

## NESTING HABITAT SUITABILITY FOR OLIVE RIDLEY TURTLES (*LEPIDOCHELYS OLIVACEA*) AT THE GAHIRMATHA ROOKERY, ODISHA COAST OF INDIA

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### Abstract

*The changes in the beach dynamics at Gahirmatha sea turtle rookery along Odisha coast of India have forced the olive ridley turtles to nests in a non-conducive environment. In the recent past, non-availability of nesting beach due to erosion was hypothesized to be one of the major reasons for non-occurrence of arribada at Gahirmatha. This paper reviews the current status of nesting habitat for olive ridley turtles at Gahirmatha and suggests onshore and offshore developmental activities close to Gahirmatha rookery should be monitored efficiently so that future arribada at this rookery should not be troubled due to habitat destruction.*

**Keywords:** Olive ridley; Nesting beach; Gahirmatha; Arribada; Threat; Odisha; India

### Introduction

Degradation, transformation and destruction of natural conditions at nesting beaches from coastal developments continue to threaten the long-term survival of many olive ridley rookeries [1]. Odisha state along the east coast of India supports a large olive ridley sea turtle (Fig. 1) population that migrates for breeding and synchronized nesting takes place at a few locations [2-4]. Olive ridleys face many threats along the coast of Odisha. Apart from offshore fishing related mortality, on the beach, erosion considered to be major factor affecting the animal directly through the loss of nesting habitat or indirectly through changes in the thermal profiles of the beach [5]. Currently the olive ridley sea turtle has been listed as vulnerable by the IUCN Red List [6] and as per CITES it is prohibited for trade of any kind and also is included in the schedule I of Indian Wildlife (Protection) Act (1972) and is legally protected.

In most of their distribution range, olive ridley turtles nest sporadically. However, at certain select locations, the members of the genus *Lepidochelys* – olive ridley (*L. olivacea*) and Kemp's ridley (*L. kempii*) – congregate in very large numbers, and synchronized nesting involving hundreds and thousands of individuals takes place [7]. The olive ridley turtle (*Lepidochelys olivacea*) is known to congregate along the Odisha coast every season between November and April and *en masse* nesting takes places on suitable nesting beaches including

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Gahirmatha. Although the nesting figures for different years from this rookery is subjected to critical review, this rookery claimed to be the largest for olive ridley turtles in its distributional range [3, 8 - 10]. Multiple mass nesting events (called *arribada* in Spanish) have been reported at Gahirmatha during some years while there are records of failure as well [3, 11, 12]. The estimate of mass nesting by Wildlife Wing of Odisha Forest Department at Gahirmatha have ranged between 1,00,000 to 8,00,000 in different years [11]. Before 1989, mass nesting occurred on a 10 km mainland beach near the river confluence, which subsequently got fragmented into smaller islands by 1999. Now, mass nesting is restricted to smaller islands, each less than one km in length. These sandbars are most unstable and dynamic and the topography and geomorphology of the beach changes with the prevailing current pattern and wind condition at the rookery. This study has made an attempt focusing on the changes in geomorphology and response of the olive ridley turtles for nesting along the *arribada* site. Although the data are only for three years, but it clearly shows an indication by the olive ridleys responding to the changes in the beach profile at Gahirmatha rookery.



Fig. 1. Olive ridley sea turtles on beach

## Materials and Methods

The study was conducted at the Gahirmatha mass nesting site, located in the Gahirmatha Marine Sanctuary of Odisha and is part of the larger Bhitarkanika National Park (Fig. 1). There are four islands each less than a km in length and width averaging 50 m where major turtle nesting takes place. Of these, during the study period, the *arribada* of olive ridley turtles have been observed in Nasi-II and < 1km long south beach of the Wheeler Island. The field work was carried out during 2007 at the Nasi-II (which was completely inundated in 2008), and from 2008 to 2010 season at the < 1km south beach of Wheeler Island.

Beach profiling was done on a fortnightly basis from November to April following standard procedures as suggested [13]. Every 100m, a permanent landmark was fixed (a). These points were marked with a handheld GPS (Garmin 72, Garmin Inc.) for subsequent monitoring. Beach width was measured perpendicular from the high tide line (HTL) to the permanent landmark.

The formula used for calculating the available nesting beach was as follows [5].

Width of the beach,  $l = a \pm b$

Where,  $b$  is the width of beach from the permanent landmark ( $a$ ).

Finally, area available for nesting ( $N$ ) was calculated as average beach width ( $l$ ) x total length of the beach.

## Results and Discussion

The *arribada* of 2007 took place largely on the sandbar detached from and located north of the Wheeler Island namely Nasi II (Fig. 2) and in which reportedly ~ 39,000 olive ridley turtles laid their eggs on the beach during February 2007 (Unpublished data of Wildlife Wing of Forest Department, Government of Odisha, 2007-08). This Nasi II Island beach got completely inundated by waves during the following few months and by May 2007, there was only 20% beach available (< 15m beach width), subsequently in 2008 the same Island got submerged and there was no beach located north of Wheeler Island. There were no *arribadas* during 2008, in spite of the fact that there was considerable beach available both north and south of the Wheeler Island (58m). The reason is unknown but beach erosion was observed during April-May 2008-2009 (< 30m) along the nesting beach of Gahirmatha (Fig. 3).

During 2009 breeding season, *arribada* occurred along the ~ 900m long extended sandbar formed south-western part of the Wheeler Island connecting with the former. The average width of beach during November-December 2008 was 55m which extended to 87m during January-February 2009 and then again decreased to 55 m during March-May 2009 due to heavy erosion all along the beach. The mass nesting took place along the ~ 900m south beach of Wheeler Island in which reportedly 120,357 turtles nested at this beach (Unpublished data of Wildlife Wing of Forest Department, Govt. of Odisha 2009).

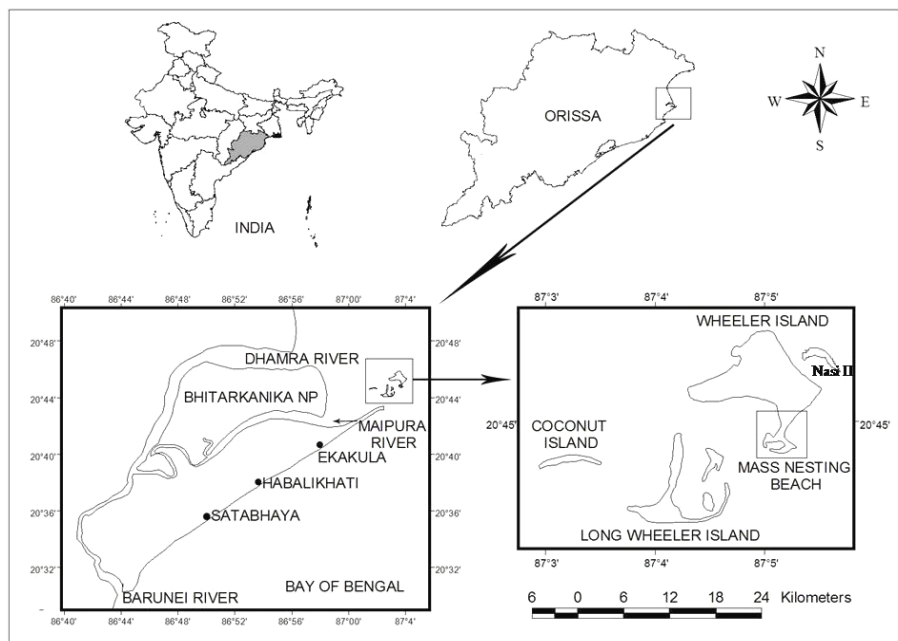


Fig. 2. The map of the Gahirmatha sea turtle rookery

Similarly, during 2010 nesting season, the extended south beach of Wheeler Island was ~ 1000m, an extension of another 100m compared to previous year and width varied between

23m and 87m. The *arribada* of 2010 also took place along the same beach in which reportedly 344,260 turtles laid their eggs (Unpublished data of Wildlife Wing of Forest Department, Govt. of Odisha 2010). The common feature observed at the Gahirmatha rookery was the intensity of erosion of the beach every year and thereby loss of the nesting habitat. Although the nesting figures for 2007 to 2010 suggests an increase in the nesting intensity, however, the numbers of *arribadas* during the same year at Gahirmatha are not the same. For example, there was only one *arribada* in 2007, but one *arribada* in 2009 and two in 2010 and the figures are not of one but a cumulative estimate. The detail *arribada* figures are given in table 1 for 2009 and 2010 breeding seasons.

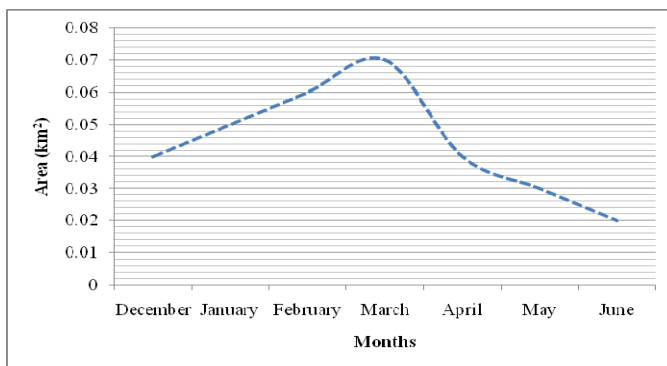


Fig. 3. Graph showing the shrinkage of extended mass nesting beach during the breeding season of 2008-2009

Table 1. Estimates of *arribada* (nesting number) for the 2009 and 2010 nesting season at Gahirmatha rookery (Source: Odisha Forest Department)

Year	No. of nesting turtles	Lower confidence interval	Upper confidence interval (95%)
2007	39,000	?	?
2008	No <i>arribada</i>		
2009	120357	109081.1	131630.6
2010 1st <i>arribada</i>	211408	185382.2	237434
2010 2nd <i>arribada</i>	132852	113579.6	152124

? Not Available

An assessment of beach profiling at Gahirmatha from 2007 to 2010 breeding season is presented in Table 2. The maximum beach erosion was observed during the month of March which was the post-*arribada* month at this rookery thereby resulting in major loss of eggs due to inundation of the beach.

Table 2. Extent of nesting beach available at the Gahirmatha study site (2007 to 2010 turtle breeding seasons)

Year	Nasi II		Wheeler Island	
	Mean Beach Width (m) (mean ± SD)	range	Mean Beach Width (m) (mean ± SD)	range
2007	15 ± 11	7-31	?	?
2008	No beach	No beach	58 ± 47	27-84
2009	No beach	No beach	55 ± 31	55-97
2010	No beach	No beach	55 ± 41	23-87

? Not Available

The Gahirmatha rookery was once believed to be the largest *arribada* ground for olive ridley turtles in the world although there are criticisms from turtle conservationist and biologists on the figures as projected in recent years [8, 9]. However, in recent years, the phenomenon of mass nesting and the figures are fluctuating with the synchronization of beach area. The mass nesting has been taking place in either alternative years or apparently absent in some consecutive years [4, 14]. The failure of mass nesting at Gahirmatha is a cause for concern due to drastic changes of nesting beach profile [4, 15].

The *arribada* at Gahirmatha was a continuous event since its discovery in 1974 till 1987. The mass nesting occurred along the 10 km mainland beach from Maipura river mouth i.e. Ekakulanasi to Habalikhathi that got detached from mainland during a cyclonic storm in 1989 after which *arribada* was restricted to a four km long island beach. Again in 1998 cyclone, the 4 km beach got fragmented in to two islands viz. Nasi-I and Nasi-II. Till 2007, the *arribada* was occurring at the Nasi-I and Nasi-II with non-occurrence of *arribada* during 1997, 1998, 2002 which also happen to be the highest incidence of failure in the documented history at this rookery [12] and also 2008 the *arribada* was absent in Gahirmatha [15].

Earlier study [16] revealed that the primary reason for non occurrence of *arribada* at Gahirmatha is beach erosion resulting from the geo-morphological changes undergone at the Nasi Islands. A study conducted by [17] to assess the factors leading to the non-occurrence of *arribada* at the Gahirmatha, indicates that the nesting beaches at Gahirmatha are eroding at a faster rate over the years. Similarly, an unpublished report of primary author [15] based on monitoring the changes in the Gahirmatha nesting beach profile from November 2007 to May 2008 reveals the changes in the beach profile as a very strong reason why *arribada* may not be taking place at Gahirmatha. During 2009 nesting season, the mass nesting took place in new formed extended sand spit adjacent to the south-western end of the Wheeler Island. The estimated number of mass nesting was 120,357 (Unpublished Report of Wildlife Wing of Odisha Forest Department).

Historically, *arribada* happen to takes place within an interval of 45 to 50 days. However, since last one decade, the second *arribada* failing to takes place at this rookery and the exact reason for non occurrence of second *arribada* is not known. Nevertheless in 2010 Gahirmatha witness two *arribada* within an interesting period of 14 days. Significant shrinkage of beach due to erosion exposes majority of nests laid during the *arribada*. Hatching success is considered to be influenced by number of variable factors such as egg fertility, egg death by dehydration or predation, nest destruction by tides, extreme weather condition and poaching [18]. At Gahirmatha, the hatching success is largely governed either by erosion or predation [3, 19]. A small that to a narrow strip of sand spit where mass nesting took place during 2009 and 2010 at Gahirmatha has been posing threats from natural disasters as 75% of turtles nests got inundated from the heavy erosion. Moreover, incubation success in sea turtles is also believed to be influenced by a number of interacting ecological factors such as sand temperature, sand particle size, water content and salinity. Wet beach condition as a result of either excessive rainfall or inundation of beach due to heavy waves and erosion has also been documented to have adversely affects the survival of post ovi-positional eggs of turtles [20, 21]. High moisture content of the beach influenced indirectly by beach inundation also reduces the hatching success by inhibiting or reducing gas exchange between egg clutch and its surroundings or by promoting fungal growth on the egg shell [22-24].

A larger portion of sand spit where mass nesting took place at Gahirmatha was inundated by high tide waves during the month of March of 2009 and 2010 which is likely to have also adversely affected the incubation success of the nests. Nests deposited on shifting beaches are more susceptible to damage due to erosion. Almost 40-60% of the nests of leatherbacks laid on shifting beaches are reported to have been lost because of beach erosion [25]. As a result of this, there has been a substantial loss of nesting habitat at this rookery. An earlier study [3, 26 - 28]

has suggested that heavy loss of the post ovipositional eggs could occur as a result of beach erosion at mass nesting sites. Erosion of Gahirmatha beach after the 1970's was due to *Casuarina* plants planted along the coast. However, the *arribada* of recent years heavily suffers not due to *Casuarina* as nesting shifted to the island, but for more than one factor including the nearly coastal industrial developments (B.C. Choudhury, personal communication).

## Conclusions

Over the years the nesting beach at Gahirmatha had been severely fragmented and shrunken possibly because of changes in the topography of landscape and seascape [15, 17, 29]. Therefore, the fate of Gahirmatha rookery is uncertain for future successful *arribadas*. Although the beach erosion phenomenon looks like a natural cause, but get intensified and induced by man-made reasons viz. The onshore developmental activities close to Gahirmatha viz. Beach armouring of the Wheeler Island and thereby shifting of the sand from armoured area and causing erosion to natural beaches. Similarly, dredging of the passage in the Dhamra estuary for Port development cause erosion of the beaches close to the area by local current movement. The olive ridley sea turtles in Odisha are now exposed to many problems other than fishing related casualty and precautionary measures need to be taken by the wildlife and forest authority to safeguard the olive ridleys and their nesting habitat including the largest rookery of turtles at Gahirmatha as more threats coming up in recent years at this rookery than anywhere else all along the east coast of India. Any unplanned developmental activities need to be monitored and suitable measures be recommended for onshore and offshore activities close to Gahirmatha rookery in Odisha.

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