

**STUDIES ON NESTING ECOLOGY AND CONSERVATION OF OLIVE
RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEAE*) AT GODAVARI
RIVER MOUTH OF ANDHRA PRADESH COAST, INDIA**

**(Final Report of UGC Major Research Project)
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**Nesting of Olive ridley Sea turtle (*Lepidochelys olivacea*)
at Godavari river mouth Nesting beach**



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ABSTRACT OF THE PROJECT REPORT

The results of this research project “Studies on Nesting Ecology and Conservation of Olive Ridley Sea Turtle (*Lepidochelys olivaceae*) at Godavari River Mouth of Andhra Pradesh Coast, India” were presented into **Six Chapters**:

Chapter-I: Gives a brief introduction of the context of the project study, review of earlier studies and its objectives.

Chapter-II: The study area is described in terms of geography, climatic conditions, and flora and fauna marine fishing activity, besides demographic information of the area.

Chapter-III: The description of material and methods adopted for the study in respect of population status, nesting biology, nesting habitats, nesting beaches, threats and conservation and management issues related to Olive ridley turtles are focused.

Chapter-IV: The results along with observations of the present project study on the said aspects related to the nesting ecology of Olive ridleys in the Godavari river mouth are presented.

Chapter-V: This final chapter summarizes the results of study findings and concluded with recommendations for the protection and conservation of Olive ridley sea turtle at Godavari river mouth of Bay of Bengal, India.

Chapter- VI: The references in the text are cited with details research publications and materials utilized for the project study

In brief, the present study recognizes the importance and need of immediate implementation of proper conservation of these **threatened sea turtles (*Lepidochelys olivacea*) population** so that they can be saved to posterity. For this, a coordinated holistic approach utilizing the best available scientific knowledge is the only answer.

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1.0 INTRODUCTION

1.1 Worldwide Status of Sea turtle Population:

The world conference on sea turtle conservation held at Washington, D.C. in 1979 recognized that many sea turtle populations are extinct and six of the seven existing species are either endangered or vulnerable. Although the Olive ridley (*Lepidochelys olivacea*) remains wide-spread and relatively abundant in tropical waters, most of their nesting sites support only small to moderate scale nesting (around 1,000 females per year) and most populations are known to have depleted severely while some are virtually extinct (Groom Bridge 1982).

IUCN Red Data Book (RDB) has been listed the Olive ridley sea turtles under “Threatened” status and included in Appendix I and II of Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES, 1973). In India, all the five known species of sea turtles, namely, *Dermochelys coriacea* Linn., (Leatherback turtle); the largest among turtles, *Chelonia mydas* Linn., (Green turtle) *Eretmochelys imbricata* Linn., (Hawks bill); *Caretta caretta* Linn., (Loggerhead turtle) and *Lepidochelys olivacea* Eschscholtz (Olive ridley), the smallest among these are now fully protected from hunting by wildlife (Protection) Act, 1972 (Kar and Bhaskar, 1982).

In recent times, almost all sea turtles are considered by the International Union for the Conservation of Nature and Natural Resources (IUCN) as threatened or endangered are included in the Red Data Book while their commerce is prohibited in those countries that have signed CITES. The sea turtles are the oldest reptiles and their future is in jeopardy as many turtle populations have declined to a point where they are no longer a significant resource, either materially or culturally (Frazier, 1980).

1.2 Background of project study:

Olive ridley turtle (*Lepidochelys olivacea*) is widely distributed throughout the tropics, with the exception of Gulf of Mexico and appear in the highest densities in the Northern Indian Ocean (NIO) and Eastern Pacific Ocean, In India, Olive ridley turtles nest along the east and west coasts, with major mass nesting beaches in Odisha state. The coast of Andhra Pradesh, lying in continuation to the south of Odisha, provides sporadic nesting habitats to Olive ridley sea turtles (Tripathy, 2005; and Raja Sekhar *et al.*, 2009) and is believed to be an important migratory route to Odisha mass nesting beaches.

Several research programs were initiated during the current decade, notably the Wildlife Institute of India’s (WII) program in Odisha, which led to the discovery of another

nesting site at Rushikulya river mouth (Pandav, 1994 and Tripathy, 2005). The program resorted to extensive tagging of mating pairs and nesting turtles further on the East Coast of India (Pandav, 2000) and also document an astronomical increase in fishery related mortality of Olive ridleys in Odisha (Pandav and Choudhury, 1999).

Strategies for protection of habitats is important to sea turtles should be fully incorporated into local and regional Integrated Coastal Zone Management (ICZM) initiatives. One of the important conservation aspects is the research priority in the inventory of nesting beaches. Long-term conservation of sea turtles will depend on the availability and condition of various nesting beaches. Index of nesting habitats should be protected to the highest degree of practicability.

Nesting beaches should be inventoried by area, habitat type, owner ship and conservative status. Records should be maintained on the loss or degradation of nesting beaches due to natural or anthropogenic causes and decisions made considering the areas of higher nesting activity that deserve regular and methodical monitoring. However, full-fledged information is essential on the turtle congregation patches to make them safe from fishing related mortality.

In view of the above background the present study was conducted at the Godavari river mouth of central coast of Andhra Pradesh for a period of three consecutive years beginning with November, 2012 and ending at December, 2015. Never before, has this region been so elaborately studied for sea turtles except for short term studies on the Olive ridleys. Status of the Olive ridley turtles was thoroughly investigated together with extensive studies on the nesting ecology followed by implementation of appropriate conservation programs to Olive ridley sea turtles in Godavari river mouth of Bay of Bengal, India.

An attempt has also been made to thoroughly propagate the use during trawl fishing of the Turtle Exclusive Device (TED) for the conservation of Olive ridleys. The management program emphasis on the need to educate the illiterate and ignorant fisher masses who poach the turtle resources for belly filling and meager gains besides mobilizing their direct involvement in the protection and conservation of this endangered Olive ridley sea turtle.

1.3 Significance of Project study:

Olive ridleys play an important role in the coastal waters of the Bay of Bengal during their breeding migration to Gahirmatha in Odisha coast, so also their hatchlings, when they emerge in large number and enter the sea. They also play an important role on several nesting beaches along the entire east and west coasts of the Indian peninsula. The eggs, hatchlings and adults of Olive ridleys serve as an important link in the food chain of coastal, offshore and oceanic ecosystems.

Knowledge on the status of sea turtles is fundamental to develop innovative approaches for effective conservation and evolve appropriate management strategies regarding common tasks like by-catch reduction and nesting beaches protection as well as to address more sensitive issues of sustainable harvest and ingenuity required to dissipate information on the status of sea turtle populations being impacted (Semirnof, 2004).

A significant portion of Olive ridley population migrates every winter to the Indian coastal waters to the mass nesting beaches in Odisha coasts, simultaneously also utilizes the beaches of Northern and Central Andhra Pradesh coasts for their nesting activity.

1.4 Aim and Objectives of the Project

This project study was aimed to determine nesting status and hatching success of Olive ridley sea turtles (*Lepidochelys olivaceae*) and evaluation of threats to breeding population for long term protection and conservation in Godavari river mouth of Bay of Bengal, Andhra Pradesh, India with the following study objectives of the project:

- (i) To identify the nesting habitats and assess the reproductive status of Olive ridley turtles in Godavari River mouth, Bay of Bengal on the East Coast of India.
- (ii) To analyze the geomorphology and topographical factors of the nesting beaches in relation to the Nesting Ecology and Reproduction Success of Olive ridleys.
- (iii) To assess the possible threats and human induced mortality of the breeding population of Olive ridley turtles.
- (iv) To suggest suitable conservation measures and management strategies for the protection of Olive ridley turtles, breeding population, nesting habitats, nests, eggs and hatchlings at the Godavari river mouth of Andhra Pradesh, India.

2.0 STUDY AREA:

2.1 Godavari River Mouth

The study area of Godavari river mouth is situated (16°17' and 18°30'N longitude and 81°30' and 82°37'E latitude) in East Godavari district of Andhra Pradesh, India (Figure 2. 1). The river mouth is one of the important nesting habitats to Olive ridley turtles after the mass nesting sites of Gahirmatha beaches and Rushikulya river mouths of Odisha coast. River Godavari is divided into two main distributaries the Vashista and Goutami Godavari before joining Bay of Bengal. The sedimentary environments of the Godavari deltaic region consists: (1) River channels and Estuary. (2) Flood Plains; (3) Natural Lagoons; (4) Tidal Channels; (5) Mangrove Forests (6) Mainland beaches, Sand spits and Sand bars,

2.2 Topography and Geomorphology:

The 48 km shore line of Godavari river mouth has diversified environments: (i) Main land elevated beaches of primary and secondary sand dunes (ii) Mangrove fringes of Riverine sand bars and spits (iii) Sacramento lagoon sand spits and calcareous shoals of (iv) Beaches separated from riverine back waters, of tidal swamps and salt water marshes (Figure 2.2). The nesting beach environments of Olive ridley were categorized into four zones based on the distinctive characteristics of geomorphology and topographical features. A total of 12 fishing villages are located in 48 km shoreline (Table 2.1)

Table 2.1: Fishing villages and shoreline characteristics in Godavari river mouth

Beach zones	Name of the Village	Shoreline characters	
		Topography	Geomorphology
I (12 km)	Vodalarevu N. Rameswaram Vasalatippa	Main land beach elevated sand dunes and moderate slopes	Sand particle deposits of medium grain sizes
I (16 km)	Chirayanam Pallam, Pandi, Pora	Beaches adjacent to lagoons of Pora, Pandi, flat terraced beaches	Sand particle deposits of medium grain sizes
III (6 km)	Neelarevu Mulletimoga Kothapalem	Sand spits and shoals adjacent to Pandi lagoon of calcareous origin with high shell content	Fine sandy beaches finest grain sizes
IV (14 km)	Balusutippa Masanitippa	Sand spits and sandy shores, mangrove fringed area	Sand particle deposits of medium grain sizes

2.3 Profile of Nesting Beaches:

Zone -I comprises of medium grain size sands with dunes of moderate slope sheltering shore line flora (sand binders) and fauna (invertebrates) together with wild jackals, foxes, mongooses and otters. Mean beach temperature in this Zone was 26.5 °C while adjacent bay waters had a temperature of >22.0°C and 32 ‰ salinity.

Zone -II comprises of flat terraced primary and secondary sand dunes that nurture halophytes, herbs and shrubs in abundance besides the fauna mentioned in the former Zone. While this beach Zone is characterized by 24.5°C, the sea water temperature and salinity of its adjoining waters were 21.0-23.5°C and 30 ‰, respectively.

Zone -III comprises of sand spits and shoals rich in calcareous matter with halophytes, herbs and shrubs in addition to the invertebrate and vertebrate fauna noted in the proceeding Zones. This Zone showed a beach temperature of 27.5°C, sea water temperature of 24.0-28.0°C and salinity of 30 ‰.

Zone -IV comprises of sandy shores with occasional spits that gave rise to mangrove herbs, shrubs and trees further to the fauna noticed in the above three distinct zones. Beach temperature on an average in this zone was 28.0°C whereas water temperature and salinity of the adjacent sea were >23.0°C and 28.0‰. The topography and geomorphologic features of Olive ridley are presented in Table 2.2.

Table 2.2: Topography and Geomorphology of nesting beaches in the Godavari river mouth

Beach Zone	Length (km)	Type of nesting beach	Average beach temperature °C)	Sea surface temperature(°C)	Seawater salinity(mg/L)
I	12	Fine sand beaches of primary and secondary dunes	26.5	> 22.0	32
II	16	Mixed sand calcareous shingle beaches	24.5	21.0 – 23.5	30
III	6	Fine sand spit shoals/off shore barrier island	27.5	24.0 – 28.0	30
IV	14	Mangrove fringed sand bars and Sand calcareous shoals	28.0	>23.0	28

3.0. MATERIALS AND METHODS:

3.1 Nesting Beach Surveys:

The present study was carried out during the breeding and nesting season of Olive ridleys covering a total period of three years from November, 2012 to December, 2015 at the Godavari river mouth in East Godavari District of Andhra Pradesh state, India. Intensive beach surveys were conducted during the breeding and nesting activity of Olive ridleys in three phases: 1) Pre-nesting season (Courtship activity) of the Olive ridley in off shore waters from November to December; 2) Nesting season from January to April and 3) Post-nesting period of four months from March to June with incubation and emergence of hatchlings.

Further each beach Zone was divided into smaller segments of 1.0 km length. These segments were demarcated with wooden made postings depicted with corresponding numbers for an easy identification of nesting Zones to calculate the nesting frequency and density and hatching success of Olive ridley turtles.

For the purpose of the survey work relevant data sheets and questionnaires prepared and were distributed in all the fishing villagers for the collection of relevant information on Olive ridleys. The survey was designed as per the study objectives and most of the information was gathered only after detailed discussions and interactions with the local inhabitants and personnel of Andhra Pradesh Forest and Fisheries departments.

Nesting and post nesting surveys were organized from January to April. When pre-south west monsoon showers occur post nesting survey related to emergence of hatchlings and to enumerate the success in all the nesting beach Zones during May to June.

3.1.1 Identification of Olive ridley:

Olive ridley sea turtle identification has been done as per the morphological descriptions and nesting biology described by Pritchard and Mortimer (1999).

Morphology: Short and wide, five to nine pairs of coastal scutes (usually six to eight) often with symmetrical configuration. The surface carapace length (SCL) is up to 72 cm with two pairs of prefrontal scales on head and two claws on each flipper. Plastron is mid to dark olive green in adults and underside is creamy-yellow. Weight measured is typically 35-50 kg.

Nesting: Nesting track width is between 70-80 cm with an alternating (asymmetrical) oblique marks made up by the fore limbs. Trail drag mark are inconspicuous or not visible and sometimes lacking. Nesting on tropical mainland shores and barrier islands occur nearer to river mouths.

Eggs: Egg diameter is typically 37-42 mm. Average clutch size ranges from 105-120 eggs. Nesting is often solitary or in small groups, but in India, Costa Rica and Mexican Arribada nesting of many thousands of animals come ashore at once.

Hatchlings: Hatchlings are in black color. The coastal scutes are usually 6 to 9 pairs. The carapace length varies between 38 to 50 mm.

3.1.2 Nesting surveys

Nesting frequency and density were determined based on crawl tracks either fresh or old (Pritchard, 1976). Freshly laid nests were identified with neat and undisturbed crawl marks, having a definite body pit and signs of covering the nest and return tracks with considerable wandering in inter tidal Zone. The frequency of nesting activity and density of nests on the demarcated beach Zones were estimated based on false crawls made by the disturbed turtles or the nesting crawls of successful emergences of the turtles.

To mark freshly laid nests, wooden pegs were placed in and around the nests with the detailed description of the date of nest laying, Zone area, so as to avoid repeated counts of the nests and also for further monitoring of nests until hatching of the eggs. The nest density was determined based on nests excavated by humans, nests disturbed by predators as well as freshly laid nests.

The beach profile distances were measured from the lowest tide surf line to high tide line beyond the sand dunes between 1.0 and 60.0 m, and were divided into three beach profile distances (0 to 20m; 21 to 40m; and 41 to 60m) to carry out detailed studies. The measurement of beach profile distance was restricted to the beach width only.

The width of the beach was fixed between the upper shore of highest high tide level to the fore shore area of marine waters. The total area available for the nesting turtles was calculated by multiplying average beach width with total length of the beach. The loss of nesting beach area due to wind erosion and tidal inundation was calculated for each beach segment by subtracting the beach width (after erosion) from the total length of the beach.

$$I = A - B$$

I = Loss of nesting beach area

A = Width of beach (from foreshore to the highest high tide water level)

B = Total length of beach

The data was collected before commencement of the nesting season and after completion of the egg laying process between February and April of every year. Nesting

population of the Olive ridley turtles were estimated based on the population census and monitoring techniques as per the formats given by Shankar *et al.* (2003) in GOI-UNDP Project Manual.

3.1.2.1 Nesting Frequency and Density

Frequency of nesting and density of nests on the demarcated beach Zones were estimated based on false crawls or the nesting crawls of successful emergences made by the disturbed turtles. Nest density was determined based on nests excavated by humans, nests disturbed by predators as well as identification of freshly laid nests. The model data sheet for intensive nesting beach surveys.

Zone	Nesting crawl (fresh/old)	Distance from high tide line	Habitat (vegetation/sand/village)	No. of nests laid/disturbed

Grain size analysis of beach sands were measured by using the standard percent particle size of weight measurements. For analysis, total weights of 500 to 1000g sand sample from low, mid and high beach Zones were collected and were brought to the dept. laboratory in the sealed polythene bags. These samples were oven dried at 50°C at least for twenty four hours prior to analysis.

For correlation of nesting frequency and density the analysis of the beach sands grain sizes was done. The beach sand samples were collected from each Zone of beach surface to a depth of 15cm, 30cm and 45cm with respect of three beach vertical distances of lower surf waters 0-20m, middle 21-40 m and upper beach of 41-60m high tide water mark. This was repeated in different beach segments of surf waters to highest high tide line of each Zone. The mean grain sizes of each sample was determined by using with grain sorting of different sizes.

Ritchie and Mather (1969) define sand grain sizes in general terms are as follows:

- Coarse sand - > 600 to < 1100 microns
- Medium sand - < 600 to > 200 microns
- Fine sand - < 200 microns

3.1.2.2 Estimation of Hatching Success:

Hatching and emergence success were ascertained by digging the nest cavity five days after emergence of the 1st hatchling and by counting the hatched egg shells (Kar and Dash

1990). Nest depth taken upon the completion of excavation and clear to egg deposition was taken from the bottom of the nest hole to the base of the posterior point of the carapace. Clutch sizes of Olive ridley nests were also noted and then eggs were placed in the nest pit without disturbing the orientation of eggs while measuring the nest depths.

Hatching Success and Hatchlings Survival Rate (Emergence Success): Percentage of hatching success and hatchling survival (emergence success) were determined as per the calculations given by Miller (1990)

$$\text{Hatching Success (\%)} = \frac{\text{No. of empty shells}}{\text{No. of empty cells + Rotten + unhatched eggs}} \times 100$$

$$\text{Emergence Success (\%)} = \frac{\text{Total number of egg shells} - \text{No. of dead hatchlings}}{\text{Total number of empty shells + unhatched eggs}} \times 100$$

Incubation period and hatching of eggs (from egg laying to hatching) were recorded for both *in-situ* protected nests as well as the re-located (*ex-situ*) nests for conservation purposes. The observations were made with regard to climatic conditions and other physical factors such as temperature, moisture, beach erosion, salinity and terrestrial predation for the entire nesting beach Zones to formulate conservation and management strategies.

3.2 Threats Assessment:

Threats to sea turtle nesting habitats and breeding population were classified into two categories and relevant data was collected to assess their possible impacts on migratory population. The nesting beaches were monitored in all beach zones and corresponding threats were assessed based on the following criteria.

(i) Direct threats:

Threats to breeding population, eggs and hatchlings and incidental catch in mechanized trawls/boats. Nests excavation, poaching of eggs and depredation by humans

(ii) Indirect threats:

Loss of Olive ridley habitats: related to marine feeding habitats, nesting beaches (erosion, sand mining and beach armoring), Pollution from nearby Industries.

Predation of nests and hatchlings on beaches: It is to be estimated by evaluating the factors i.e. Human excavated nests, eggs robbed by domestic and feral animals, nests spoiled due to wild animals, erosion of the beach sands, flood tides and other abiotic factors were considered together. Predation of nests was recorded based on symptomatic characteristics left by the predators at nest site carefully examining of the remaining egg shells

scattered around the nest pit or by visual witnessing the predation (Drake, 1993). Model basic data sheet for mortality and threats survey is as follows:

Date of Survey _____ Beach Name/Zone ----- Distance sampled

Status of the migrating turtles at off-shore waters based on incidental capture and mortality of breeding turtles as well as stranded dead turtles (carcasses) washed on to shore line was assessed. The incidental capture and mortality of Olive ridley turtle caused due to gill nets, trawl nets shore seines and from artisanal fishing gear have thoroughly investigated.

Turtle carcasses washed ashore were marked on their carapace with a designated serial number and date of occurrence as to avoid duplication during subsequent counts. The incidental capture of Olive ridley turtles and their mortality were calculated as per the following guidelines given by NMFS (National Marine Fisheries Service), researchers and observers of United States.

Calculating catch Rate (CCR) = turtles / hour / try net

(Average try net size is 15 ft or 4.6 m)

Threats to sea turtle habitats and breeding turtles were classified into four categories and the relevant data was collected to assess their possible impacts on migratory population. The nesting beaches with reproductive success (hatching and emergence success) were monitored in the entire beach Zones and corresponding threats were assessed based on the following criteria.

- a. On the shore line threats**
 - i. Sand mining
 - ii. Beach armoring
 - iii. Artificial illumination
 - iv. High ways and marine drives
 - v. Exotic plantations
 - vi. Ports, harbors and Jetties

- b. In the off-shore waters threats**
 - i. Pollution
 - ii. Fisheries and aquaculture
 - iii. Tourism

For control of predation by feral and wild predators from beach erosion the following conservative measures were adapted:

- (i) Involvement of the local fishermen communities and frequent beach patrolling is to keep egg collectors and turtle poachers away and to bring the natural predation under control.
- (ii) Protection from beach erosion, turtle nests too close to the sea in areas where high tides or storms are likely to erode the beach during the incubation were shifted and relocated to the nearby nesting beach areas.
- (iii) Extension programs were conducted at each village and the villagers and school children were educated through audio visual aids on the importance of the sea turtles, need to conserve them and how they can help.

The cooperation of the fisheries and Forest departments (wildlife wing) were sought who also displayed several boards of posters on sea turtles conservation and relevant acts. Several sea turtles captured by the crew of the mechanized boats and fishermen have been released after educating and convincing them on the need on importance. All such data were systematically recorded on the field notes.

4.0 RESULTS

4.1 Nesting Beaches :

Nesting beaches of Olive ridley turtles in the Godavari river mouth were identified into four types: the mainland beaches of Zone-I in southern part of the Godavari river mouth stretch to a length of 12 km with elevated sand dunes of 2 to 6 m height. This section of coast line is dotted with dense Casuarina (*Casuarina equisetifolia*) plantations. The zone-II beaches cover a total length of 16 km, interspersed with back water creeks, swamps and salt marshes. Zone-III shore line extended to 6 km and is a Lagoon sand spit consisting of fine sandy beach (Sacramento shoals) generally called as Masanitippa.

This beach stretch is sandwiched between swampy marshes of Pandi lagoon at the western side and Bay of Bengal on the eastern part. The Pandi lagoon back waters are connected to Goutami Godavari River in northern side. Topography of this beach is subjected to dynamic changes often varying between 40m and 60m width. The southern part of the beach zone-IV (Karakutippa) is an isolated sand bar fringed by mangroves measuring to a length of 14 km bordering Coringa mangrove reserve forest to the northern part of Goutami-Godavari river.

4.1.1 Nesting beach flora & fauna:

Shore line vegetation of the nesting beaches were dominated by Sea pinks (*Spinifex littoreus*), Horse shoe creeper (*Ipomoea pes-caprae*), Screw pine (*Pandanus fascicularis*), Sand binder (*Launaea sarmentosa*) though several other plant species also coexist. Shore line fauna of the nesting beaches mostly consists of crustaceans such Ghost crabs (*Ocypode ceratophthalmus*), Sand crabs (*Ovalepis austariliensis*), insects like mites, ants and maggot larvae. Avian fauna such as Cranes (*Grus communis*), Sea gulls (*Larus brunnicephalus*), Pond herons (*Ardeola grayii*), House crows (*Carvus splendens*) and mammals such as Jackals (*Canis aureus*), Fox (*Vulpes bengalensis*), Mongooses (*Herpestes edwardsii*); and river otters (*Lutra perspicillata*) also dwell in the region while Domestic dogs (*Canis familiaris*) and Pigs (*Sus scrofa*) were present in the areas particularly where human habitation is prevalent. The vegetation communities with plant species and fauna of shoreline are given in **Table 4.1** and **Table 4.2**.

4.2 Nesting Ecology:

4.2.1 Migratory Population:

The abundance of migratory population in the Godavari river mouth was 2 mating pairs/ sq.km transect and number of breeding pairs decreased from 2 pairs/sq.km in January to 1 pair/sq.km in April. Highest abundance of Olive riley turtles per unit area was estimated at 4 pairs /sq.km during December. The Olive ridley population congregates at Godavari river mouth for their breeding (courtship, mating, breeding, nesting, incubation and hatching) and foraging activity from November to March. Every year, the courtship and mating of Olive ridley occurs at the beginning of winter months (November and December) at Godavari river mouth of Bay of Bengal, while they are migrating towards the mass nesting beaches of Odisha.

4.2.1.1 Courtship and mating:

Olive ridley turtle is an oviparous animal that breeds annually. The breeding season is almost synchronized with non-monsoon (winter and early summer) seasons of the region. The breeding activity of Olive ridleys has been classified into the following three distinct phases. Courtship and mating starts from mid-November and extends for nearly three months until mid-February with the end of winter season. Maximum number of mating pairs was recorded during December and January months of every year.

4.2.1.2 Nesting process:

Nesting takes place between early January and late March, with a peak nesting activity during March and April, when the air temperature gradually increases. Intensive sporadic nesting activity was observed between February and March of every year while a gradual decrease of nesting activity was recorded during April. Precisely the maximum nesting activity of Olive ridleys in Godavari river mouth was observed for three months, starting from the beginning of February and ending with April.

4.2.1.3 Nests and Clutch Sizes:

The nest depth ranged from 40 to 75 cm while the maximum number of nests was at a depth range of 50 to 60 cm. The clutch size ranged from 82 to 124 eggs/nest, while majority of the clutches showed a mean of 103 eggs /nest.

4.2.1.4 Eggs and hatchlings

Eggs of Olive ridley turtles were in white color and round in shape with a diameter measuring from 38 to 45 mm and weight range of 22.0 to 36.0 g. The shell was porous, delicate and slightly flexible. The size and weight of the eggs varied in the clutches of different months. Hatchlings were emerged from early March to late May during which, the air temperatures gradually increased. The time interval between courtship and nesting was one month, while between nesting and hatching of eggs was of two months period. The entire breeding activity from courtship to hatching of eggs was a total period of six months from November to April.

4.2.2 Status of Nesting:

4.2.2.1 Nesting frequency

Zone-wise enumeration of nesting activity of Olive ridleys of Godavari river mouth showed that emergence of nesting turtles was greatly varied from Zone III (59.89%) to Zone II (6.20%) beaches. Frequency of nesting varied in each Zone with highest density of nesting (33.99 crawls/ km) in Zone-III area (Sacramento sand spit) of Goutami Godavari river mouth. The month wise nesting density of Olive ridley at Godavari river mouth revealed that peak nesting activity during March (53.97%) and April (19.37%) followed by February (18.51%).

However the nesting was low in December (2.76%) and January (5.38%). From the total 428 nests observed during the study period, highest number of nests of 58.64% were recorded between 36.0 and 45.0 m followed by 20.55% nests were at 46.0 to 60.0 m, where as the lowest number of nests of 8.25% were observed between 10.0 and 20.0 m. The zone-wise and month wise nesting activity (false crawls plus nesting crawls) of Olive ridleys for the study period are presented in **Table 4.3 and Table 4.4.**

4.2.2.2 Nesting Density:

Nesting density revealed that highest nesting density of 33.99 nests/ km were observed at Sacramento sand spit of Zone III beaches, followed by 4.64 nests / km in Zone I, while 2.16 nests/ km in Zone II and 3.14 nests / km in Zone IV. Month wise nesting activity of Olive ridleys at Godavari river month revealed that maximum nesting density was observed during March (50.15%) and April (22.36%) while the lowest nesting density was during the month of January (8.28%) and February (17.24%). Whereas the nest laying activity was negligible (1.97%) in the month of December. The Zone wise and month wise nesting density of Olive ridleys during the study period is given in **Table 4.5 and Table 4.6.**

4.2.2.5 Zone Wise Hatching Success:

A total of ten freshly laid nests in four beach Zones were observed for hatching success in natural condition (*in situ*). The hatching success and emergence of hatchlings varied from Zone I to Zone- IV. Highest number of eggs was hatched in Zone-III beaches (52.50%) followed by Zone-IV beaches (37.50%), Zone- I beaches (36.35%) and Zone-II beaches (34.88%).

Hatching success of Olive ridley nests in three profile distances showed significant variation with a mean hatching success of 52.51% at 20m profile distance, while 62.71% in 21-40 m profile distance and 48.50% in 41-60 m profile distance. The salinity and moisture content at the three profile distances were ranged from 28 to 32 ‰ and 2.42% to 12.94% respectively. The details of Zone wise hatching success of Olive ridley nests are shown in **Table 4.7**

4. 2.3 Threats to Olive ridley turtles:

The identified threats to Olive ridley turtles in the study area were classified into offshore and on shore from which the biotic factors consist of incidental capture, predation of nests and eggs, human induced coastal developmental projects and their impacts and fungal infestations. While abiotic factors include wind erosion, tidal inundation, cyclonic storm impacts (beach fragmentations) and marine pollution.

4. 2.3.1 In off Shore Waters

During migration (courtship and mating) the breeding population of Olive ridleys is exposed to various threats either from human induced activity or the direct involvement like intensive fishing activity in off-shore waters. The developmental activities have adverse impact on sea turtles and their habitats in off shore waters and on shore nesting beaches.

4. 2.3.2 Incidental Mortality:

The major cause of mortality to Olive ridley populations in Godavari river mouth was the fishing related incidental capture. Zone wise incidental capture of Olive ridleys during the study period was a total of 668 mating pairs from which gill nets were responsible for 57.14% mortality, where as the trawl net operation contributed 30.36% captures. The remaining mortalities were from shore seines (8.92%) and artisanary fishing 3.58%. Maximum numbers of incidental captures were recorded during the months of December followed by January and February.

4. 2.3.3 Stranding of Dead Turtles:

A total of 326 carcasses of Olive ridleys were stranded on the shore line due to incidental capture related mortality from the nesting beaches of Godavari river mouth with the highest number of carcasses in Zone IV ($120/\text{km}^{-14}$) followed by zone II ($83/\text{km}^{-16}$), zone III ($65/\text{km}^{-6}$) and zone I ($58/\text{km}^{-12}$).

4. 2.3.4 Nesting Beaches:

The factors related to human exploitation of eggs, animal predation (wild and feral animals), eggs spoiled due to wind erosion, tidal inundation and fungal infections were considered as threats on the nesting beaches to the Olive ridleys.

4. 2.3.5 Animal Predation:

Predation of eggs and hatchlings by dogs, foxes and jackals was very high on the nesting beaches of Godavari river mouth. The nests are vulnerable to heavy predation in zone III with 50.0 % loss in case of wild animals and 53.7% by feral animals followed by Zones I, IV and II with 19.6% and 13.7%, 15.7% and 9.5%, 11.7% and 23.2%, respectively (Figure 4.1). Month wise predation of Olive ridley nests indicates a maximum loss during March (49.13%) followed by February (22.37%), April (15.26%). Lowest predation (13.26%) was observed in January.

4. 2.3.6 Erosion and tidal inundation:

The southern winds during early summer months (March & April) causes erosion of nesting beaches and maximum of 18 nests were damaged in Zone III, followed by 6 in Zone I, 5 nests in Zone II, and 4 in Zone IV.

4. 2.3.7 Fungal infestations:

Considerable loss of eggs and hatchlings is caused due to fungal infestation, especially in zone- IV with maximum damage of 42.3% followed by zone II with 30.8% and zone- I with 19.2% loss, whereas in zone -III, the eggs and hatchlings that suffer maximum threat from all other factors are subjected to a minimum loss of 7.7% from fungal infections. where the beaches were prone to frequent inundation of and subject to heavy root growth of nearby plants. The details of abiotic and biotic factors are presented **Table 4.8**.

In overall of anthropogenic and natural threats to Olive ridleys is by coastal and offshore developmental projects (60%), followed by destruction of mangrove forests (20%), predation of nests and eggs (12%), plantations on shore line (5%) and beach erosion and tidal inundation factors (3%) respectively (Figure 4.2).

4.3 CONSERVATION AND MANAGEMENT

4.3.1 Offshore Protection:

The congregations of Olive ridley breeding population were observed up to a distance of eight nautical miles near the Godavari river mouth. The mortality rate of breeding turtles in this congregation was very high due to incidental capture with a frequency of 2 turtles /2 nautical mile/1 hour haul. The gill net mortality was highest (3 turtles /2 nautical mile/1 hour haul) and where as other nets like purse seines recorded 0.5 turtle /2 nautical miles /1 hour haul.

4.3.1.1 Protection to Breeding Population:

As the migratory breeding populations, travel along the Andhra Pradesh coast line, to reach the mass nesting sites of Odisha, these populations are subjected to exposure to various threats at off shore water of Kakinada, Hope Island and Sacramento shoals. The incidental capture and mortality of the Olive ridley breeding population in the vicinity of Godavari river mouth can be reduced through implementation of TED (Turtle Exclusive Device) to the bottom trawl nets and motorized boats which operate gill nets. A demonstration of TED in this region was carried out with the active cooperation of fishers and found that a meager 2% decline in catch, where as there are no incidental mortality of Olive ridleys were observed.

4.3.1.2 Implementation of Turtle Excluder Devise:

According to Andhra Pradesh Marine Fisheries Regulation (APMFR) Act, 1995, use of TED was made mandatory on trawlers/mechanized boats. Demonstration of field trials with TED by State Institute of Fisheries Technology (SIFT) in Andhra Pradesh coastal waters have shown a statistically non-significant catch loss in the range of 1.00% to 3.60% for shrimp. However, the effective implementation of TED regulations could depend critically on the extension and awareness of TED technology to trawler fishermen and monitoring and enforcement of TED regulations on the part of the Government.

4.3.2. Onshore Conservation:

4.3.2.1 Protection to Nesting Beaches:

As the nesting beaches are subjected to frequent erosion and tidal inundation, hence the following measures were implemented for protection of nesting beaches at Godavari river mouth.

Control of beach Erosion: During March to April the south west winds eroded the nesting beaches and the surface sand layers reducing 2 to 5 cm sand layer. This type of erosion can be prevented through rehabilitation of native characteristic beach vegetation from foreshore to sand dune region consisting of the species, Casuarinas, Sand binders, Sea pink and, Screw pines, etc.

Control of Human Predation: The human predation for turtle eggs was prevalent in Zone- I and Zone- IV nesting beaches either for personal consumption or for sale in local markets during nesting season. Awareness generation among the local communities with involvement of all age groups were conducted and succeeded in the subsequent years with gradual decrease of poaching of eggs from the nesting beaches and selling in local markets.

Protection to Nests and Eggs:

Predation on nesting beaches is more intensive during the nesting season from January to April. The vertebrate predators, jackals, foxes were frequently encountered at the nesting sites during the survey of the nesting beaches. To prevent the predation of eggs, nests and hatchlings, regular patrolling of the beaches during nights with the help of local fishermen community was organized and protected the nests in their natural (*in situ*) state and relocated to nearby protected beaches for *ex situ* conservation and management.

A. In-situ Conservation:

As part of *in-situ* (natural) conservation, a total of six nests were protected and hatched under natural conditions, of which the mean hatching success obtained was 62 to 82 % with mean incubation time of 55 to 60 days.

B. Ex- situ Management:

Freshly laid nests of Olive ridleys in low lying areas of Zone I were relocated to the nearby suitable protected beaches for *ex-situ* management. Twelve nests were relocated to nearby

protected beaches during the study period. The mean hatching success of these nests was between 52 and 58 % with a mean incubation period of 51 to 56 days .Where as nests which are subject to heavy natural predation were protected with fence guards (2.5 x 1.5 ft) made of bamboo material and placed without disturbing the eggs or nests at a depth of 0.5 to 1 ft. The hatching success of these naturally protected nests was recorded between 62.5 and 82.0 % with a mean incubation period of 55 to 60 days.

4.3.2.2 Awareness and Education:

Awareness and education programs were organized in all the major fishing villages and fish landing centers at Godavari river mouth to prevent exploitation of Olive ridley turtles for meat, shell, poaching of eggs and also for implementation of TED. They were sensitized on the need for conservation sea turtles for overall benefit of the marine ecosystem. Protection of nests, eggs and hatchlings during the reproductive period of Olive ridley has been taken up with the involvement of local fishing community by offering monthly monetary benefits and organized awareness campaigns to the local fishermen communities for protection of Olive ridley turtles and their breeding habitats of nesting beaches.

Educational awareness campaigns and workshops were organized in fishermen villages and to school children on the importance of ecological significance of Olive ridley turtles. Conservationists and Non-governmental organizations were encouraged to participate in the design, funding and implementation of turtle conservation

“Village level sea turtle protection committees” are constituted at each Nesting Beach Zone for the protection of nesting turtles, nests, eggs and hatchlings.

6.0 SUMMARY AND CONCLUSION

The project study on “**Nesting Ecology and Conservation of Olive ridley Sea Turtles (*Lepidochelys olivacea*) at Godavari river mouth of Andhra Pradesh coast, India**” was carried out for a period of three years from November, 2012 to December, 2015. The objective of the project study was to identify the nesting beaches, assess the reproductive activity and threats to Olive ridleys for conservation and long term protection of Olive ridley sea turtle population in Godavari river mouth of Andhra Pradesh coast, India.

The project report is presented in six chapters, of which **I chapter** gives a brief introduction about the world-wide decline of sea turtle populations, importance of present study and objectives of the study, a brief review of literature in respect of the sea turtles in general and Olive ridleys is presented in this chapter In **II chapter**, the details of study area of Godavari river mouth, demography, marine fishing activity, geography, geomorphology, flora and fauna are narrated. The relevant material and methods adapted for the study are given in **chapter III**.

In **Chapter IV** the results and observations on the profile of nesting beaches, grain size analysis and moisture content, nesting biology, i.e., nesting activity and reproductive success and assessment of threats for the conservation of Olive ridley sea turtles at Godavari river mouth are presented. **The chapter V** presents a summary of study findings and concluded with recommendations for the conservation of nesting habitats and breeding population of Olive ridleys at Godavari river mouth.

The study area, the Godavari river mouth (16° 17' and 18° 30' N longitude and 81° 30' and 82° 37' E latitude), is situated in East Godavari District of Andhra Pradesh, India. The Godavari river divided into two main distributaries Vasista and Goutami before joining Bay of Bengal. The Goutami Godavari river joins Bay of Bengal at two places, one near Bhiravapalem and the other near Mulletimoga-Kothapalem. The Goutami Godavari river is also connected to Kakinada Bay by two distributaries, namely the Coringa river and Gaderu river.

The study area comprises a cluster of twelve fishing villages (Vodalarevu, N. Rameswaram, Vasalatippa, Chirayanam, Pallam, Pandi, Pora, Neelarevu, Mulletimoga, Kothapalem, Balusutippa and Masantippa) along the 48 km coast line. The villagers' mostly of fishing community main occupation and livelihood is fishing. The study region has typical coastal climate with four distinct seasons. The average rain fall and temperatures of the region

recorded from 59.88 mm to 104.87 mm and 22.40°C to 36.80°C respectively. Most of the rain fall occurs during the South-West Monsoon season and remaining occurs during North East Monsoon season.

Nesting beaches of Godavari river mouth were divided into four distinctive Zones (I, II, III and IV) based on their topography and morphological characteristics. The main land beaches of Zone- I are characterized by high elevated terraced flat form type, while the sand spits and lagoon fringed beaches of Zone II, III and IV are fine sandy shores abutting mangrove swamps and river mouth.

Nesting beach profile, distances and grain sizes were analyzed for the beach Zones to estimate the nesting activity, nesting density and hatching success were correlated. The density of Olive ridley populations is estimated to be 2 to 3 mating pairs/ km² during pre nesting period of December - January. Zone wise nesting frequency of Olive ridleys was estimated to be highest (59.89%) in zone III while the lowest (6.20%) in zone II beaches.

Nesting density (Nests/km) in zone III was recorded 34.0 nests/ km⁻¹ followed by zone I with 4.64 nests/ km⁻¹, zone IV with 3.14 nests/ km⁻¹ and zone II with 2.16 nest/ km⁻¹ in the Godavari river mouth. Intensive nesting activity was observed during March (50.15%) and April (22.36%) while the lowest nest laying activity was recorded during the month of January (8.28%), February (17.24%) and almost negligible in December (1.97%).

Clutch size of Olive ridley had a range between 82 and 124 eggs and with a mean of 103 eggs. Hatching success of the Olive ridley nests has greatly varied from zone I to IV. Highest hatching success and emergence of hatchlings were recorded in zone II beaches (52.50%), while the other beaches showed an average hatching success of 36.20%.

Survival of eggs and hatchlings at different beach profile distances from surf waters to 60 m are varied in all beach zones due to frequent erosion and inundation of beaches. Highest nest survival with hatching success was recorded between 21 to 40 m of beach profile distance (62.71%). Beach profile distances of surf waters to 20m, 41 to 60 m and beyond are vulnerable to predation and fungal infestation because of lowest salinity and moisture resulting in poor hatching success.

Threats to Olive ridleys were classified into at offshore waters and on nesting beaches. Incidental capture due to intensive fishing operations with mechanized craft was identified as one of the major threats to Olive ridley turtles in Godavari river mouth. It has been observed that 57.14% incidental capture mortality was due to gill nets followed by 30.36% mortality

belongs to trawl net operations while 8.92% from shore seines and 3.58% deaths were recorded from artisanal fishing activity (drift nets/float nets). Zone wise dead turtle carcasses were noticed highest on the shore line of zone IV (36.81%) and minimum strandings were in zone I (17.79%).

On shore threats to the Olive ridleys in the study area were categorized into beach erosion, tidal inundation, predation of eggs & hatchlings, cyclones and beach fragmentation, coastal developmental projects and their impacts. In overall ratings, the developmental projects like oil exploration and drilling operations were contributed 60.00% of the threats to the breeding Olive ridley populations, followed by 12.00% from natural predation of nests and eggs, 5.00% by exotic plantation, 3% by natural calamities like beach inundation and erosion and the remaining 20.00% was due to denudation of mangrove forest and habitat loss (breeding and foraging).

As such, based on the assessment of threats, suitable conservation and management strategies have been recommended for long time protection of Olive ridleys. The study findings reveal that the Godavari river mouth is a potential “**Reproductive patch**” of Olive ridleys after Gahirmatha and Rishikulya river mouths of Odisha state on the East Coast of India.

The Northern part of Godavari river mouth consists of Coringa reserve forest which is under the protection of Andhra Pradesh Forest Department as a Wildlife Sanctuary for the conservation of mangrove flora and wildlife fauna. However the Southern part of Godavari river mouth (Goutami and Vasistha) did not find the place in the protected list of Andhra Pradesh, even though it has diversified coastal and marine habitats of sand spits, lagoons, mangrove swamps and nesting beaches of Olive ridleys.

Hence, this part of Godavari river mouth deserves to be protected as a ‘**Conservation Reserve**’ for the conservation of coastal and marine biodiversity as well as nesting habitats and foraging grounds of the Olive ridley turtles by the Government of Andhra Pradesh, India. Declaration of conservation reserve certainly attract a larger number of Olive ridley populations and would become an alternative rookery site to Olive ridleys next to Odisha mass nesting beaches on the East Coast of India.

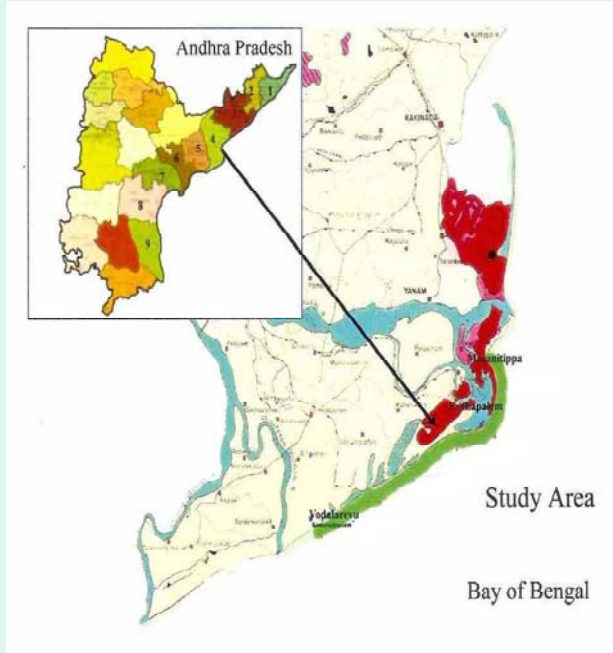


Figure 2.1. Map showing the study area of Godavari river mouth at Bay of Bengal, Andhra Coast, India

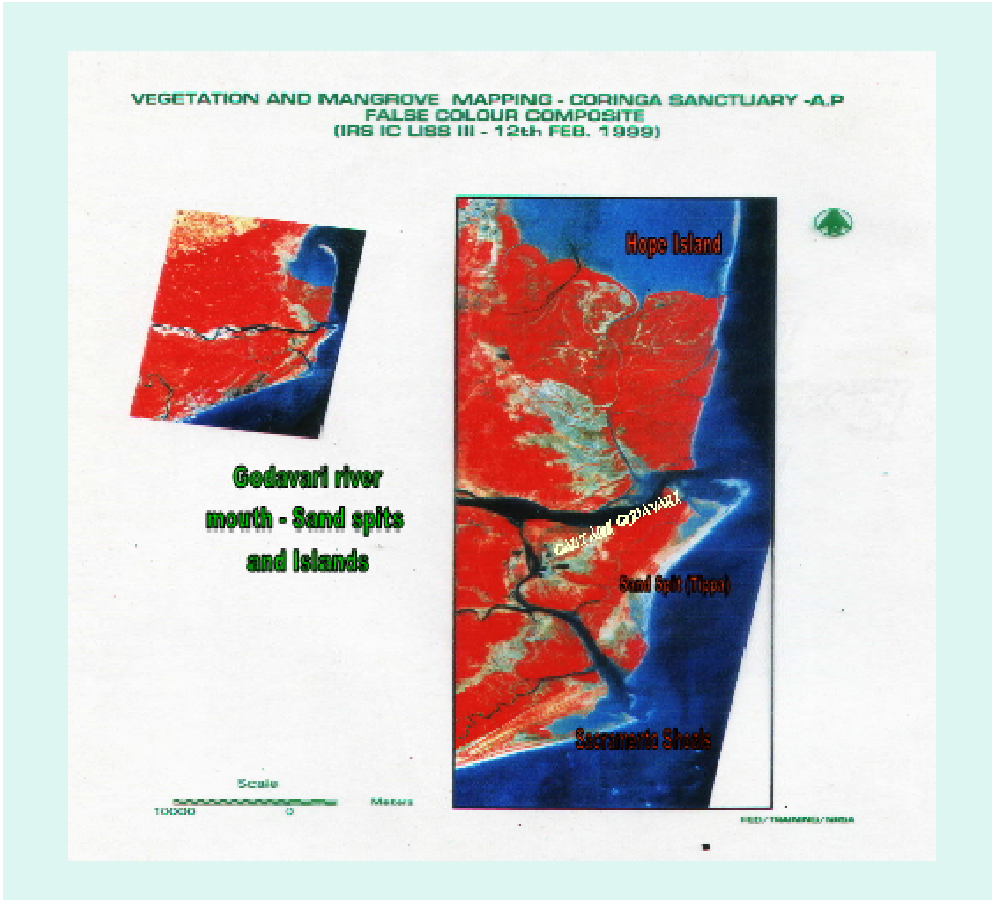


Figure 2.2: Godavari river mouth with Sacramento shoals of Olive ridley (*Lepidochelys olivacea*) Nesting beaches.

Figure 4.1 : Contribution of Factors in Percent Responsible for the Loss of Olive ridley nests

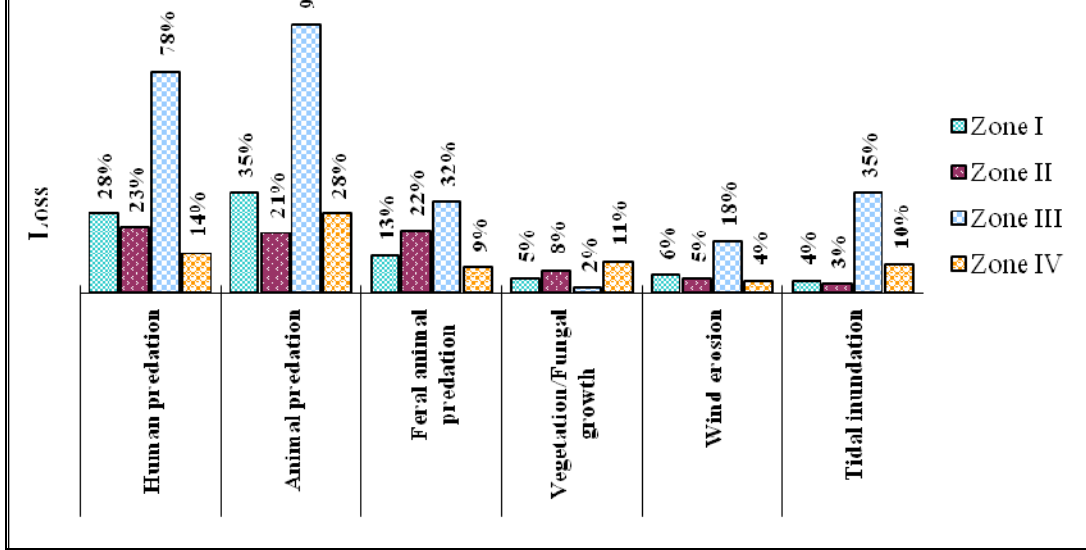


Figure 4.2: Natural and anthropogenic threats to Olive ridley nests and nesting beaches

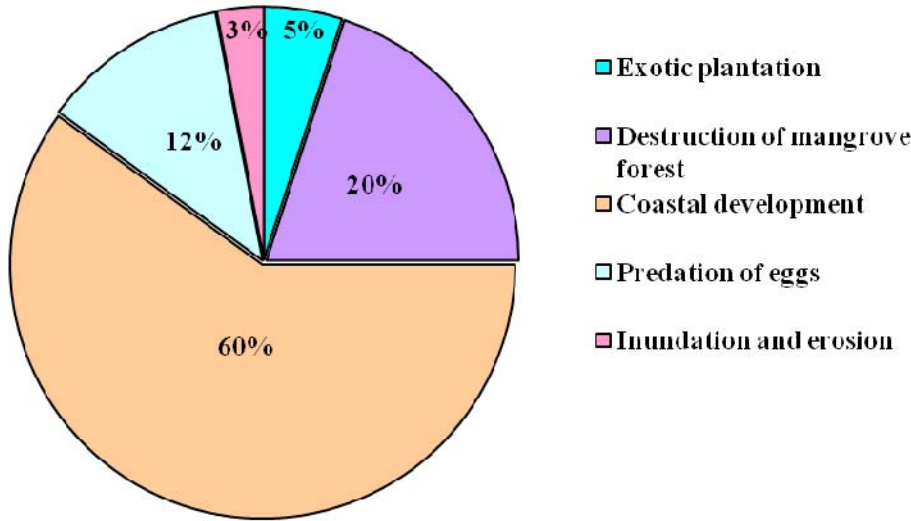




Plate 1: Olive ridley sea turtle as by catch in Trawl Fishing gear at Godavari river mouth



Plate 2: Successful Nesting Crawl of Olive ridley Sea turtle at Godavari river mouth



Plate 3: Freshly laid nest with eggs of Olive ridley Sea turtle (*Lepidochelys olivacea*)



Plate 4: Excavation of eggs of Olive ridley sea turtle for *in situ* protection



Plate 5: *In situ* protection of Olive ridley nests at Godavari River mouth nesting beaches of Bay of Bengal



Plate 6: Hatched eggs of in *situ* protected nests of Olive ridley

13. Achievement of the Project:

The Northern part of Godavari river mouth consists of Coringa reserve forest which is under the protection of Andhra Pradesh Forest Department as a Wildlife Sanctuary for the conservation of mangrove flora and wildlife fauna. However the Southern part of Godavari river mouth (Goutami and Vasista) did not find the place in the protected list of Andhra Pradesh, even though it has diversified coastal and marine habitats of sand spits, lagoons, mangrove swamps and nesting beaches of Olive ridleys.

Hence, this part of Godavari river mouth deserves to be protected as a “**Conservation Reserve**” for the conservation of coastal and marine biodiversity as well as nesting habitats and foraging grounds of the Olive ridley turtles by the Government of Andhra Pradesh, India.

Declaration of conservation reserve certainly attract a larger number of Olive ridley populations and would become an alternative rookery site to Olive ridleys next to Odisha mass nesting beaches on the East Coast of India.

The Godavari river mouth nesting beaches are the mass nesting habitats to Olive ridley sea turtle (*Lepidochelys olivacea*) and recognized as “**Rookery**” by the Andhra Pradesh Forest Department APF), Govt. of India. It was estimated that every year during breeding season from February to March a total of 3,000 to 4,000 migratory Olive ridleys do their nesting at Godavari river mouth nesting beaches of sand spits and sand bars.

In earlier periods the nests and eggs were not protected and subjected to heavy predation from jackals, foxes, dogs and shore crabs as well as local communities poaching the eggs for personal consumption or for sale in local markets.

In view of above status the project study was undertaken ***In situ* conservation and management programs** to protect the nests, eggs and hatchlings at Godavari river mouth beaches of Sacramento sand spits and shoals in collaboration with A.P.Forest department and local fishermen communities.

During the period of study from January 2013 to December, 2015 a total of 300 to 400 Nests/year were protected ***In situ*** on the beaches of Godavari river mouth until hatching and released into marine waters. Now the conservation programs are implementing by the

A.P.State Forest Department with the help of local fishermen communities every year even the project study was completed.

This effort, coupled with active involvement of local fishermen community, helps not only the conservation of Olive ridley sea turtles in Godavari river mouth, but also the fishers, who have long been dependent on natural resources for their livelihood and subsistence.

14. Summary of the findings (in 500 words)

This project study on **“Nesting Ecology and Conservation of Olive ridley sea turtle (*Lepidochelys olivacea*) at Godavari river mouth, Andhra Pradesh Coast, India”** was carried out for a period of three years **from 01.07.2012 to 31.12.2015**. The study area of Godavari river mouth is situated (16°17' and 18°30'N longitude and 81°30' and 82°37'E latitude) in East Godavari district of Andhra Pradesh, India. River Godavari is divided into two main distributaries the Vasista and Goutami before joining Bay of Bengal.

Nesting beaches of Godavari river mouth were divided into four Zones (I, II, III and IV) based on their topography and morphological characteristics. The main land beaches of Zone-I are characterized by high elevated terraced flat type beaches, while Riverine sand spits and lagoon fringed beaches of Zone II, III and IV were fine sandy shores abutting mangrove swamps.

Olive ridley population in the Godavari river mouth was estimated that nearly 3 to 6 thousands of breeding pairs congregate in and around the Godavari river mouth for nesting in nearby mainland beaches, sand spits and sand bars. Nesting frequency of Olive ridleys was estimated to be highest (59.89%) in Zone- III, while, lowest (6.20%) in Zone -II beaches. Density of nests (nests/km) in Zone-III was 34.0 nests/km⁻¹ followed by Zone -I with 4.64 nests/ km⁻¹, Zone- IV with 3.14 nests/ km⁻¹ and Zone- II with 2.16 nests/ km⁻¹ at Godavari river mouth beaches.

Intensive nesting activity was observed during March (50.15%) and April (22.36%) while, lowest nesting activity was recorded during the month of January (8.28%), February (17.24%) and almost negligible in December (1.97%). The clutch size of Olive ridley had a range between 82 and 124 eggs and with a mean of 103 eggs. Hatching success of the Olive ridley nests has greatly varied from Zone-I to IV. Highest hatching success and emergence of hatchlings were recorded in Zone-II beaches (52.50%), while other beaches showed lowest hatching success of 36.20%.

The survival of eggs and hatchlings at different beach profile distances from surf waters to 60 meters varied in all beach Zones due to frequent erosion and inundation of beaches. Highest nest survival with hatching success was recorded between 21 to 40 meters of beach profile distance (62.71%). The profile distances of surf waters to 20 meters, 41 to 60 meters and beyond are vulnerable to predation and fungal infestation because of lowest salinity and moisture content resulting in poor hatching success.

Threats to Olive ridleys were classified into: (i) Offshore waters and (ii) Nesting beaches. It has been observed that 57.14% mortality was due to gill nets followed by 30.36% belongs to trawl net operations, while 8.92% from shore seines and 3.58% deaths were recorded from artisanal fishing (drift nets/float nets). Zone wise turtle carcasses were noticed highest at Zone -IV (36.81%) and minimum stranding were in Zone -I (17.79%).

In overall, the developmental projects like oil exploration and drilling operations, etc. were contributed 60.00% of threats to the breeding Olive ridley populations, followed by 12.00% from natural predation of nests and eggs, 5.00% by exotic plantation on shoreline, 3% by natural calamities of beach inundation and erosion and remaining 20.00% was due to denudation of mangrove forest and habitat loss (breeding and foraging).

These study findings indicated that Godavari river mouth is a potential “**Reproductive Patch**” of Olive ridleys, after Gahirmatha and Rishikulya river mouths on the East Coast of India. Thus the present study has emphasizes the need for restriction of commercial fishing activity in the Zone of ‘**Reproductive Patch**’ during winter months, i.e., December to March to reduce the incidental capture and mortality of Olive ridley turtles.

15. Contribution to the study:

Sea turtles have complex life cycles during which they migrate over long distances to reach their nesting grounds. There has been considerable concern over the mortality of Olive ridley turtles along the Indian coast. Threats to Olive ridleys include due to marine pollution and incidental mortality in fishing nets. The marine turtle population has been subjected to pressures and is dwindling as major cause of this mortality is the incidental capture of turtles in trawl and gill nets.

Incidental mortality of sea turtles is reported to occur particularly along the east coast of India during mechanized trawling operations. Sea turtles are an endangered species, which are protected under Schedule-I of the Indian Wildlife (Protection) Act, 1972 and various international conventions such as Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

Along the east coast of India, Andhra Pradesh coast has several Olive ridley nesting sites, but several thousands of turtles die every year due to intense fishing activities, intense coastal development and increase in shore- based tourism that have resulted in the damage or elimination of important nesting beaches along the coast. Hundreds to thousands of Olive ridley females converge in coastal waters, then come ashore for mass-nesting event known as an Arribada (in Spanish, "Arrival by Sea").

There is an urgent need for formulating appropriate strategies and standard guidelines in order to ensure the survival of sea turtles. Proper conservation and management techniques encourage the collection and analysis of data on the reproductive and nesting status of the turtles that will enhance the chances of effective implementation of time bound programs.

In spite of the fact that the sea turtle conservation programs have been encouraged in the important nesting beaches, the future of sea turtles is still threatened due to decline of their natural populations, especially in nesting areas. Focused attention on critical conservation issues will serve in the protection and management of sea turtle resources. Research and conservation activities on sea turtles are increasing, but there are still many gaps in our knowledge of the life history of these animals.

The project work identified important nesting habitats and provided new insights on the Olive ridley sea turtle nesting activity and reproductive status in the Godavari river mouth, Andhra Pradesh, India as well as some vital information on the status of nesting biology, threats, conservation and management strategies to safeguard the Olive ridleys.

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(a) Manpower Trained During The Project Study:

As the project study was carried out at nesting beaches of Godavari river mouth for conservation of Olive ridley sea turtles. A total of 12 fishing villages are located in the Godavari river mouth and local communities are belongs to fishermen engaged in traditional fishing and mechanized fishing for livelihood at Godavari river mouth and marine waters of Bay of Bengal.

The fishermen youth from local fishing villages were recruited for monitoring of nesting beaches, protection of nests, eggs and hatchlings from animal predation and beach erosion until hatchlings released into marine waters. The selected youth were trained and employed in the conservation programs of Olive ridley sea turtle on the following aspects:

- A. Monitoring of nesting beaches during breeding season of Olive ridley sea turtles protection and Management
- B. Protection of nests until hatching of eggs and safe release of newly born hatchlings
- C. Ex-situ management of newly born hatchlings until seven days old and release in to marine waters.
- D. Head starting programs of newly born hatchlings in natural pens at Pandi Lagoon for a period of 30 days, fed with marine algae and invertebrate fauna.

The above conservation programs were implemented with a total of 24 fishermen youth selected from 12 villages and were trained:

(i) Identification techniques of newly laid nests with sea turtle crawl marks, (ii) Handling and relocation of eggs to nearby suitable beaches for ex situ management programs, (iii) Rearing of hatchlings in constructed pens at sea waters, (iv) Monitoring of hatchlings health, feeding techniques and (v) Measurements of growth and weight of hatchlings.

Moreover the youth were trained how to install the Turtle Excluder Devices (TED) to mechanized boats to prevent sea turtle mortality in marine waters.

The engaged fishermen youth were paid a monthly consolidated pay of Rs. 600/- for each person for a total of six months period from December to May i.e from nesting to until hatching of eggs. An awareness program on sea turtle conservation was organized at fishermen villages about the importance and significant role of sea turtles in food chains of marine ecosystem.

Summary of the UGC Major Research Project:

Introduction:

Olive ridley turtle (*Lepidochelys olivacea*) is widely distributed throughout the tropics, with the exception of Gulf of Mexico and appear in the highest densities in the Northern Indian Ocean (NIO) and Eastern Pacific Ocean. The IUCN Red Data Book (RDB) has been listed the Olive ridley sea turtles under “Threatened” status and included in Appendix I and II of Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES, 1973).

In India, Olive ridley turtles nest along the east and west coasts, with major mass nesting beaches in Odisha state. The coast of Andhra Pradesh in continuation to the south of Odisha, provides sporadic nesting habitats to Olive ridley sea turtles and is believed to be an important migratory route to Odisha mass nesting beaches of Gahirmatha and Rushikulya River mouth.

Strategies for protection of nesting habitats is an important to sea turtles and should be fully incorporated into local and regional Integrated coastal zone management (ICZM) initiatives. One of the important conservation aspects is the research priority in the inventory of nesting beaches. Long-term conservation of sea turtles will depend on the availability and condition of various nesting beaches. Index of nesting habitats should be protected to the highest degree of practicability.

Nesting beaches should be inventoried by area, habitat type, ownership and conservative status. Records should be maintained on the loss or degradation of nesting beaches due to natural or anthropogenic causes and decisions made considering the areas of higher nesting activity that deserve regular and methodical monitoring. However, full-fledged information is essential on the turtle congregation patches to make them safe from fishing related mortality.

In view of the above background the present study was conducted at the Godavari river mouth of central coast of Andhra Pradesh for a period of three consecutive years beginning with November, 2012 and ending at December, 2015. This project study on **“Nesting Ecology and Conservation of Olive ridley sea turtle (*Lepidochelys olivacea*) at Godavari river mouth, Andhra Pradesh Coast, India”** was carried out for a period of three years **from 01.07.2012 to 31.12.2015.**

Never before, has this region been so elaborately studied for sea turtles except for short term studies on the Olive ridleys. Status of the Olive ridley turtles was thoroughly investigated together with extensive studies on the nesting ecology followed by implementation of

appropriate conservation programs to Olive ridley sea turtles in Godavari river mouth of Bay of Bengal, India.

An attempt has also been made to thoroughly propagate the use during trawl fishing of the Turtle Exclusive Device (TED) for the conservation of Olive ridleys. The management program emphasis on the need to educate the illiterate and ignorant fisher masses who poach the turtle resources for belly filling and meager gains besides mobilizing their direct involvement in the protection and conservation of this endangered Olive ridley sea turtle.

Aim and Objectives of the Project

This project study was aimed to determine the status of nesting and hatching success of Olive ridley sea turtles (*Lepidochelys olivaceae*) and evaluation of possible threats to the breeding population for long term protection and conservation in Godavari river mouth of Bay of Bengal, Andhra Pradesh, India with the following study objectives:

- (i) To identify the nesting habitats and assess the reproductive status of Olive ridley turtles in Godavari River mouth of Bay of Bengal on the East Coast of India.
- (ii) To analyze the geomorphology and topographical factors of the nesting beaches in relation to the Nesting Ecology and Reproduction Success of Olive ridleys.
- (iii) To assess the possible threats and human induced mortality of the breeding population of Olive ridley turtles.
- (iv) To design conservation measures and management strategies for protection of Olive ridley population, nesting habitats, eggs and hatchlings at Godavari river mouth

STUDY AREA;

The Godavari River Mouth:

The study area of Godavari river mouth is situated (16°17' and 18°30'N longitude and 81°30' and 82°37'E latitude) in East Godavari district of Andhra Pradesh, India. River Godavari is divided into two main distributaries the Vasista and Goutami before joining Bay of Bengal. Nesting beaches of Godavari river mouth were divided into four Zones (I, II, III and IV) based on their topography and morphological characteristics. The main land beaches of Zone-I are characterized by high elevated terraced flat type beaches, while Riverine sand spits and lagoon fringed beaches of Zone-II, III and IV were fine sandy shores abutting mangrove swamps.

Olive ridley population was estimated nearly three to six thousands of breeding pairs congregate in and around Godavari river mouth for nesting in nearby mainland beaches, sand spits and sand bars. Nesting frequency of Olive ridley was estimated to be highest (59.89%) in Zone- III, while, lowest (6.20%) in Zone -II beaches. Density of nests (nests/km) in Zone-III was 34.0 nests/km⁻¹ followed by Zone -I with 4.64 nests/ km⁻¹, Zone- IV with 3.14 nests/ km⁻¹ and Zone- II with 2.16 nests/ km⁻¹ at Godavari river mouth beaches.

Intensive nesting activity was observed during March (50.15%) and April (22.36%) while, lowest nesting activity was recorded during the month of January (8.28%), February (17.24%) and almost negligible in December (1.97%). The clutch size of Olive ridley had a range between 82 and 124 eggs and with a mean of 103 eggs. Hatching success of the Olive ridley nests has greatly varied from Zone-I to IV. Highest hatching success and emergence of hatchlings were recorded in Zone-II beaches (52.50%), while other beaches showed lowest hatching success of 36.20%.

The survival of eggs and hatchlings at different beach profile distances from surf waters to 60 meters varied in all beach Zones due to frequent erosion and inundation of beaches. Highest nest survival with hatching success was recorded between 21 to 40 meters of beach profile distance (62.71%). The profile distances of surf waters to 20 meters, 41 to 60 meters and beyond are vulnerable to predation and fungal infestation because of lowest salinity and moisture content resulting in poor hatching success.

Threats to Olive ridleys were classified into: (i) Offshore waters and (ii) Nesting beaches. It has been observed that 57.14% mortality was due to gill nets followed by 30.36% belongs to trawl net operations, while 8.92% from shore seines and 3.58% deaths were recorded from artisanal fishing activity (drift nets/float nets). Zone wise turtle carcasses were noticed highest at Zone -IV (36.81%) and minimum stranding were recorded in Zone -I (17.79%).

In overall, the developmental projects of oil exploration and drilling operations, etc. were contributed 60.00% of threats to the breeding Olive ridley populations, followed by 12.00% from natural predation of nests and eggs by feral dogs, Jackal and Foxes, 5.00% by raising plantations of *Casuarina equisetifolia* on shoreline of nesting beaches, 3.00% by natural calamities of beach erosion and inundation. The remaining 20.00% was due to over exploitation of mangrove fauna and flora causes habitat loss for breeding and foraging activity of Olive ridley sea turtles.

These study findings indicated that Godavari river mouth is a potential “**Reproductive Patch**” of Olive ridleys, after Gahirmatha and Rishikulya river mouths on the East Coast of India. Thus the present study has emphasizes the need for restriction of commercial fishing activity in the zone of ‘**Reproductive Patch**’ during winter months, i.e., December to March to reduce the incidental capture and mortality of Olive ridley turtles.

Research Publications:

**The following Research Papers are published in Proceedings of
International Sea Turtle Symposium**

**33rd Sea Turtle Symposium, Baltimore, U.S.A.
(2nd to 8th February, 2013)**

1. Conservation and Management of Olive ridley Sea Turtle (*Lepidochelys olivacea*) at Intensive Sporadic Nesting habitats of Andhra Coast, Bay of Bengal, India.
2. Nesting Ecology and Reproductive Success of Olive ridley (*Lepidochelys olivacea*) Sea turtle at Godavari River Mouth Nesting Beaches, Andhra Coast, Bay of Bengal, India.

**35th Sea turtle Symposium, Dalaman Mogale, Turkey
(18th to 22nd April, 2015)**

3. Conservation of Olive Ridley Sea Turtle (*Lepidochelys Olivacea*) At Godavari River Mouth Rookery of Andhra Coast, Bay of Bengal, India
4. Nesting Beaches Geomorphology and Reproductive Status of Olive Ridley sea turtle (*Lepidochelys olivacea*) at Godavari river rookery, Andhra Pradesh, India.