SEA TURTLE CONSERVATION

ECO (TURTLE) FRIENDLY COASTAL DEVELOPMENT

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Cover photo: Beach armouring in Lakshadweep, Kartik Shanker
Beach armouring is a major threat to sea turtles; it obstructs them from nesting and aggravates erosion on nesting beaches.

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A GOI – UNDP PROJECT MANUAL

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Contents

Photo - Kartik Shanker

Coastal offshore and onshore habitats have great significance for the survival of marine and coastal flora and fauna. As an ecotone between the two habitats, beaches are dynamic and subject to a variety of changes. While the biota of this region have adapted themselves to diurnal, tidal, lunar, seasonal and stochastic events in this zone and any acute or chronic changes in this habitat due to anthropogenic actions can have irreversible negative consequences. In this context, it is important to understand the impact of anthropogenic activities in the coastal zone and how they can be prevented or mitigated.

Marine turtles, whose lifecycles are intricately linked to both onshore and offshore coastal habitats, can be important indicators of impacts, since their survival is dependent on the well being of these habitats .

The purpose of this manual is to provide wildlife management authorities, coastal community groups, environmental organizations and other agencies with basic information on sea turtle biology and related coastal issues. We hope to provide some pointers on how to conduct developmental activities in a manner that is ecofriendly in general and sea turtle friendly in particular.

India has 7,500 km of coastline under 53 coastal districts of 10 maritime states and six union territories including theBay islands of Andaman & Nicobar archipelagoand the atoll island group of Lakshadweep, which harbor a vast extent of coastal and marine habitats. According to the 1991 census, nearly 50% of the country's population inhabit these areas, which has put tremendous pressure on the coastline. This coast, frequented by sea turtles, though for a short duration, is subject to a multitude of developmental activities. These activities are not necessarily turtle friendly and in most cases adversely impact the nesting females as well as sea turtle hatchlings, even though with a slight change in approach, both can coexist.

In India, coastal states have their own maritime acts, which are meant to safeguard marine resources and prevent detrimental activities within the territorial waters of the country, which is up to 12 nautical miles from the shore. Similarly, along the coast, the CRZ (Coastal Regulation Zone) safeguards marine turtle nesting beaches, with additional support being provided by the Wildlife (Protection) Act, 1972, in which all species have been listed in Schedule-1, which affords maximum protection.

Photo - Basudev Tripathy

Sea turtles and the coast

All species of marine turtle share a similar life cycle pattern with very minor differences. As adults, they migrate from their foraging areas to breeding areas hundreds or thousands of kilometers away. They mate in the offshore waters of the breeding areas, following which adult females heave themselves up above the high tide line, excavate a nest with their hind flippers, lay 100 or more eggs and cover them up with sand. Their investment in this particular nest is over, though some of them may haul themselves up more than once in a single season to lay further clutches of eggs. The eggs remain in the nesting beach for about 50-70 days (the exact period depending on overall sand temperature), and are vulnerable to various predators and impacts of many anthropogenic activities.

During the migration adult male and female turtles cross the international boundaries of many countries. It is this complex link of marine turtles to a nesting beach in a particular country, and their migration path spanning vast stretches of open seas through international boundaries , that makes marine turtles a global resource.

Five species of marine turtles namely, olive ridley (*Lepidochelys olivacea*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys Coriacea*) and loggerhead turtles (*Caretta caretta*) occur in the Indian coastal waters of the Bay of Bengal and Arabian Sea.

All, barring the loggerhead, nest on the coast of India. The most important beaches are the olive ridley nesting beaches along the Orissa coast, the leatherback nesting beaches in Andaman & Nicobar Islands, the green turtle nesting beach in Gujarat and Andaman & Nicobar and the hawksbill nesting beaches in the Andaman & Nicobar Islands. In addition, practically all coastal states have sporadic nesting beaches and offshore congregation zones for sea turtles.

Even though sea turtles cover the world's tropical and subtropical seas with spectacular adaptations for a life in water, they are highly dependent on the well being of beaches. Though many reptiles have returned to partial or complete lives in the water (such as freshwater turtles, sea turtles, snakes and crocodiles), they are all still tied to land for one phase of their life, namely reproduction. Hence, sea turtles need sandy beaches to lay eggs. Furthermore, sea turtles are highly philopatric, meaning that females return to the same beaches where they were born, to lay eggs as adults. Hence, the loss of nesting habitats can have disastrous consequences for sea turtle populations.

Besides, sea turtles mate in the offshore waters of their nesting beaches, and juveniles and adults of many species feed in nearshore shallow water habitats, such as coral beds sea grass beds, mangroves creeks and lagoons. Thus the lives of sea turtles are intricately linked to the health of coastal habitats.

Photo - Basudev Tripathy

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

Photo - Kartik Shanker

Leatherback *(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

Photo - Kartik Shanker

Hawksbill *(Eretmochelys imbricata)*

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

Photo - Mathew Godfrey

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

Photo - Bivash Pandav

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

Threats to sea turtle habitats

Basically, marine turtles must have access to undisturbed beaches with deep, loose sand above the high tide line during their nesting season. Some turtles nest seasonally while others nest throughout the year. This may vary between species and also between sites.

The following developmental activities adversely impact sea turtles and their habitats, especially when they are unplanned or unregulated. Such impacts have been previously documented, both in the marine as well as onshore habitats along the coast. And we examine four categories of threats to coastal habitats

a. On the beach

i. Sand mining
ii. Beach armoring
iii. Artifical illumination
iv. Highways and marine drives
v. Exotic plantations
vi. Ports, harbours and jetties

b. In the offshore waters

i. Pollution
ii. Fisheries

c. Aquaculture

d. Tourism

Threats on the beach

During nesting, the female returns to the shore for a period of one to a few hours, depending on the species. Although the time spent on land is minimal, the beach serves as an incubator for the turtle eggs and is therefore a critical part of their life cycle. It is also a period when both eggs and hatchlings are most vulnerable to human related threats. Some sea turtles, like green and hawksbill turtles prefer to nest on islands, while others like olive ridleys nest in large numbers on sand spits near river mouths. These nesting beaches are often dynamic in nature and are subject to several natural changes. Human related activities at these sites interferes or aggravates the process of natural change and may permanently alter sea turtle nesting habitats

Photo - Kartik Shanker

Photo - Bivash Pandav

Sand mining

The coastal and nearshore marine environment, sea sand in particular, is a source for a variety of minerals of geological and biological origin that have been extracted and utilized by man for centuries. In general, marine sand used for building and construction are utilized locally, whereas those products that have a world market, such as jewellery and industrial metals, may be largely exported in one form or other. The mining or extraction of these minerals, however, tends to be unplanned and unmanaged causing severe and long lasting detrimental impact to the environment.

Sea beaches are dynamic landforms and are constantly subject to erosion and/or accretion. The sand on the beach is subject to storms, waves, and buffeting from the force of sea waves. This in turn results in the movement of sand from one part of the beach by erosion and accretion of the same sand in another region. The condition of a sea beach is the reflection of the local balanced or unbalanced gain due to deposition or loss due to erosion. While natural beachfront and sea erosions do occur, anthropogenic alteration of the beach has significantly contributed to beachfront erosion. Therefore, beach conservation should be based on the premise that any removal of sand can have adverse impacts by disrupting the natural cycle.

Impact of sand mining on sea turtle nesting beaches

Coastal sand mining can change the entire beach geomorphology and restoration of the beach often takes years resulting in loss of available habitat for marine flora, fauna and sea turtles. The immediate deleterious impact of beach sand mining on sea turtles is to uncover and destroy nests. Raking can also leave ruts and ridges that disrupt hatchlings' sea finding behaviour.

While beach nourishment is one solution for what has been lost due to sand mining, it can negatively impact sea turtles if the sand is too compacted for turtles to nest in. If the sand imported is drastically different from native beach sediments, it may affect nest-site selection, digging behaviour, incubation temperature, gas exchange and the moisture content of nests, all of which can ultimately impact the reproductive fitness of sea turtles.

In India, there is severe damage to the nesting beaches of olive ridley turtles along the Orissa coast (sand mining for rare earth metals), Andhra Pradesh (sand mining for minerals), and Kerala (sand mining for building constructions). In Andaman & Nicobar Islands, in the absence of riverine sand, large scale sand mining from narrow fringes of sandy coastline impacts nesting beaches of olive ridley, green, hawksbill and leatherback turtles.

Guidelines for coastal sand mining

The Government of India, in 1991, issued a major notification under the Environmental Protection Act, 1986, framing rules and regulations (Coastal Regulation Zone (CRZ) Rules) for various developmental activities along the coast. The maritime states are in the process of preparing CRZ maps, which clearly delineate fragile, sensitive and ecologically important nesting beaches of rare and endangered fauna and such identified zones are not to be subjected to any form of sand mining. In this context, before taking up any coastal sand mining activity, the concerned agencies must ensure that the targeted areas are not important habitats of any marine fauna.

These sensitive coastal stretches need to be identified, properly marked with site boards and labels and removal of sand from such zones or primary dunes should be completely prohibited.

Even where sand mining may be allowed, the actual mining must be preceded by proper impact assessment studies conducted by the development agencies in collaboration with the coastal resource management authorities including environment, forest and wildlife agencies.

If sand extraction from the landward side of the berm is permitted, it should be carefully conducted avoiding the main nesting season of sea turtles and other rare and endangered fauna, and hard engineering exercises must be stopped at night.

Sand mining activities must ensure adequate control to prevent sedimentation of watercourses from spoil deposits and other disturbance on the land surface.

Sand fill and other restoration processes need to be monitored to confirm whether such restoration processes actually rehabilitate sand dunes, and whether the new fill is compatible with the needs of nesting sea turtles and other coastal fauna and flora.

Photo - B.C. Choudhary

Beach Armouring

The deliberate ‘armouring’ of the coast with the sole purpose of protection of upland structures is rapidly degrading sea turtle nesting habitats in many parts of the country. Coastal armouring is exhibited in many different forms such as

i. bulkheads and seawalls
ii. revetments
iii. sandbags and geotextile tubes
iv. soil retaining walls
v. dune reconstruction.

Sea beach erosion has been a problem especially along the west coast of India. To mitigate erosion, beaches have been armed with concrete tetrapods and sand bags along the Kerala coast, Lakshadweep and Andaman & Nicobar Islands. Wherever coastal development has been planned and the area is subjected to some degree of erosion, concrete armouring has been carried out without conducting any impact assessment studies on marine flora and fauna.

Possible impact on sea turtles

There are four broad consequences to the beach/dune system that can result from coastal armouring.

i. Coastal armouring structures cause reflection in wave energy, which can increase erosion seaward of these structures.

ii. The intensity of long shore currents can be increased, moving sand away from the site more rapidly and in greater quantities.

iii. The natural exchange of sand between the dune and the beach is prevented; the wave energy is concentrated at the end of armoring structures, which can exacerbate erosion at an adjacent, unarmoured beach.

iv. These structures physically block female turtles from reaching suitable nesting sites, or simple the presence of structures is aversive to nesting females. These structures may also disrupt seafinding of any hatchlings produced on the beach.

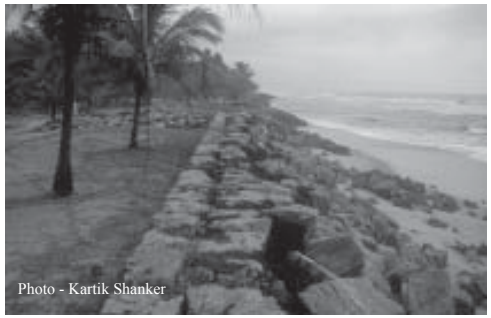


Photo - Kartik Shanker

Guidelines for ecofriendly armouring

All important sea turtle nesting beaches of moderate intensity must be identified and should be free from beach armouring as sea turtles normally prefer gentle sloping seaward sand dunes rather than beaches which are subject to regular erosion.

Beach changes must be measured and monitored on a regular basis. This information should be used by planning agencies and others to reduce the problems caused by coastal erosion and to conserve and effectively manage coastal development.

Construction of temporary sand trapping fences

A typical sand fence consists of vertical slats joined with wire/rope or supported with sand posts. Such structures have proved to be more effective in controlling beach erosion and are relatively sea turtle friendly. Caution must be used when selecting the placement of these fences so as to avoid impacting nesting females. In general, sections of fence should be no more than 3 meters in length and should run at a 45° angle relative to the high tide line. The sections of fence should all be parallel to each other.

Sand trapping fences may be constructed in destroyed, eroded beaches during the non-nesting season and once the sand is trapped sufficiently and a dune is created, it should be planted with appropriate vegetation. This will further reduce erosion and remove the need for armouring.

Depending upon availability, the fence can be constructed with discarded coconut branches, dry wood and logs, and other materials. The fence must be stabilized with vegetation.

Coastal vegetation promotes the large scale trapping of sand. The stems of beach grasses reduce the wind velocity near the surface resulting in deposition of sand. The plant roots also serve to bind and consolidate the sand. Therefore, revegetation is a suitable option for eroded beaches where armoring is planned.


Photo - Kartik Shanker

However, this should be area specific and depend upon the characteristics of a particular site. For example, olive ridleys prefer wide sandy beaches, and no vegetation should be planted up to a distance of 50-100 m from the high tide line. On the other hand, green turtles prefer to nest in coastal undergrowth vegetation rather than on open sandy beaches.

Photo - Yohan Thiruchelvam

Artificial illumination

Adult female turtles leave the sea more than once in a season to come ashore at night, spending an hour (olive ridleys) or three to four hours (leatherbacks) on the beach, to make a nest, deposit the eggs and to camouflage the nesting site. The eggs remain in the nest for about 50-60 days incubated by the sun and the metabolic heat generated by the development of the embryo. Once the hatchlings are completely developed and ready to emerge from their nest, they break the eggshells beneath the sand and make their way to the surface during the night. Upon reaching the surface, the hatchlings quickly scramble towards the sea triggered by the brighter horizon of the sea. Both nesting and hatchling emergence and sea finding occur primarily at night. This has evolved to maximize the survival by minimizing the risk of predation and desiccation for both adult females and hatchlings.

The emergence of the adult females to successfully nest in a particular beach depends on many factors including the natural suitability of the nesting site, presence or absence of abiotic and biotic disturbance factors. With increasing use of the coast for developmental activities, nesting sites are often abandoned by sea turtles due to human induced activities including artificial coastal illumination.

How does coastal illumination impact sea turtles ?

Adults

Artificial illumination on the nesting beaches impacts adult sea turtles by disrupting nest site selection, abandonment of nesting behaviour, disruption of sea finding ability and disorientation following unsuccessful nesting.

The most clearly documented effect of artificial lighting on sea turtle nesting beaches has been the non-emergence of adult females to the nesting beach. Dramatic reductions in nesting attempts by sea turtles at brightly lit nesting beaches have been documented for all species of sea turtles. Along the Indian coastline, artificial illumination near Gahirmatha and Rushikulya in Orissa had to be turned off during the nesting season to avoid disruption of nesting by olive ridley sea turtles.

Sea turtles are particularly sensitive to disturbance during the initial phase of nesting. Generally, female turtles will abandon egg laying and return to the sea if disturbed by lights and otheractivities. After nesting, sea turtles may move towards the brightly illuminated landward side of the seashore rather than going back to the sea. Such bright illumination along the seashore often comes from highways, beach resorts, industries, coastal village street lights and townships, ports and jetties and in recent years, coastal aquaculture farms.

Hatchlings

Sea turtle hatchlings orient themselves towards the sea as soon as they emerge from the nest. Under natural conditions, the hatchlings recognise the direction of the ocean almost exclusively by visual stimuli, detecting the brightness of the open seaward horizon, due to the reflection of stars and moonlight on water. Sand dunes and vegetation along the nesting beach also help create a darker horizon on the landward side. However, on beaches where artificial lighting is clearly visible, the hatchlings journey to the sea is disrupted. Hatchling sea turtles emerging from nests at night are strongly attracted to visible light sources along the beach. Consequently, hatchlings move toward the source of artificial illumination and away from the ocean. Hatchlings thus fail to find their way to the sea, and succumb to predators and exhaustion or dehydrate in the morning sun. Their orientation towards the artificial lights is so strong that even a small torch light left on the beach can attract hundreds of hatchlings towards it.

Photo - Bivash Pandav

Some of the major nesting sites of olive ridleys in India like Rushikulya in Orissa are now subject to heavy artificial illumination. This has resulted in heavy mortality of turtle hatchlings. During mass hatchling emergence following a mass nesting at this site in April 2001, hundreds of thousands of hatchlings strayed into the fields and vegetation behind the beach. These were collected in the morning by conservation volunteers, state Forest Department and local communities, for release into the sea. With the present trend in coastal development, artificial illumination is going to pose a serious impediment for sea turtles along the entire mainland coast, and even if they nest successfully, the hatchlings may stray on to land and die.

Guidelines for coastal illumination

Any light that is visible to the human eye at turtle level on a beach affects either the nesting turtles and/or the turtle hatchlings. The most direct and complete way to resolve the problem of lights near sea turtle nesting beaches is to put off all artificial lights visible to the nesting beaches during the breeding season. Unfortunately eliminating all the beach front lighting is not always possible. Under such circumstances, following a few simple measures can help and save sea turtles.

i. Artificial illumination along important sea turtle nesting beaches during the nesting season must be turned off (depending on the species, the peak nesting season at any particular location usually does not exceed three months of the year).

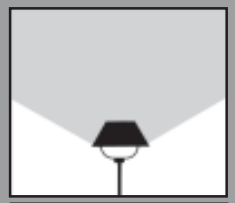
ii. The number of lights near sporadic and secondary nesting beaches must be reduced to the minimum necessary and switched off during peak nesting nights.

iii. Illumination reaching the nesting beach can be reduced by lowering, shielding, and redirecting light sources onto immediate land rather than towards the sea. Even the glow on the horizon can affect sea turtles. Low mounted lights are better than lights that shine upwards from a high pole

iv. An easy means to reduce the influence of light on turtle beaches is to screen them on the seaward side. This can be done by applying dark tinting to windows visible to the beach and by drawing curtains after the dark to shield lights from going to the seashore. Additionally, a vegetation wall or green fence can be created to block light from reaching the sea.

v. Care in placement and orientation of light fittings on coastal buildings and infrastructure will considerably reduce the impact of direct and scattered lighting on turtle beaches. This can easily be done by orienting lights towards land or by directing lights downwards and by using lamp shades that do not allow lights to reach the beach.

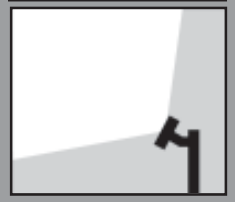
vi. Studies have shown that fluorescent, mercury vapour, high pressure sodium vapor, metal halide and white incandescent lighting disorient sea turtles the most. Studies need to test which lights affect sea turtles the least (and this may be species specific). For loggerheads, low pressure sodium vapor lights (not to be confused with high pressure sodium vapor) that emit a pure yellow light seems to work best. Similar studies need to be carried out for olive ridleys which nest along much of the Indian coast and are most affected by lighting problems.



Low level "Mushroom" lighting
Mounting suitability: Good if mounted at foot level.
Directional suitability: Poor.
Overall suitability: Fair. Good to excellent if used so that vegetation and topography block it's light from the beach.

Low level "Tier" lighting
Mounting suitability: Good if mounted at floor level.
Directional suitability: Poor but can be good if the fixtures has louvers that eliminate lateral light.
Overall suitability: Fair. Good to excellent if used so that vegetation and topography block its light from the beach.

Light bollard with louvers
Mounting suitability: Good of mounting height near 1 m.
Directional suitability: Good.
Overall suitability: Good.

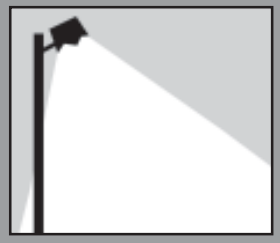


Ground-mounted floodlighting
Mounting suitability: Poor because of its upward aim.
Directional suitability: Fair to good.
Overall suitability: Fair to poor if directed away from the beach. Very poor if directed toward the beach.

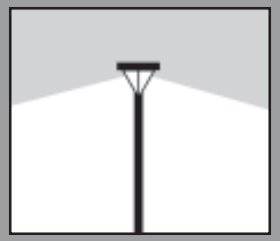
Poor: Poorly directed balcony lighting can cause problems on sea turtle nesting beaches.

Better: Completely shielding fixtures with a sheet of metal flashing can reduce stray light reaching the beach.

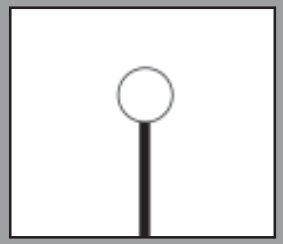
Best: Louvered step lighting is one of the best ways to light balconies that are visible from nesting beaches.



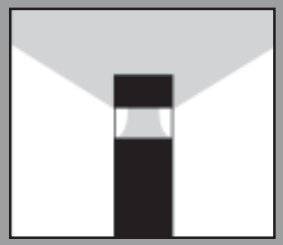
Pole-Mounted flood lighting with full visor
Mounting suitability: Good if directed downward and away from the beach.
Directional suitability: Good.
Overall suitability: Good if directed downward and away from the nesting beach and if light does not illuminate objects visible from the beach.



Pole-Top-Mounted Cutoff lighting, "Shoebox" fixture.
Mounting suitability: Good to poor, depending on mounting height. Mounting height should be no more than 5 m within 100 m of a nesting beach.
Directional suitability: Fair to good, as determined by reflectors.
Overall suitability: Fair to good, when mounting heights are low.

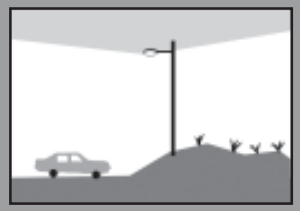


Decorative globe light
Mounting suitability: Fair if mounted at heights lower than 2 m. Poor if mounted higher.
Directional suitability: Very poor
Overall suitability: Very poor. This fixture is difficult to shield and should not be used near nesting beaches.

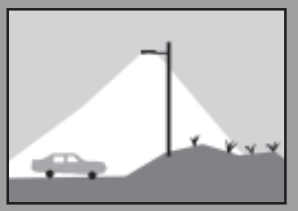


Lighting bollard with hidden lamp
Mounting suitability: Good if mounting height is near 1 m.
Directional suitability: Poor to fair.
Overall suitability: Fair. Good if additional shields on the beach side of the fixture are used.

Diagrams adapted from Witherington, B.E., and R.E. Martin. 1996. Understanding, assessing and resolving light pollution problems on sea turtle nesting beaches. Florida Marine Research Institute Technical Report TR-2. 73 p.

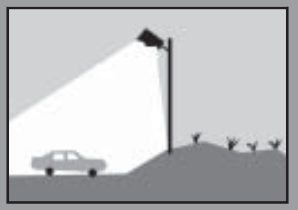


Poor: Poorly directed parking lots lighting can cause problems on sea turtle nesting beaches.



Better: Fixtures with 90^0 cutoff angles can reduce the amount of stray light reaching the beach.

Much better : Fully hooded floods can direct light accurately and reduce stray light even more.



Best: Low-mounted, louvered bollard fixtures are the best way to light parking lots near nesting beaches.

vii. Security lighting can be placed on motion sensitive switches that keep lighting off when it is not needed. Lights that come on only when approached can be quite effective for security purposes.

viii. Vegetation can suitably "block" artificial lighting from reaching the beach. This might not be applicable in all situations, but may work in specific cases.

There is a definite need for a 'Coastal Illumination Act' to define appropriate beachfront lighting, to set standards, to apply regulations, and to deal with offenders. ***Compared to other kinds of coastal development, light pollution is probably one of the problems that can be solved with relative ease, if the government and local residents are committed to conserving sea turtles.***

Photo - Kartik Shanker

Highways and marine drives

Highways connect human settlements along the coast. In the process of construction of highways, coastal geomorphology is considerably altered. Engineering actions are often geared towards the highways rather than towards the natural coastal geomorphology and ecological processes. Deltaic drainages, coastal vegetation and the seashore sand dunes often get impacted irreversibly. Other than reducing natural coastal habitat, highways also bring in new impact factors not present in the areas before the construction of the highways. In the context of marine turtles, coastal highways on sand dunes have invaded sea turtle nesting sites, and highway illumination and vehicular traffic illumination have impacted marine turtles directly.

With increasing access to the coast, human settlements crop up on the coast and along with human, their accompanying livestock and pets (dogs) cause considerable damage to the coastal ecosystem. Predation on adult and hatchling turtles gets enhanced significantly as the presence of subsidized predators increases.

Photo - Kartik Shanker

Possible impact on sea turtles

Roads that are constructed on the dune and/or very close to the high tide line of the sea, directly impact sea turtles by:

i. Reducing the space available for them to nest

ii. Disturbing their egg laying activities with vehicular traffic during the night.

iii. Increasing human and other biotic disturbance on the nesting beach.

iv. Removing beach sand for road construction, thereby eliminating significant amounts of nesting habitat

v. Altering the geomorphology of the sand dunes and reducing the natural nesting beach over a period of time.

For example, the 15 km coastal highway that is part of the Puri-Konark marine drive which passes through the Puri-Balukhand wildlife sanctuary has had tremendous impact on the nesting grounds of olive ridley sea turtles in Orissa**.**

Mitigation measures

i. Locating coastal highways sufficiently far away from the coastal sand dune habitat, preferably on the landward down slope of the sand dunes rather than the seaward slope.

ii. Plantation of indigenous species on the seaward side of the highways to reduce lights on the beach from vehicular traffic and marine drives and also to safeguard the highway from sand deposition.

iii. Closures of vehicular traffic at night, at least during nesting season at prime sea turtle nesting areas.

iv. Creation and restoration of degraded sand dune habitats caused by highway constructions.

Photo - Kartik Shanker

Photo - Bivash Pandav

Exotic plantations

While the beach itself is devoid of any vegetation due to the constant action of waves, the sand dune zone above the high tide line has various types of natural vegetation despite being subjected to wind action. Sand dune grass and other spiny vegetation trap blowing sand and help stabilize, maintain and elevate dune structures. There are also other salt tolerant creepers that help bind the sand. Behind the sand dune, and towards the landward side are shrubs.

Sea turtles prefer open sandy beaches for nesting. Coastal sand dunes with natural vegetation such as *Ipomea pescaprae* and *Spinifex littoreus* are ideal nesting sites for sea turtles in India. The natural dune vegetation and sand dune structures are closely interrelated and have coevolved to support a myriad of floral and faunal communities obligate to the coastal sand dune habitat. However, in recent years, as a measure of control of beach erosion, creation of vegetation shelterbelts against cyclonic storms and afforestation of the coastal zone, large scale plantations of alien and exotic plant species have been taken up, without any impact assessment studies. One of the exotics that has been planted along most of the Indian coast is the Australian Screwpine *Casuarina equisitifolia*.

Photos - Kartik Shanker

However, as the pictures show, these plantations can hardly withstand cyclones unlike natural mangrove forests.

How coastal plantations are detrimental to sea turtles

Photo - Kartik Shanker

Exotic coastal plantations have proved to be detrimental to the nesting of sea turtles in more ways than one.

i. Plantation of exotic beach vegetation drastically alters the beach profile and may often be a deterrent for sea turtle nesting.

ii. Since all coastal plantations are taken up on either side of the sand dune berm, there is significant loss of sea turtle nesting habitat between the high tide line and the berm on the seaward side.

iii. Alien vegetation such as *Casuarina* with its superficial root growth and thick litter fall renders the beach unsuitable for turtles to nest.

iv. Dense *Casuarina* and other plantations cause excessive shading of the nesting beach. Nests laid in shaded areas are subject to lower incubation temperature, which alters the natural sex ratio of turtle hatchlings, producing more males.

v. Plantation of exotic vegetation on the beach also affects the natural beach formation process.

vi. Dense vegetation on the coastal sand dunes provides shelter for both natural (jackal, hyena, monitor lizard, wild pig etc.) and subsidized predators (dogs, pigs etc.) to breed and add additional predation pressure on nesting females, eggs and hatchlings.

In India some of the important mass nesting beaches of olive ridleys along the coast of Orissa have been drastically altered with dense *Casuarina* plantations. Nesting beaches like Gahirmatha and Devi River mouth that were used by olive ridleys in extremely large numbers in the early 1970s and 1980s have been completely abandoned by sea turtles after dense strands of *Casuarina* were planted.

Photo - Bivash Pandav

Guidelines for ecofriendly coastal vegetation

The biological and ecological significance of the beach is often overlooked while undertaking developmental activities or afforestation programmes. The following guidelines are therefore suggested for ecofriendly revegetation of the coastal sand dunes.

i. As a policy, no exotic species should be planted in CRZ areas to prevent unknown ecological impacts.


Photo - Satish Bhasker

ii. Environmental and ecological impact assessment studies must be conducted before taking up any afforestation programmes along the coast, with provisions set up to evaluate any post-project impacts on sea turtles.

iii. Plantation of exotic vegetation should be clearly avoided on beaches that are known to be sea turtle nesting grounds.

iv. Apart from the high priority sea turtle nesting beaches where no plantation should be taken up, in sporadic sea turtle nesting areas, plantations should be carried out beyond 200 m from high tide line (HTL) and on the landward side slope from the berm thereby setting aside enough space for sea turtles to nest.

v. In historically known sea turtle nesting sites, alien and exotic plantations should be gradually removed to restore the nesting beach to its former state.


Photo - Kartik Shanker


Photo - Kartik Shanker

Ports, harbours and jetties

Port, harbour and jetty development facilities on the coastline are required for the shipping industry, offshore oil and gas development, marine fisheries operations, naval and other military operations, and navigation. Major impacts of such developments are (i) shrinkage of natural coastal habitats, (ii) dredging and destructive disposal of dredge spoils, (iii) obliteration and destruction of nearshore benthic ecology (iv) increasing spills and pollution and (v) increased coastal illumination.

Impact on sea turtles

Ill planned location of ports, harbours and jetties close to or on marine turtle nesting sites and breeding congregations directly impacts their populations in addition to permanent loss of their nesting and congregating habitats. Sea turtles also loose important foraging grounds when large scale dredging operations destroy the seafloor.

The increased navigation of ships, boats and other vessels directly interferes with the migratory routes of marine turtles. Since marine turtles are known to have strong affinity and fidelity to their natal nesting beaches, any infringement on their migratory route will have an impact on their reproductive cycle as well as disorienting them from their breeding and congregating grounds.

Other impacts that directly affect sea turtles are injuries due to collision with propellers of marine vessels. Such mortality of adult turtles have an important bearing on their population as sea turtles reach sexual maturity after ten or more years

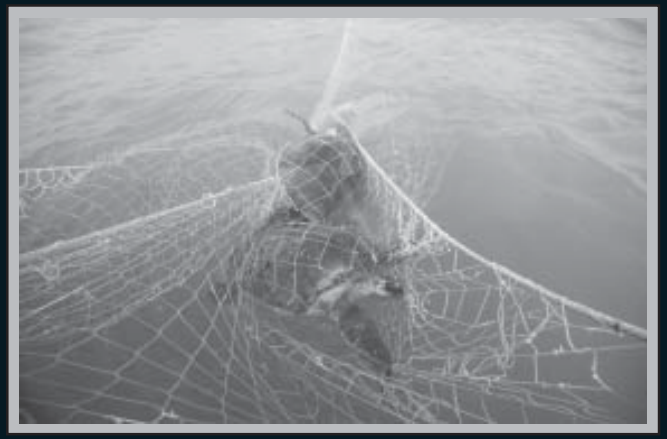
Guidelines for ecofriendly ports, harbours and jetties

i. No ports, harbours and jetties should be planned within a range of 25 km from any important nesting and congregating site.

ii. Environmental impact assessment studies and alternate site locations to eliminate such impacts should be a mandatory regulation for the establishment of ports, harbours and jetties.

iii. Existing ports, harbours and jetties must develop a protocol and strictly implement them to reduce impacts on sea turtles. Based on such practices, ports, habours and jetties can be given a green rating.

Photo - B. C. Choudhury



Threats in offshore waters

With the onset of the breeding season, sea turtles leave their foraging areas and arrive in the coastal waters of breeding grounds. Species like olive ridleys congregate in large numbers in the coastal waters off nesting beaches and spend nearly six months in a year in this habitat. Green and hawksbill turtles use shallow water lagoons as their developmental habitat during the juvenile and sub-adult stages of their life.

These near shore waters are often subject to heavy use by human beings in terms of marine fishing, aquaculture, coastal tourism and other recreational activities. These coastal zones are also susceptible to indirect pollution from industrial or agricultural run-off. These activities impact sea turtles during various crucial stages of their life cycle.

Photo - Bivash Pandav

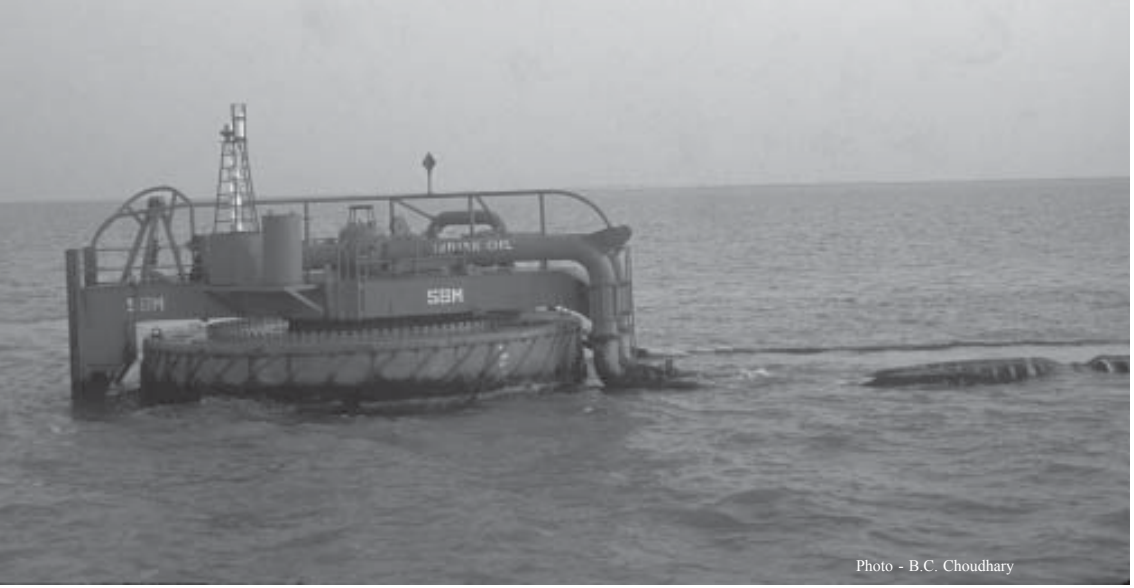


Photo - B.C. Choudhary

Pollution

Coastal waters and beaches are under constant threat from pollution originating from landward activities as well as from the sea. Such pollutants have often proved to be the primary cause of death of marine plants and animals. For sea turtles, such pollution does not necessarily impact them directly. However, changes in water temperature and quality results in changes in their offshore breeding congregation locations. Changes in salinity profile and levels of organic and inorganic pollutants in the vicinity of mass nesting sites will impact adults and hatchlings.

The following pollutants are known to impact sea turtles directly or indirectly through their food chains or altering their preferred offshore/onshore habitats.

Sewage, nutrients and fertilizers discharge

In sheltered lagoons, organic sewage, nutrients and fertilizers tend to accumulate and hasten the process of algal bloom and seaweed growth, changing the food chain composition.


Photo - B.C. Choudhary

Heated water from power station and industrial plants

In lagoons and offshore waters, release of heated water from power plants and other industrial installations changes the water temperatures significantly altering the distribution pattern of microorganisms. This in turn impacts the distribution of organisms at various trophic levels and also of sea turtles.

Petroleum hydrocarbons and crude oil from oil spills

Considering the large volume of oil transported and high rate of tanker movement and establishment of oil refineries along the coast, the probability of acute and chronic oil spill is very high. There is severe damage to marine life worldwide due to oil pollution along the coasts. Sea turtles are exposed to the harmful effects of oil pollution in many ways. Floating crude oil in the immediate offshore waters get coated on the eyelids, nostrils and mouths of sea turtles, leading to mortality. This has been recorded along the west coast of India. On nesting beaches, oil deposits could interfere with proper aeration of the turtle nest and impair normal development of the embryos. The crude encrusted hard substrate also does not allow the embryos to successfully emerge from the nest. Onshore oil deposits are high along the west coast of India, particularly along the Gulf of Kutchh where the presence of many oil refineries have resulted in chronic crude oil spills into the sea.

Chemicals and synthetic paints, pesticides & herbicides and heavy metals

These may selectively destroy or damage phytoplanktons and zooplanktons of reef and lagoon communities as well as planktonic larvae. Such accumulation has severe physiological effects on filter feeding animals and reef fish and may be accumulated in animals like the sea turtles. Pesticides and other industrial chemicals have been identified as “environmental estrogens.” These can impact the reproductive system of animals including turtles if the beach sand becomes contaminated with these types of chemicals.


Photo - Basudev Tripathy

Radio active waste

In recent years, research has shown marine turtles exhibiting carcinogenic growths and deformities attributed to radioactive residues. There is also a suspicion that radioactive waste may result in long term and largely unpredictable effects on the genetic nature of the biological communities in the sea, including sea turtles.

Debris


Photo - Yohan Thiruchelvam

Marine debris is prevalent in nearshore habitats and there are numerous reports of the occurrence of marine debris in the digestive tracts of hatchling and adult sea turtles. The list of materials found in the digestive track of sea turtles is extraordinary. Plastic bags, sheets, beads, pellets, lines, rope, strapping, pieces from bottles and hard pieces of unknown origin are commonly ingested by sea turtles. If sufficient material is swallowed it can cause complete stoppage of the gut and result in death. Leatherbacks feed principally on jellyfish and are known to swallow plastic bags by mistake, often leading to their death.

Options to minimize pollution

1. Monitoring of levels of pollution both onshore and offshore particularly in sea turtle congregation areas.

2. Prohibition of discharge of crude oil, pesticides, heavy waters, heavy metals and other poisonous effluents to estuaries and coastal areas and near turtle nesting beaches.

3. Prohibition of discarding of fishing lines, nets, plastic bags other trash into the water or on the beach which results in ghost fishing and incidental mortality of sea turtles.

4. Organized cleaning up of the beach and nearshore waters by local forest and fisheries departments and other governmental agencies in collaboration with non-governmental organizations, coastal communities, and school and college students. This should particularly be taken up prior to the breeding season of sea turtles in an attempt to clean up the habitat as well as to educate people about marine turtles.


Photo - Bivash Pandav

Fisheries

Fishing is a major occupation along the coast of India. A majority of fishers along the coast are artisanal fishers who use traditional methods or a combination of traditional and modern methods. However, since the 1970s, there has been a dramatic increase in mechanized fishing with thousands of motorized boats and trawlers operating in each state. The interface between marine fisheries and marine turtles has been a major concern not just for the well being of sea turtle populations all over the world, but also for local and international commerce, artisanal fisheries, by-catch reduction policy, marine fishing ground health and the development of eco-friendly fishing gear.

How fisheries affects turtles ?

Fisheries related mortality is one of biggest threats to sea turtles worldwide. In India, thousands of turtles die along both mainland coasts and in the Andaman and Nicobar Islands when they drown in fishing nets. Mortality occurs primarily in gill nets and in trawl nets. Sea turtles usually stay submerged for half an hour or more, but the fishing nets are operated for many hours, and the stress of being trapped usually results in drowning. In Orissa, more than 100,000 dead turtles have been counted since 1993, and ten to fifteen thousand turtles are washed ashore each year, predominantly due to trawlers. Researchers have documented that ten to twenty turtles can be trapped and killed during a single trawl. In 2002, researchers and conservationists also documented gill nets with 100 – 200 dead turtles trapped in each net. The real mortality rate may be even higher, since not all the turtles killed are washed ashore.

In addition, the operation of trawlers in breeding congregations may disrupt breeding congregations and prevent the onset of mass nesting. Along the shore, many fishers operate zero mesh nets to catch shrimp seeds. These can interfere with the nesting of turtles and prevent hatchlings from reaching the sea.


Photo - Bivash Pandav

Mitigation measures

No fishing zones

Many maritime states already have laws to prevent mechanized fishing in certain zones, including all states on the east coast of India. Marine turtles are protected in Orissa by Orissa Marine Fisheries Act (1982) and Rules (1983) which prohibit all mechanized fishing within 5 km of the coast. Fishing is also prohibited in the Gahirmatha Marine Sanctuary within 20 km of the Gahirmatha coast (~ 35 km). The Andhra Pradesh Marine Fishing (Regulation) Rules, 1995, states that 15 m mechanized vessels may not operate within 8 km of the coast and vessels above 15 m in length may not operate within 25 km of the coast. Similarly, in Tamil Nadu, mechanized fishing is prohibited within 5 km of the coast, and in the Gulf of Mannar Marine National Park. Similar laws exist for mechanized vessels in the state of West Bengal. However these laws are hardly implemented, and as a consequence, artisanal fishers, fish stocks and sea turtles all suffer.

Seasonal fishing ban

Many maritime states including Kerala, Tamil Nadu and Andhra Pradesh have seasonal fishing bans. These are currently during the southwest monsoon (May and June) to allow the replenishment of fish stocks. These bans could be extended for particular areas to the turtle breeding and nesting season as well.

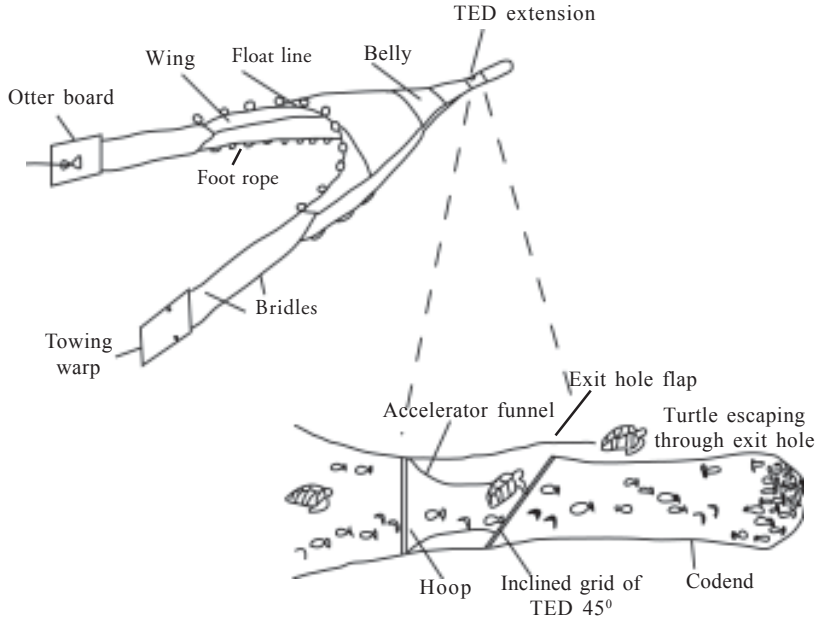
Turtle Excluder Devices

A TED is a frame consisting of a grid of bars installed before the cod end of the trawl net at an angle leading upward or downward to an escape slit. Small animals such as shrimp, slip through the bars and are retained in the cod end, while large animals, such as turtles, large fishes and large elasmobranches are stopped by the grid bars and can escape through the opening. Many different kinds of soft and hard TEDs are available.

In India, the Central Institute of Fisheries Technology, Kochi has developed an indigenous TED, called CIFT TED. The production of this TED is currently being funded by the Marine Products Export Development Authority. TEDs have been distributed in West Bengal, Orissa and Andhra Pradesh, but are being used principally in Andhra where they have been promoted by the State Institute of Fisheries Technology, Kakinada.


Photo - Bivash Pandav

The use of TEDs has been made mandatory for trawlers in Orissa, and other states are following suit. The use of TEDs will be helpful, since they will prevent bycatch of many marine organisms, not just sea turtles. However, sea turtles and other fauna are also killed by gill nets. Furthermore, the livelihoods of poor artisanal fishers must also be protected. Hence a combination of seasonal and area wise fishing bans and TEDs will probably give the best results.



Turtle Excluder Device

Threats due to aquaculture

In recent years, marine and brackish water aquaculture has been spreading all along the coastline of maritime states. In most cases, aquaculture activities use either the land along the sea beach (shrimp, brackish water fish farming) or the shallow sea beds (for artificial reef, and other mariculture practice). Such intensive and uncontrolled aquaculture expansions along the coast have resulted in the loss of sea turtle nesting and foraging habitats.

Photo - B.C. Choudhary

Aquaculture has also been causing environmental problems such as local eutrophication and depletion of benthic fauna through the accumulation of food residues and excrement and also toxic pollution through the escape of chemicals and antifouling products. In addition, aquaculture farms along the coast have become a major source of light pollution for marine turtles.

Shrimp culture facilities are largely dependent on good quality juvenile prawn seed. Instead of producing them in shrimp hatcheries, in many parts of India, coastal communities are encouraged to scoop prawn seedlings out from nearshore waters. Lured by the lucrative prices, thousands of fisherfolk use shore seine nets and enclose stretches of nearshore water adjacent to nesting beaches resulting in blocking the nesting females approach to the land as well as movement of hatchlings into the sea. A fairly large number of adult turtles also get killed in such improvised non target fishing practices along the coast of West Bengal, Orissa, Andhra Pradesh and Andaman & Nicobar Islands, even though such practices are illegal.

Guidelines for ecofriendly aquaculture

i. Delineation of proper aquaculture zones away from important sea turtle nesting sites.

ii. Total ban of prawn seed collection from the immediate offshore waters using any kind of scoop net.

iii. Ban on the use of bright illumination that spreads light to the seashore during the nesting and hatching seasons

iv. Total prohibition on the release of chemicals and effluents from aquaculture farms and hatcheries into the marine and coastal riverine systems.

Threats due to tourism

The beachfront and the immediate adjacent land, the lagoons and offshore waters are preferred locations for coastal tourism. One of the major impacts from such development is the drastic alteration of the natural landscape often completely stopping or interfering with ecological processes. In the context of sea turtles, ill-planned coastal tourism impacts almost all stages of their life cycle from eggs and hatchlings to juveniles to adults.

Photo - B.C. Choudhary

Photo - B.C. Choudhary

Coast based tourism is one of the fastest growing sectors not only in mainland India but also in the Andaman & Nicobar and Lakshadweep group of islands. In fact, sun and sea tourism has been projected as the future mainstay of the economy of the Andaman & Nicobar and Lakshadweep group of islands. Coast based tourism infrastructure development and activities are a potential source of ecological, social and economic conflicts. Rapid changes in the land use patterns, alien resource exploitation methods and invasion of multiple cultural elements are some of the concerns in the context of coast based tourism.

A much less discussed impact, however, is the environmental degradation resulting from ill-planned tourism, which often threatens the tourism industry itself. For coast based tourism, the well being of the environment itself is critical. An eco-friendly coastal tourism strategy and action plan, therefore, should seek to optimize developmental benefits while preserving the natural environment and the socio-cultural scenario upon which the sector depends. While nature based tourism resources are limited, their users often far exceed the carrying capacity. Lack of proper plans, rules, guidelines and standards for implementation and enforcement undermines the effort at maintaining a level of development that is environmentally and socio-culturally sustainable.

How coastal tourism impacts sea turtles ?

Tourism infrastructure: Hotels, Apartment, Restaurant, Cafes etc.

Physical alteration and loss of nesting beaches comes about as a result of erection of structures on the beachfront such as hotels, apartments, restaurants, mobile shops etc. They also disorient adult and hatchling movements due to artificial illumination. Shadows from buildings close to the high tide line can alter sand temperatures and thus the sex ratios of hatchlings.


Photo - B.C. Choudhary

Removal of vegetation, sand and corals etc.

Removal of vegetation, sand and other materials for recreational tourism results in erosion of sand from nesting beaches and makes the beach unsuitable for sea turtles to nest. Green and hawksbill turtles prefer to nest below the shade of coastal vegetation and once vegetation is removed, they may not use such beaches for nesting.


Photo - Bivash Pandav

Speedboat movements and anchorings

Small propeller driven recreational and other commercial boats used by inexperienced boat handlers often causes considerable physical damage to shallow marine habitat including reefs, particularly at low tide. A large number of marine turtles succumb to propeller related injuries. Anchoring of boats in shallow water areas, particularly in corals and seagrass beds, damages these habitats. Plough anchors are known to be particularly destructive.


Photo - B.C. Choudhary

Beach chairs, sun beds, umbrellas, etc

Sun beds, umbrellas etc. on the beach stop female turtles from reaching suitable nesting locations. Installations of such artifacts can also damage the nest on the beach and/or interfere with incubation temperatures due to increased shade.


Photo - B.C. Choudhary

Mechanical cleaning

Mechanical cleaning of the beach contributes to the compaction of sand and destroys turtle bests. Further, mechanical cleaning changes the beach slope and configuration thereby deterring adult female turtles from using the area for nesting.


Photo - B.C. Choudhary

Movement of people on the beach during night

Moving lights (torch lights and other illumination used by beach users and tourists) scares nesting turtles and emerging hatchlings move towards the light source rather than to the sea.


Photo - Karthik Shankar

Joy rides on the sea beach using animals

Use of heavy animals for joy rides on the beach tramples turtle nests and continuous movement of these animals on the beach also results in compaction of beach sand which makes the beach unsuitable for nesting and emergence of hatchlings.

Littering of beach by plastic and other garbage by tourists

Trash and debris on the shoreline not only threatens the health and safety of beach users but also entangles marine animals including sea turtles. Debris such as plastic sheets, scraps of nylon nets and ropes often causes severe entanglement of nesting turtles. Tourism related recreational activities in the offshore waters and lagoons also pose a serious threat to turtles as sea turtles spend long periods in these habitats for foraging and breeding.


Photo - B.C. Choudhary

Oil pollution from tourist boats

Oil spillage and chronic leakages from tourist and other boats are a major source of pollution in lagoons and nearshore waters.


Photo - B.C. Choudhary

Snorkeling and scuba diving

Snorkeling and scuba diving by tourists in turtle congregating areas disrupts the foraging and breeding activities of turtles. Since such activities are often near coral reefs, they also cause unintentional damage to corals and other reef biota resulting in significant loss of sea turtle habitat.


Photo - B.C. Choudhary

Lagoon/coral bed fishing

Recreational fishing in lagoons and coral beds, harpooning, use of explosives, collection of ornamental fish, live corals, shells, seagrass and seaweeds not only hampers major activities of sea turtles but also reduces forage availability and causes considerable damage to this unique habitat.

Guidelines for an eco (turtle) friendly coastal tourism

i. Seasonal closure of coastal tourism activities in nesting beaches and lagoons.

ii. Tourism infrastructure development should only be permitted beyond 200 meters from the high tide line or on the landward slope of the sand dune berm rather than the seaward slope

iii. All illumination in the coastal tourism infrastructure must be made sea turtle friendly. Green ratings and punish and award system can be adopted to encourage turtle friendly infrastructure.

iv. A total ban on joy rides on nesting beaches using animals or heavy vehicles.

v. Beach leveling and removal of natural vegetation should only be permitted in consultation with sea turtle biologists or coastal zone management authorities.

vi. Controlled foot traffic on sea turtle nesting beaches during daytime to avoid compaction of sand, and during nighttime to avoid disturbing nesting turtles, other than those areas where tourists are taken under well organised sea turtle watch programmes.

vii. The tourism department, beach resorts and other beneficiaries of beach tourism can involve local communities and schools to adopt a particular sea turtle nesting beach and demonstrate turtle friendly practices.

On sea turtle nesting beaches where tourism is also an important focus, the following provisions must be made:

i. Provision of litterbins
ii. Installation of warning notices and boards
iii. Demarcation of turtle sensitive areas
iv. Display of guidelines for lagoon and offshore habitat users

Combining sea turtles with coastal tourism

Innovative methods can be used to promote sea turtles as a coastal tourism resource adopting turtle friendly tourism such as turtle watch in lagoons, nesting turtle watch, turtle egg collections and hatchery operations & release of hatchlings and voluntary nesting turtle counts. Such activities are not only educative but also generate a great deal of interest and support for sea turtle conservation. Such tourism activities are flourishing in Malaysia, Australia, USA, Brazil and Costa Rica.

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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 fourth 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
- Population Census and Monitoring

This manual was produced as part of the GOI - UNDP Sea Turtle Project. The project, funded by UNDP, was executed by the Ministry of Environment and Forests, Government of India, and implemented by the Wildlife Institute of India, Dehradun.