempt to evaluate track longevity. Fresh, old and false crawls must be enumerated separately. Surveys must be carried out at regular intervals with consistency for all sites under study. For an example of a survey method, see Godley, Broderick and Hays (2001), Tripathy et al. (2003) and Bhupathy and Saravanan (2002).

It is very important to distinguish nests, tracks and other spoor that are associated with successful nesting attempts. In some beaches, more than half the nesting emergences made by females are unsuccessful. These unsuccessful attempts, known by various names such as false crawls, half moons, etc. can result from various causes. However, including counts of these unsuccessful attempts in overall results of the study can completely invalidate efforts to estimate population size and trends

Types of data collected

Track counts versus Direct observations of nesting turtles
When nesting intensities are particularly high, track counts alone are unlikely to be a reliable method of estimating nesting, much less successful nesting. It may be quite difficult to erase 50 – 100 tracks each night over a small stretch of beach during peak nesting, or even 10 – 20 leatherback tracks. Moreover, in cases where nesting occurs in high density, turtles that nest later can obscure the tracks left by earlier turtles, making it difficult to accurately count the total number of turtles that nested. In such instances, direct counts at night offer the most reliable method of counting turtles. Both methods can be combined, so that track counts are used during periods of lower intensity of nesting and direct observations are used during peak nesting. However, it is necessary to test the correspondence of indirect counts with direct counts.

Fresh versus Old crawls
Some surveys count fresh crawls (ie. crawls made during the previous night) while others count all visible crawls, regardless of age. The age of a crawl is usually very hard to determine, given the variety of factors that can affect the persistence of a track. Ideally one should record four categories of tracks: a) very fresh successful crawls; b) very fresh false crawls; c) successful crawls more than one day old; and d) false crawls more than one day old. Doing so will enable more flexibility during analysis.

Counting fresh crawls:
A particularly effective way of enumerating fresh crawls is to conduct a pre-survey. One day prior to the survey all existing tracks on the stretch of beach to be covered are raked over (or driven over) or otherwise obliterated or marked, so that fresh crawls can be readily identified and enumerated during the survey.

Estimating proportions of false crawls:
It may be difficult to distinguish between successful and false crawls. Another approach to resolving this is to carry out observations during the night to determine what proportion of emergences result in nesting. Thus nesting can be estimated from counts of total crawls during surveys. However, this may vary substantially between species, site and season. For the same site and species, it may vary across years. Hence it will need to estimated separately for each survey.

Variables affecting data collection during track counts

Observer / Surveyor Accuracy/ Experience:
The ability of the observer to identify and distinguish different types of tracks depends upon the expertise and experience of the observer. The observer must be able to distinguish different species and also whether tracks are fresh/old and nesting crawls or false crawls. Hence observers should be adequately trained in advance of any serious data collection.

Turtle species:
Different turtle species leave different kinds of tracks. When old crawls are being considered, this is of particular relevance since the persistence of the tracks of different species can vary substantially. Hence a count of the old crawls of green turtles and olive ridleys are not likely to give an accurate account of relative abundance since the crawls of green turtles will remain on the beach much longer and hence represent nesting from a much longer time period.

Nesting density:
Track counts are not very useful when nesting densities are very high, and crawls overlap extensively with one another.

Beach type:
Sand texture and compaction can affect the crawls and cause difficulty in identifying the species or differentiating nesting and non nesting crawls. It will also affect the persistence time of crawls.

Rainfall, Wind and Human Activity:
All of these can obscure crawls and confound identification, in addition to affecting the persistence time of crawls.

Time of Day:
Apart from affecting sighting of crawls (which may not be a significant difference in ground as opposed to aerial surveys), time of the day will affect the freshness of the crawl especially when human activity is present. Hence it is recommended that surveys are carried out early in the morning for best enumeration of fresh crawls. It is also good because when the sun is in a low position on the horizon, it is easier to distinguish the characteristics of the crawl.

Stratification of the beach

Sometimes, different kinds of beaches may have different nesting densities. For example, beaches on islands or sand bars, or beaches adjacent to river mouths may have different densities from other mainland beaches. Hence beaches may need to be classified on the basis of characteristics that affect nesting. However, some preliminary information is required before such stratification can be carried out. Once the beach has been classified, the different classes need to be sampled independently.

The index beach (or sample beach) can be divided into zones (of 1.0 km or less) to obtain fine resolution data on nesting density, nesting site fidelity, nesting success or habitat alteration. The zones can be marked using posts or by the presence of other permanent structure or markers. However, regular verification of index beaches is necessary, since in more dynamic areas of the coast, turtles may move to different areas.

Substituting time for distance to calculate location of nest/track/observation

Sometimes, it may not be possible to physically mark the sectors on the beach. In this case, if the surveyor walks at a standard pace, time can be used to measure distance. First, the surveyor's standard walking speed needs to be estimated. The time of the individual observations relative to start time can then be used to calculate the distance of the track or the nest from the starting point.

Track persistence

This can be measured by monitoring a track over several days/weeks. Several measurements (15 – 30) need to be obtained to derive an average. Since this may vary with time and place, track persistence needs to be evaluated for different seasons and different sites / beaches separately.

A recommended ground survey methodology

1. Conduct an extensive survey of the entire study area

2. Locate a series of index beaches that represent different densities of nesting, nesting by different species, and span the entire coast.

3. Conduct daily or weekly surveys on each of the index beaches during the nesting season. Periodic surveys need to be at consistent intervals.

4. Count fresh, old and false crawls separately. If surveys are not daily, conduct a presurvey so that the number of fresh crawls is estimated accurately.

5. Obtain an estimate of track persistence

Data sheet for intensive nesting beach survey

Daily Report

(Use a different form for each species)

Date of Survey ____________________ Time start ______ Time End _______

Beach Name/zone____

Observer ____

Weather:

Species:

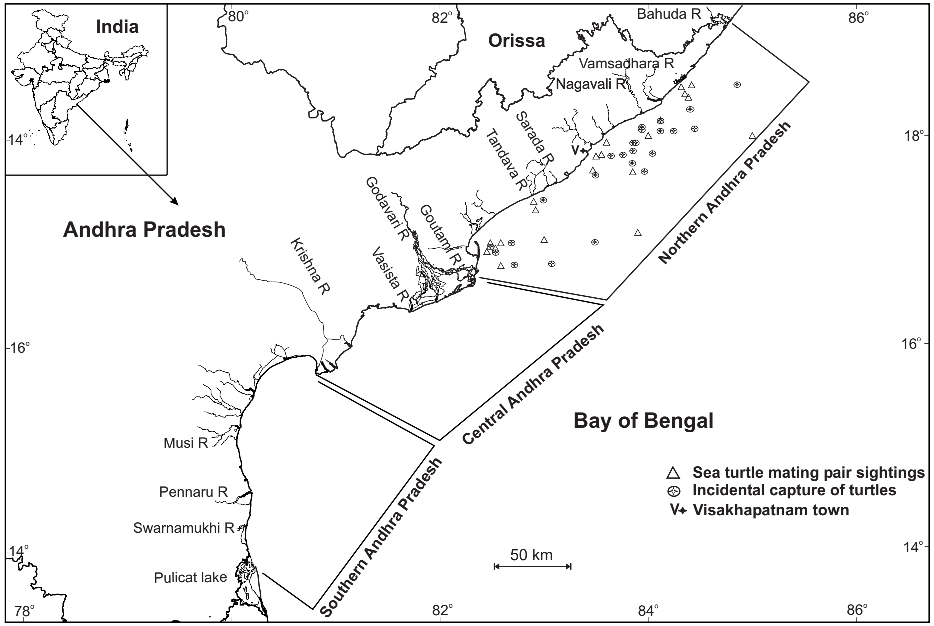
S.No.	Nesting crawl (fresh/old)	Distance from High Tide line	Habitat (vegetation/sand/village)	Distance to village

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:

Example - Survey of the Andhra Coast

During the 2000-01 GOI UNDP project, the Andhra Pradesh coast was surveyed by the Wildlife Institute of India (Tripathy *et al.*2003).



"During this survey, the coast was first divided into three zones, i.e. northern, central and southern Andhra Pradesh, based on broad topographical differences. Each zone was divided into sectors based on physiographic features such as river mouths, bays and estuaries. During the pre-nesting survey, one coastal village or fish landing centre was visited per 20 km of coastline, covering all 10 sectors. Information was collected from fishers, coastal Forest Department offices and state Fisheries offices using questionnaire interviews. Beach characteristics (topography, lighting, plantations and human habitation close to the beach) were evaluated subjectively.

During the nesting survey, each sector was covered once each month to obtain an assessment of relative nesting in the different zones and sectors. Additionally, four index beaches were selected on the basis of the preliminary survey and patrolled daily during January - March. Only fresh crawls and freshly depredated nests were counted. The results of the daily patrols represent total nesting during these months at these four beaches" (extracted and adapted from Tripathy et al, 2003).

Alternately, Bhupathy and Saravanan (2002) sampled 50 km sectors each week by sampling 10 km per day. Each sector of 50 km was sampled once a month. These data were used to arrive at nesting densities for the entire coast.

Estimating population size

(from indices such as nest counts)

Nest counts conducted throughout the nesting season are often used as an index of population size. However, if nest counts need to be converted into population size, two parameters are required. To estimate the annual number of turtles nesting, data are required on clutch frequency of a turtle. These can be derived from estimates in literature or can be estimated for a particular population if such data are available. Intensive tagging and monitoring studies are required to estimate the seasonal clutch frequency, which can vary from 1 – 6 clutches per season.

Average clutch frequency can sometimes be derived from data on tagged turtles. However this is possible only if the entire nesting population is adequately sampled. Otherwise multiple nesting emergences of large numbers of turtles are likely to be missed while renesting at sites not being monitored. The nesting periodicity and internesting interval can again be derived by tagging turtles, but only with adequate coverage.

Annual nesting population size = *Total No. of nests in a season / average number of egg clutches laid per female per season*

Not all the turtles in a population nest each year. Remigration rates vary from annual remigration (in some but not all ridleys) to once in 3 – 5 years or longer in leatherbacks and green turtles. The average remigration interval can only be obtained from long term studies.

Total population size = *Annual nesting population size* × *remigration interval*

Or

Total population size = *Seasonal nest count* × *remigration interval / average number of egg clutches laid per female per season*

Where:

Remigration interval – average number of years between nesting migrations (this should not be confused with the interval between nests in a single season which is about two to three weeks and referred to as internesting interval)

Seasonal nest count – total number of nests per season (ideally an average across several seasons)

Photo - Bivash Pandav

Counting turtles during arribadas

Ridley turtles are known for their mass nesting behaviour or arribadas. During arribadas, hundreds or thousands of turtles come ashore simultaneously to nest. Standard survey methods are not effective in counting thousands of nesting turtles. Olive ridley mass nesting beaches are found in Pacific Costa Rica and Mexico, and in Orissa. Though many mass nesting beaches have been monitored for years, the lack of consistent counting methods has meant that the estimates are not useful in determining whether the populations are increasing, decreasing or stable.

Sources of Error

Errors can stem from a variety of sources, but we will deal with some key factors to keep in mind while making estimates.

Estimating error

Any statistically rigorous method needs to incorporate a measure of variance or error in the estimate. As an example, suppose we use a sample method to estimate tigers in a forest. We may estimate 10 tigers in 100 km^2. This is only an estimate and we do not know (and probably never will know) the true value. However, a good statistical procedure can inform us about the precision of our estimate. If the estimate is based on good data (large sample size), the standard error of the estimate will be low, and we might be able to say (within 95 % confidence intervals) that there are between 8 – 12 tigers in 100 km^2. The 95 % confidence interval (CI) implies that if we were to make this estimate 100 times, the value would lie between 8 and 12 on 95 % of the occasions. On the other hand, if the 95% confidence interval (CI) for the estimate were 1 – 84, this would not be a very useful estimate of tigers in the forest. However, it is important to know how good or bad (how precise) our estimate is.

Similarly, when estimating turtles in an arribada, we might estimate 112, 345 turtles, but does the true value lie between 100,000 and 120,000 or between 25,000 and 400,000? A good sampling methodology combined with rigorous statistical analysis should be able to give this information.

Here, we describe a method which provides a precise estimate of nesting along with an estimate of variance and confidence intervals.

False crawls

Many earlier counting methods have counted all turtles within blocks or strips without checking whether or not the turtles were laying eggs. Many of these turtles may have returned without nesting and returned later to nest, thus resulting in the recounting of many turtles. Hence such counts result in overestimates of nesting. **The best way of avoiding this problem is to count only turtles that are actually laying eggs.**

The idea of the transect

The strip transect is a useful method to count stationary objects such as plants in a forest or nesting turtles on a beach. The strip is considered to be a representative sample of the area. The width of the strip is narrow enough to enable easy counts of the animals within the strip. In Orissa in 1999, the Wildlife Institute of India used 20 metre wide strip transects to count turtles. However, equally robust estimates can be generated if the strip is only 1 or 2 metres wide. Once an estimate is available for this strip, it is extrapolated to the entire beach. Strips are usually laid perpendicular to the coastline of the beach, which provides a good sample of different zones of the beach. Several parallel strips are sampled simultaneously, providing a coverage of the length of the beach along which nesting occurs.

Variables to be measured

Total duration of arribada:

The number of turtles that nests during a session varies throughout the arribada. A session may be defined as a period (day or night or both) of continuous nesting. This may vary due to the intensity of nesting or the length of each session. For example, during some sessions, the arribada may begin at 8 pm and end by 2 am, while during others, they may begin at 5 pm and end at 6 am. Usually, the number of nesting turtles is lower during the first and last days of the arribada, with a peak in the middle. Hence, the number of nesting turtles must be estimated separately for each session of the arribada.

Duration of each session:

Beginning of arribada:

For each session, it is important that sampling is initiated at the beginning of the arribada. If this is not carried out for any reason, the time of the beginning of the arribada must be recorded, so that nesting can be estimated for the duration when no sampling was carried out.

End of arribada:

Similarly, sampling must be carried out till the end of the arribada, or an accurate estimate of the time of the end of arribada must be made.

Total area of arribada:

Mass nesting usually occurs over a kilometer or several kilometers of beach, depending on the availability of space and suitability of the beach. The intensity of nesting will not be constant across the entire beach, and there will be areas that have much higher densities than others. Hence, one must ensure that both areas of low and high intensity nesting are sampled. A simple way to ensure this is to have equally spaced transects that cover the length of the beach where nesting occurs. Hence, if nesting occurs over a range of 2 km of beach, transects can be spaced 100 m apart from end to end, giving a total of 20 transects.

Transect length:

Transects can be equal and unequal in length. If transects sample the beach from the high tide line uptil dune/vegetation (or wherever nesting ends), they will tend to be unequal in length since this distance will vary in different sectors of the beach. In this case, the length of each of the transects must be carefully measured.

Duration of oviposition:

A very important factor in the calculation of the number of nesting turtles in an arribada is the time taken to lay eggs or the duration of oviposition. During or before the arribada, turtles must be carefully observed while nesting, and the exact amount of time taken for oviposition (from laying the first to the last egg) must be measured. This can be measured for 20 – 30 animals to get a good estimate for each population.

The method

A. Mark a permanent transect from the high tide line to the point of the beach where nesting ends (may be vegetation, dune or water body) with poles. The poles should be connected by a taut coloured tape / rope.

B. There should be one transect every 100 metres.

C. After the onset of the arribada, each transect should be walked once every hour

D. During each transect walk,

  1. Walk in a straight line between transect poles, along the tape or rope connecting the poles.

  2. Check all turtles within 1 metre of the transect on either side.

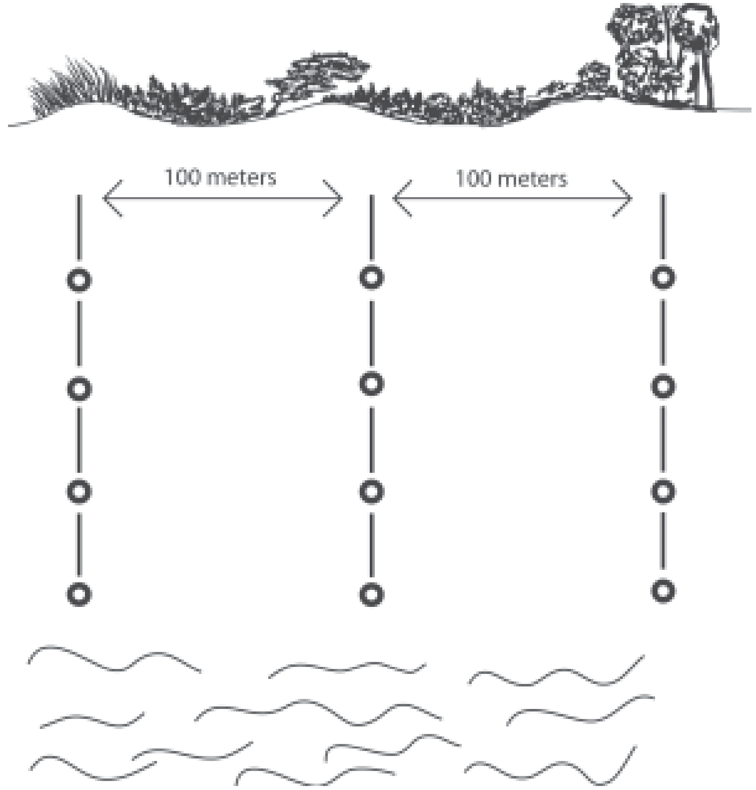
  3. Check if the turtle is ovipositing (laying eggs). This can be determined initially by digging behind the turtle. Expert observers can judge this by the splayed position of the hind flippers and signs of cloacal contractions during oviposition. Also the turtle spends a long time without moving whereas during and after oviposition, a period of rest is followed by digging or sand throwing.

  4. Use a calibrated 1 metre stick to determine whether the nest is within 1 metre of the transect. Only nests that are fully within one metre of the transect should be counted.

  5. Repeat once every hour for each transect.

Points to be noted

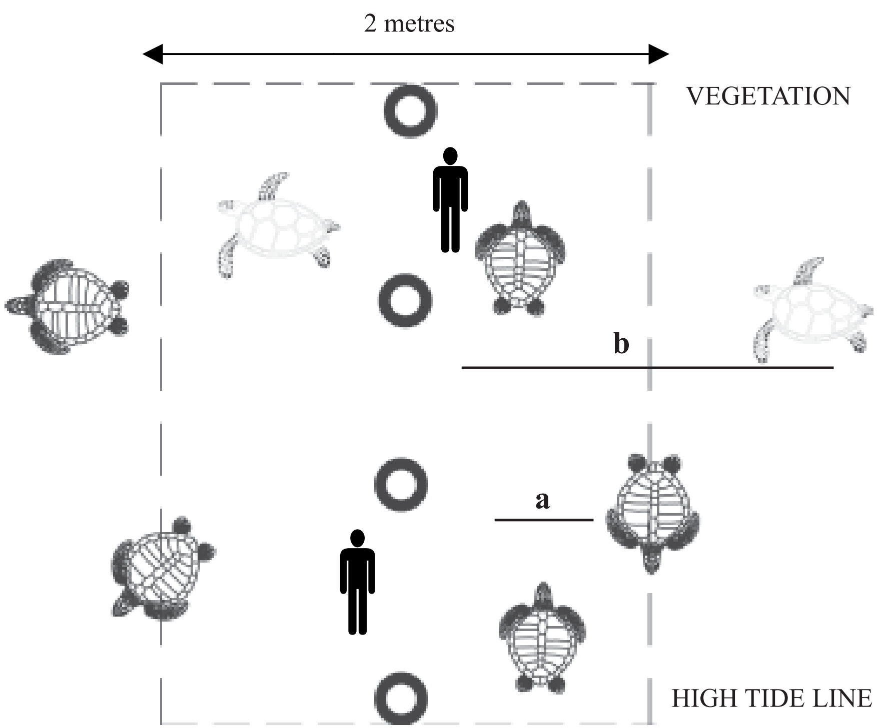
Each surveyor should complete his transects within 10 – 15 minutes of the hours. Hence each observer should not cover more than 10 transects. If nesting is spread over 2 km, this requires 20 transects (at 100 metre intervals) which can be covered by 2 surveyors. Note that these detailed observations can be taken by as few as 2 observers.



Transects

A number of parallel transects are established on the beach where mass nesting typically occurs. These transects are straight lines running from the high tide line to the vegetation or sand dune (point beyond which nesting typically does not occur), marked by wooden poles. The poles should be about 10 metres apart, so that each pole along the transect can be viewed from the previous pole at night with a small torchlight.

Transects are placed every 100 metres. Each surveyor walks in a straight line along the transect (using the poles or ropes as a guide) starting at the high tide line and finishing at the last pole. All transects must be surveyed during each sampling session.



Step 1: Walk along the transect

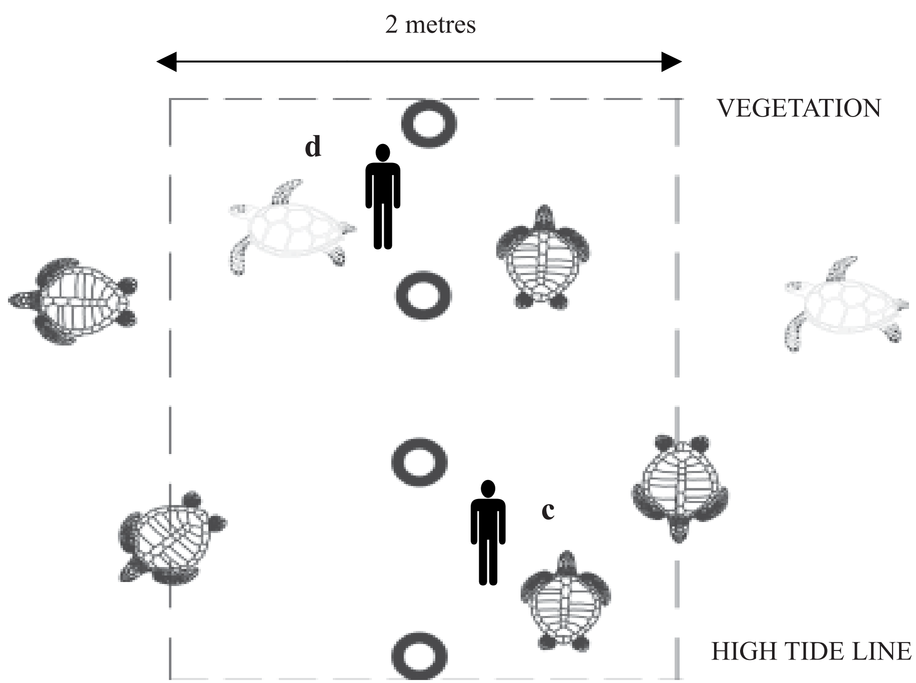
Step 2: Check whether the turtle is within the transect

When a turtle is seen near the transect, check whether the turtle is within the transect ie. whether it is within 1 metre of the pole on either side. This can be done using a tape or a calibrated one metre stick. The centre of the turtle should be within one metre of the transect (ie. Within one metre of the tape/rope or imaginary line that connects the poles on the transect).

In the above diagram,

a. the turtle is within one metre and should be considered

b. the turtle is not within one metre and should not be considered

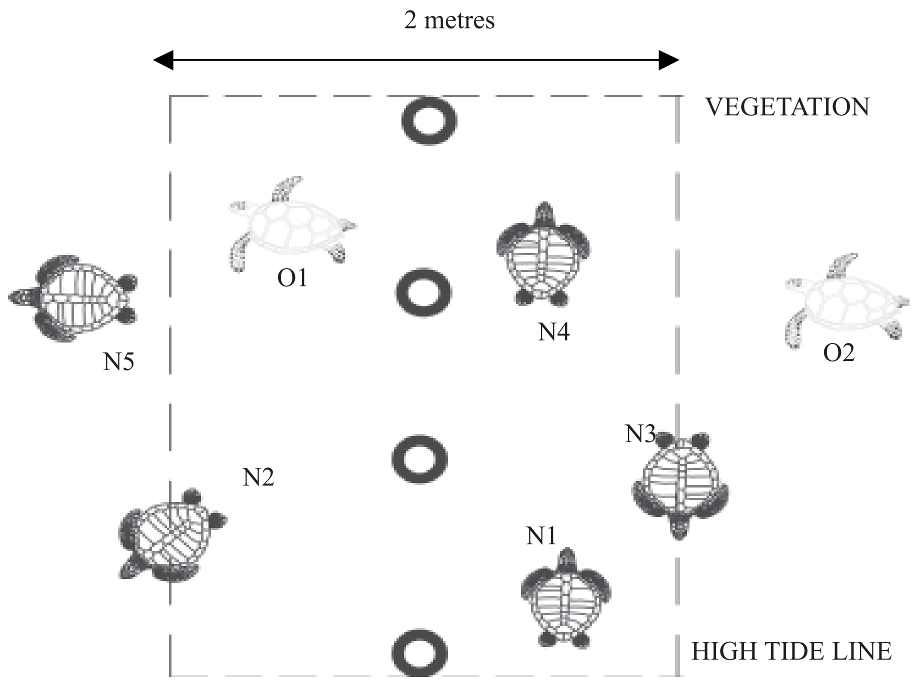


Step 3: Count egg laying turtles within transect.

If the turtle is within the transect, check whether it is laying eggs or not. This can be done by digging behind the turtle and checking if oviposition has started. One can also observe the turtle for a few minutes; egg laying turtles have their hind flippers splayed out, while those that are still digging will make periodic movements of their hind flippers.

c. the turtle is laying eggs and should be COUNTED

d. the turtle is not laying eggs and should NOT be counted



IN THIS DIAGRAM:

N1 - N5 are turtles that are LAYING EGGS

O1 - O2 are turtles that are NOT LAYING EGGS

N1, N2, N3, N4 AND O1 are WITHIN THE TRANSECT

N5 AND O2 are OUTSIDE THE TRANSECT

The total number of egg laying turtles within this transect = 4

The analysis

Nesting is estimated as follows:

$$\text{Estimate of Nesting} = \frac{\text{total available nesting area (m}^2) \times \text{duration of arribada} \times \text{sum total of egg laying turtles}}{\text{width of transect} \times \text{number of sampling periods} \times \text{sum of length of transects} \times \text{average duration of oviposition}}$$

This equation can be further simplified if the suggested methodology is followed:

- One transect each 100 metres
- Each transect is two metres wide
- Transects are conducted each hour.
- Each transect extend from high tide line till nesting ends (at dune, vegetation or water body)

$$\text{Estimate of Nesting} = \frac{\text{sum total of egg laying turtles counted} \times \text{beach to transect ratio} \times \text{duration of each sampling interval}}{\text{average duration of oviposition (min.)}}$$

Proportional area of nesting beach to transect = 100 metres / 2 metres = 50
Duration covered by each sample = 1 hour = 60 minutes

Hence,

$$\text{Estimate of Nesting} = \frac{\text{sum total of egg laying turtles counted} \times 3000}{\text{average duration of oviposition (min.)}}$$

Caveat

The above analysis is to be used if the exact method described here is followed. For further details, see Valverde and Gates (1999). Several variations in the method can be introduced in sampling interval (eg. half hour or two hour intervals) or transect interval (50 m or 200 m intervals) and analysis will vary depending on this. If transects are of equal length, calculations will vary.

Validation

It is always useful to be able to verify or validate the results from a particular method. The total number of turtles nesting in the entire arribada will never be known, but total counts can be carried out for a 100 metre section of the beach for an hour of nesting. This can be carried out a few times in different parts of the beach to check the accuracy of the estimates. Even a few such total counts require considerable effort, but may provide valuable information about the efficacy of the method.

Calculation of variance

The calculation of variance is slightly more complex and requires the use of a computer program or a spreadsheet such as MICROSOFT EXCEL or LOTUS. A program for the estimation of nesting turtles and variance can be obtained from the internet. Alternately, the authors of this manual are available for any help or advice for these calculations.

$$\hat{M} = \frac{AH}{2wtl.} \; \frac{n..}{h}$$

The variance of the estimated number of nesting turtles in the arribada is:

$$\hat{v}(\hat{M}) \approx \hat{M}^2 \left[\frac{\hat{v}(n..)}{n..^2}\right]$$

If transects are approximately of equal length:

$$\hat{v}(n..) = \frac{m\sum\sum nij^2 \quad \sum_{i=1,t} ni^2}{m-1}$$

If transects are not of equal length:

$$\hat{v}(n..) = \frac{m^2 \sum_{i=1,t}\left[L \sum_{j=1,m} ljnij^2 - \left(\sum_{j=1,m} ljnij\right)^2\right]}{L^2\,(m-1)}$$

The associated 95 % confidence interval is given by the approximation:

$$\hat{M} \pm \hat{M}\sqrt{\frac{\hat{v}(n..)}{n..^2}}$$

The coefficient of variation is given by:

$$cv\,(n..) = \sqrt{\frac{\hat{v}\,(n..)}{n..^2}}$$

The length of the session can be calculated using the simple equation:

$k = t * r$

VARIABLES

M	=	estimated number of nesting turtles;
A	=	total available nesting area (m^2);
H	=	duration of the *arribada* (min.);
w	=	half width of transect (m);
t	=	number of sampling periods;
Σlj=l.=L	=	sum of the length of all transects (m);
n..	=	sum total of egg laying turtles counted;
h	=	average time spent by turtles laying eggs (min);
v (M)	=	estimated variance of estimate;
v (n..)	=	estimated variance of the total number of egg-laying females;
m	=	number of transects;
nij	=	number of turtles laying eggs in the i^{th} period and the j^{th} transect;
ni.	=	sum total of turtles in all transects in the i^{th} period;
k	=	length of session (min.);
r	=	inter-sampling interval (min.)

Photo - Kartik Shanker

Mass Nesting at Gahirmatha in March, 1999 - An example

The strip transect method was used to quantify the 1999 arribada at Gahirmatha (Shanker *et al*. 2004). We provide here brief extracts from the methods and results.

Methods

"*Olive ridley turtles were counted during the arribada between March 25 –31, 1999 at Nasi 2 island, Gahirmatha, using a method modified from Valverde and Gates (1999). A total of seventeen strip transects were established, one each at every 100 metres, over the entire length of the beach (1.8 km). Each 20 metre wide transect was marked by wooden poles and extended from the high tide mark till the riverine face of the island, i.e. across the entire width of the island. Transect lengths depended on the width of the island and therefore were unequal. Each transect was walked once every hour from 6 PM till 6 AM and all ovipositing turtles within the strip were counted. During this period, an arribada also occurred on Nasi 1, the adjacent island. Though the beach was not censused, the area and period of nesting was documented. The duration of oviposition was documented for 20 nesting turtles to obtain an average value for estimation of population size during the arribada*." (extracted from Shanker *et al.* 2004)

Data sample

Sample data

This represents data from Day 1 of the arribada described above. Each of the 17 transects was counted on the hour from 6 PM till 6 AM the following morning

Day	Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	nj..
1	6:00 PM	0	0	0	0	0	0	3	17	28	25	42	37	39	39	10	23	4	267
	7:00 PM	0	0	0	0	0	0	3	22	33	30	25	33	36	53	15	23	4	277
	8:00 PM	0	0	0	0	0	0	2	12	25	32	23	32	14	60	10	32	6	248
	9:00 PM	0	0	0	0	0	12	3	13	38	39	28	23	44	36	12	36	14	298
	10:00 PM	0	0	0	0	0	3	6	8	24	38	24	27	41	42	20	32	12	277
	11:00 PM	0	0	0	0	0	2	3	10	23	30	24	20	20	23	14	31	10	210
	12:00 AM	0	0		0	0	9	2	14	20	13	19	11	10	12	11	26	12	159
	1:00 AM	0	0	0	0	0	7	4	6	18	11	17	11	9	19	3	22	11	138
	2:00 AM	0	0	0	0	0	6	1	7	15	11	17	15	7	17	2	18	5	121
	3:00 AM	0	0	0	0	0	4	1	5	20	9	14	16	4	14	3	13	4	107
	4:00 AM	0	0	0	0	0	7	1	3	16	8	10	13	4	12	2	11	3	90
	5:00 AM	0	0	0	0	0	4	2	5	16	5	13	5	5	7	5	11	4	82
	6:00 AM	0	0	0	0	0	2	2	4	4	10	9	7	5	12	2	3	4	64
																			2338

Note that these are 20 metre wide transects in comparison with the 2 metre wide transects that are being recommended in this manual.

Estimate of nesting

Total area of nesting (m2)	= 102850
Duration of aribada	= 780
Sum total of egg laying turtles	= 2338
Width of transect	= 20
Number of sampling periods	= 13
Sum of length of transects	= 1028
Average duration of oviposition	= 13.5

$$\text{Estimate of Nesting} = \frac{\text{total available nesting area (m2)} \times \text{duraton of aribada} \times \text{sum total of egg laying turtles}}{\text{width of transect} \times \text{number of sampling periods} \times \text{sum of length of transects} \times \text{average duration of oviposition}}$$

$$= \frac{102850 \times 780 \times 2338}{20 \times 13 \times 1028 \times 13.5} = \mathbf{51980.83}$$

As shown on page 34, this can also be roughly estimated as follows:

$$\text{Estimate of Nesting} = \frac{\text{sum total of egg laying turtles counted} \times \text{beach to transect ratio} \times \text{duration of each sampling interval}}{\text{average duration of oviposition (min.)}}$$

$$= 2338 \times \frac{100}{20} \times \frac{60}{13.5} = \mathbf{51955.56}$$

A minor discrepancy occurs due to the calculation of total area in the first equation

Results

"*Mass nesting occurred over 5 days on two islands in Gahirmatha in March, 1999. During 4 days of peak nesting, 116,500 to 153,500 ridley turtles are estimated to have nested on Nasi 2 island* "

Table 4a: Estimates of nesting numbers on Nasi 2 in March 1999

Day	Mean (with 95% confidence intervals)	Standard Error	Coefficient of Variation
1	51981 ± 7544	3772.21	7.26 %
2	55182 ± 6583	3291.46	5.96 %
3	17053 ± 1925	962.85	5.65 %
4	10850 ± 2578	1289.28	8.87 %
Combined	**135066 ± 18630**		

(*extracted from Shanker et al. 2004*)

Photo - Kartik Shanker

Habitat surveys

Though there are vast areas that appear to be potentially suitable for nesting and foraging, this does not necessarily imply the presence of sea turtles. Hence in order to identify important habitats for sea turtles, one must conduct a broad scale survey to locate potential habitats, and then conduct intensive surveys at these sites to determine the nesting and foraging population size.

Nesting habitats

Interviews: Substantial local knowledge exists on many aspects of turtles as well as other wildlife. Most coastal fishing communities are aware of sea turtle nesting, if it occurs in their region, and are likely to have even more specific information if they consume the meat or eggs. The precision of species identifications varies from region to region and must be carefully evaluated.

Preliminary habitat surveys: Preliminary habitat surveys can take into account habitat features that are required for nesting ie. the presence of sandy beaches, the nature of the offshore approach, the level of disturbance in offshore waters, and the level of disturbance on land. Beach characteristics include the width of the beach, dominant beach vegetation, grain size and texture, sand compaction, moisture, beach profile, wave conditions, and presence of rivers and estuaries (see beach preference for different species).

Intensive surveys: Intensive population surveys can be carried out to evaluate the species and intensity of nesting as well as to determine the total habitat available and threats. Since it is not feasible to conduct population surveys to determine total nesting across several hundreds of kilometers, the nesting from index beaches can be extrapolated to the entire coast if the total available habitat is evaluated. This will differ from coast to coast for a variety of reasons. In India, in Orissa, 400 out of 480 km of coastline is suitable for nesting, the remainder being unsuitable because of mud flats and rocky coast. In Kerala, only 100 out of 600 km is suitable for nesting, the rest having been blocked by beach armouring to prevent erosion. Hence habitat suitability can be affected by both natural and human related factors, which needs to be evaluated thoroughly.

Foraging habitats

Interviews: Again, interviews can provide much valuable information about the occurrence of sea turtles in offshore waters. The coast guard, fishermen and ship crews can provide information based on sightings.

Preliminary surveys: Surveys need to be carried out using SCUBA or snorkelling to ascertain the presence of foraging turtles. Sea turtle presence can also be evaluated from indirect evidence such as the presence of food items specific to particular turtles such as sponges for hawksbills, sea grasses for green turtles and crabs and other crustaceans for ridleys and loggerheads.

Intensive surveys: This can include transects and mark recapture studies to estimate population size in offshore waters and foraging habitats. For long term inputs, one can set up sighting networks where observers (coast guard, fishermen) can send in information on a regular basis.

Photo - Manjula Tiwari

Secondary data and market surveys

While primary data may be the best way to collect data on turtle populations and threats, there are several constraints, including time and money. Further, secondary data can provide clues to long term trends for which primary data cannot be collected in a short period of time. Secondary data may include collection of data from published and unpublished or grey literature, or collection of information from stakeholders.

Literature survey

It is rare that no information is available on a subject such as nesting of turtles on a particular beach. Often, the problem lies in the fact that the information is in unpublished reports, or papers in journals that are not widely accessible. Researchers should first check whether such reports are available with enforcement agencies (forest and fisheries departments) and conservation groups (NGOs) and research groups associated with the area in question. Methods of data collection vary, and may not always be clearly outlined in such reports, and hence the data may not be directly comparable, and one should exercise caution in arriving at conclusions based on these data. However, these can usually provide a baseline for planning and designing a study for the collection of primary data.

Interviews

Interviews are useful to collect information quickly and inexpensively, summarise the experience of knowledgeable people and communities, compile information otherwise available only orally, and supplement data collected by direct observation. Though the data collected in interviews may not be standardised and usually cannot be used for quantitative comparisons, they synthesise a body of knowledge available within a community collected over several years or even generations and thus have a value that primary data cannot easily provide.

Conducting interviews

Interviews can be conducted in several different ways. However, a common theme to all interviews is that the observer must ensure the quality of the information collected. In order to ensure this, the interviewer must understand the politics of the information to be collected, the people being interviewed and his own position. For example, fishers may not reveal the magnitude of incidental mortality if they feel threatened by the interviewer. Mainly, the interviewer must be prepared to be courteous, listen carefully, and be respectful of the interviewee. One must know the language, or be certain that the translator is entirely objective with regard to the issues and the people.

Interviews should be carefully designed to get the most accurate understanding of the interviewee's knowledge. Questions can be framed in two or three different ways to obtain the same information, so that concordance can be used as a quality check. Questions should be objectively framed, so as not to reveal the bias of the interviewer. Thus one should ask 'Has the number of nesting turtles changed?' or 'Are there more or less turtles than before?' rather than 'Has the number of nesting turtles decreased?' which reveals the expectation of the interviewer. If the interviewer needs to understand

how the interviewee arrived at a conclusion, he should investigate it carefully, but courteously.

One more important consideration is the ethics of information collected by interviews. In the context of intellectual property rights, one must acknowledge the value of information collected during interviews. Mutual gain and equitable exchange must be the expected outcome of an interview. In some cases, interviewees may require and request anonymity which must be fully respected.

Types of interviews

Interviews can be conducted using questionnaires, prompting a discussion using lead questions, or completely open ended discussions. Questionnaire based interviews are the most structured format and result in the data most amenable to statistical analysis. However, open ended discussions often provide understanding of complex issues, that may not have been previously known to the interviewer. Ideally, a combination of these methods can be used.

Recording information

Information can be recorded by hand, tape recorder, videography, or even memory. The method chosen should best suit the interviewee so that they are comfortable and not threatened in any way by the mode of recording.

Reply paid post cards

In India, a number of surveys have used reply paid post cards to collect information, especially from state agencies and non government organisations. An advantage of this method is that a large number of individuals and agencies can be contacted without visiting them personally. However, this precludes any evaluation of the socio political standing of the interviewee, and hence makes it difficult to assess the quality of the information.

Market Surveys

Market surveys can compile information on levels and types of sea turtle use, organisation of market structure, increase or decrease in product availability and demand, role and importance of turtles in the diet and income of people in an area, cultural connections, people's attitudes to turtles, and ecological information. Such surveys can collect information using interviews or direct observation of the market and associated disposal sites.

Information that can be collected during interviews

On biology, status and distribution
What species of turtles are seen ? How are they identified ? Do they have local names ?

How many turtles are seen (per distance or area unit) ? How many turtles nest (per distance per time) ? Which turtles are the most common (relative or ranked abundance) ?

Where are the turtles found ? What are they doing (foraging or nesting or migrating)? What times of the year are they encountered ? What sizes and sexes are found and where and when ?

How many turtles were found in the area (nesting, foraging or captured) 10 / 20 / 50 years ago. Has there been a change ? Why ?

Utilisation
Do people consume turtles or use their products ? How are turtles used ? Are eggs and meat consumed ?

How many turtles (species, size) are caught ? How, where, when ?

What are turtles used for ? Are they caught intentionally or opportunistically ? What proportion of the diet / income do the turtles form ? What proportion of the community uses or depends on turtles ?

What are the selling prices of turtles and their parts ? How long have they been used?

On Threats
What are the main threats to the eggs ? What are the main threats to the hatchlings once they emerge from the nest ? What are the main threats to the adult turtles ?

Are hatchlings caught in nets or fishing gear ? What kind ? Do many hatchlings die before they reach the sea ? Why ?

Are adult turtles caught in nets or fishing gear ? What kind ?

Is anything needed to protect the eggs ? Hatchlings ? Adults ? Are eggs / hatchlings / adults protected by law ?

Laws and conservation programs
Are there local agreements or laws concerning the use of turtles ? Are they working? Who enforces them ? Are they necessary ? Are they fair ?

Are there conservation programs ? What do they involve ? Who conducts them ? Are local communities involved ? What do local communities think of these programs ? Do they benefit ?

Are government agencies involved in turtle conservation or management ? What do they do ? What do local communities think of these programs and how are they affected ? Do either government or conservation agencies share information with each other or with local communities ?

Do you think conservation is necessary ? What action are you willing to take ?

Have flipper (or other) tags been encountered ? What is done with such tags ? What is the perceived purpose of these tags ?

On fishing
Do you fish ? For how long have you fished ? Do you use a boat ? What kind / size ? Do you use nets ? What kind / size ? How far offshore do you fish ? How often (days / week, hours / day) ? What is the most important fish that you catch ?

Information on the locality
What is the spoken language ? What communities live in the area ? What is the population size ? What are the common livelihoods ? What facilities and infrastructure are available (hospital, school, water, sanitation, electricity) ?

Information source
Name and Address
Sex, Age, Occupation,
Date and location of interview

Market survey Information
- Name and location of market
- Date, day of the week, time visited
- Number of vendors (selling turtles, turtles parts and turtle products)
- Number of turtles, species, size and sex
- List of items, seasonality, popularity, prices
- Sources of turtles, parts and products, locations of collections, livelihoods of collectors
- Organisation of market and vendors
- Number of vendors surveyed or interviewed

Questionnaire used for interview with fishers on the AP coast
(from Tripathy et al., 2003)

Wildlife Institute of India, Dehradun GOI UNDP Sea Turtle Project – Andhra Pradesh Survey

Nesting beach Interview Questionnaire

Date of Survey ______________________ Time start ______ Time End _________

Beach Name/zone____

Observer ____

Name and occupation of interviewee: ______________________________________

Turtle information

What turtles are seen in this area?

Local names:
How are different species identified?

When are the turtles seen (season)? Peak ?

How many turtles are seen nesting (species wise abundance/ area/ day) ?

How many turtles were there earlier (20/ 50 years ago)?

Is there a decline? Why ?

Are turtles or turtle eggs consumed?

What is the perception of marine turtles – beneficial / harmful / irrelevant ?

Are turtles protected ? By whom?

Information on locality:

Number of people in the village:
Castes/ communities/ religion:
Livelihood:
Socioeconomic status:
Basic facilities (electricity, water, health care, education):

Photo - J. Vijaya

Estimating threats

In order to successfully conserve a species, one must have a clear idea of the factors contributing to its decline. While some onshore threats may be more visible, offshore factors such as fishery related mortality either at the breeding ground or along the migratory route may contribute much more significantly to the decline of the population.

Categorising threats

Threats can be classified into direct and indirect threats. As it is, survival rates are low, and eggs are predated by small carnivorous mammals and crabs and hatchlings are predated by birds, mammals and crabs. Once they are in the sea, a variety of predators plague them through their juvenile stages. Only large sharks, perhaps killer whales and humans predate adults.

Indirect threats:

- Sand mining from nesting beaches for building constructions, extraction of minerals and radioactive materials
- Coastal armoring for protection against beach erosion
- Ports, harbors, jetties
- Coastal highways and marine drives
- Exotic plantations and afforestation
- Artificial illumination
- Marine pollution
- Coastal aquaculture
- Coastal tourism

These are dealt with in greater detail in the manual on Eco (Turtle) Friendly Coastal Development.

Direct threats:

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

Mortality count

A commonly used index of threats to sea turtle populations is enumeration of stranded turtles ie. turtles that wash up injured or dead on the beach after drowning in fishing nets. It may be difficult to deduce what kind of net (gill net, trawl net, etc.) the turtle was trapped in. Furthermore, many turtles that die in fishing nets may never wash up on the beach. Some estimates suggest that as few as 10 % of the turtles that drown as incidental catch wash up on the beach. Even so, the number of dead turtles during a season can provide a good index of the degree of threat and whether conservation measures have worked.

Observers should note information about carcasses which may help identify the source of the threats. However, it can be hard to assign the cause of death. Even propeller cuts on the flipper and carapace are not conclusive since they could have occurred post

mortem. The extrusion of the genitalia is generally considered as a sign of asphyxiation, which implies that the turtle died in a fishing net. Necropsies of turtles can usually provide a fund of information, but this requires expertise and experience. The total stranding count is still useful, since it can be combined with other information to deduce what the threats are.

Using a network

While individual research projects conduct threat surveys, more information can be gathered if there is systematic data collection by a formal network along the coast. This can include officers of government forest or fisheries departments, non government organizations, colleges, and individuals. Such networks can help document stranded sea turtles, salvage dead individuals for necropsy and rehabilitate or release live sea turtles. Data can be used to identify sources of mortality, document locations of conservation concern, evaluate the effectiveness of regulations, and help make management decisions.

It is useful for large networks to have a regional coordinator who can help train local participants, coordinate data collection and verify data such as species identification and sex of the turtle. If mortality surveys are carried out, these should be conducted at periodic intervals, say 1 – 3 times a week. Ideally, dead turtles should be painted to avoid recounting.

Standard Data

- Observer's name and contact information
- Stranding date
- Stranding location
    - with reference to town or landmark
    - latitude-longitude if possible
    - inshore (bays, estuaries) or offshore (oceans and their beaches)
- Species
    - Reliability of the identification (ID verified by)
- Sex
    - Male, female, undetermined
    - How sex was determined ?
- Condition of turtle (Alive, fresh dead, moderately decomposed, severely decomposed, dried carcass, skeleton or carapace)
- Tag numbers, if any
- Remarks (gear or debris entanglement, oil or tar, wounds, propeller damage, papilloma)
- Measurements (units)
- Final disposition of turtle (painted, left on beach; buried; salvaged for necropsy; unpainted, left on beach; alive, released; alive, taken to a holding facility)

SEA TURTLE STRANDING AND SALVAGE NETWORK - STRANDING REPORT

OBSERVER'S NAME / ADDRESS / PHONE:

First__________________ M.I.____ Last __________________

Affiliation ______________________________________

Address ______________________________________

____

Area code/Phone number ______________________________

STRANDING DATE:

Year 20☐☐ Month☐ ☐ Day☐☐

Turtle number by day ☐ ☐

State coordinator must be notified within 24 hrs; this was done by

Phone:

E-mail:

Species: (check one)

☐ CC = Loggerhead

☐ CM = Green

☐ DC = Leatherback

☐ EI = Hawksbill

☐LO = Olive Ridley

☐UN = Unidentified

Check Unidentified if not positive. Do not guess.

STRANDING LOCATION: ☐Offshore (Atlantic or Gulf beach) ☐ Inshore (bay, river, sounds, inlet, etc.)

State ______________________ District ______________________

Descriptive location (be specific) ______________________________

____

Latitude ______________________ Longitude ______________________

Carcass necropsied?☐Yes☐ No

Photos taken? ☐ Yes ☐ No

Species verified by state coordinator?☐ Yes ☐ No

Condition: (check one)

☐0 = Alive

☐1 = Fresh dead

☐2 = Moderately decomposed

☐3 = Severely decomposed

☐4 = Dried carcass

☐5 = Skeleton, bones only

FINAL DISPOSITION: (Check)

☐ 1 = Left on beach where found: painted?☐ Yes*☐ No (5)

☐ 2 = Buried: ☐ on beach / ☐off beach;
carcass painted before buried?☐ Yes ☐No

☐ 3 = Salvaged: ☐all / ☐part(s), what/why?____________

____

____

☐ 4 = Pulled up on beach/dune; painted?☐ Yes* ☐ No

☐ 5 = Alive, released

☐6 = Alive, taken to rehab. facility, where? ____________

____

☐ 7 = Left floating, not recovered; painted?☐ Yes*☐ No

☐8 = Disposition unknown, explain____________________

____

*** If painted, what colour?** ______________________

Sex:

☐Undetermined

☐ Female ☐Male

Does tail extend beyond carapace

☐Yes; how far?__________cm / in

☐ No

How was sex determined?

☐ Necropsy

☐Tail length (adult only)

TAGS: ***Contact state coordinator before disposing of any tagged animal!!***

Checked for flipper tags?☐Yes☐No

Check all 4 flippers. If found, record tag number(s) / tag location / return address

____

____

____

PIT tag scan? ☐ Yes ☐ No

If positive response, record location (flipper)

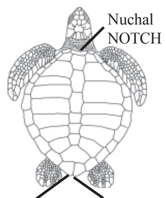
____

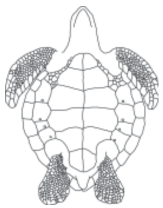
Check for living tag?☐ Yes ☐No

If found, record location (scute number & side)

CARAPACE MEASUREMENTS: (see drawing)

Using calipers		**Circle Unit**
Straight length (NOTCH-TIP)	____________	cm/in
Minimum length (NOTCH-NOTCH)	____________	cm/in
Straight width (widest point)	____________	cm/in
Using non-metal measuring tape		**Circle unit**
Curved length (NOTCH-TIP)	____________	cm/in
Minimum length (NOTCH-NOTCH)	____________	cm/in
Curved width (Widest Point)	____________	cm/in
		Circle unit
Weight ☐actual / ☐est.	____________	kg / lb





Modified from NMFS - Sea Turtle Stranding and salvage network

Mark wounds / abnormalities on diagrams at left and describe below (note tar or oil, gear or debris entanglement, propeller damage, epibioata, papillomas, emaciation, etc.) **Please note if no wounds / abnormalities are found.**

____

____

____

____

____

____

Basic data sheet for mortality survey

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:

Selected Bibliography and Further Reading

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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 third 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
- Research and Management Techniques
- Eco (turtle) friendly coastal development

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