SHORT NOTE The Herpetological Bulletin 130, 2014: 18-20

World's largest olive ridley turtles *Lepidochelys olivacea* nesting grounds: Gahirmatha rookery now uncertain for arribada in future, East-Coast of India

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ABSTRACT - The nesting season of olive ridley marine turtles *Lepidochelys olivacea* is confined to between November and May at the Gahirmatha rookery of Odisha state, India. Historically nesting has occurred all along the Gahirmatha rookery, however in recent times the nesting has been confined to isolated areas of coast. The Gahirmatha rookery on the Odisha Coast of India is the largest known mass nesting rookery for olive ridley sea turtles in the World. The recent nesting decline at Gahirmatha is likely due to the unavailability of available nesting areas on the beach. The long-term conservation of this species at Gahirmatha is now under serious concern among managers, scientists and conservationists.

INTRODUCTION

Of the seven species of sea turtle found in the Indo-Pacific region (*Caretta caretta, Chelonia mydas, Eretmochelys imbricata, Lepidochelys kempii, L. olivacea, Natator depressus, Dermochelys coriacea*), five are found in India. Of these, four are reported to occur in the coastal waters of Odisha (Fig. 1). These are the Leatherback (*D. coriacea*), green turtle (*C. mydas*), hawksbill (*E. imbricata*) and the olive ridley turtle (*L. olivacea*). The latter is the most common and is known to nest en-masse along the Odisha coast (Dash & Kar, 1990); Pandav, 2000). This species is known to form enormous congregations along the Odisha coast during the breeding season (November to April) with nesting taking place along suitable nesting beaches at Gahirmatha, Rushikulya and Devi rookeries. Gahirmatha is known to be the largest Olive ridleys rookery in the World (Bustard, 1976; Dash & Kar, 1990). Estimates of annual turtle nesting in Gahirmatha have ranged from between 100,000 to 800,000 in different years (Patnaik et al., 2001; Tripathy, 2002). Although multiple mass nesting events have been reported at Gahirmatha there are also records of failure (Dash & Kar, 1990; Patnaik & Kar, 2000; Shanker et al., 2004). At Gahirmatha, the recent trend on mass nesting has occurred either in alternative years or apparently absent in some consecutive years (Pandav & Choudhury, 2000; Draft Final Report WII, 2011). For instance, the failure of mass nesting in 1997 and 1998 at Gahirmatha is a cause for concern due to drastic changes of nesting beach profile (Pandav & Choudhury, 2000; Shanker et al., 2004) since nesting has been a continuous event since its discovery in 1974 until 1982. Historically, mass nesting has taken place along the 10 km of mainland coast in the Bhitarkanika Wildlife Sanctuary. However, from 1989 nesting became restricted to a 4 km long isolated sand bar projecting into the Bay of Bengal. A super cyclone in 1999 fragmented the 4 km nesting beach into two islets viz Nasi-I & Nasi-II. There was an absence of nesting at Nasi-I and Nasi-II during 1997, 1998, 2002 (Shanker et al., 2004) and 2008 (Draft Final Report WII, 2011), the highest incidences of failure in the documented history at this rookery. The Defence Research and Development Organisation have reported that mass nesting now takes place along a section just 900 m long beach of the Wheeler Island, which is located at the tip of the sand bar. In this paper we describe recent nesting activity at the Gahirmatha rookery on the east coast of India.

METHODS

The field work was carried out between 2009 and 2012 season at the < 1km (900 m) south beach of Wheeler Island (Fig. 1). Beach profiling was carried out on a fortnightly basis from November to April following standard procedures as suggested by Cooper et al., (2000). 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 land-mark. The formula for calculating the available nesting beach was first by finding the width of the beach (l) from a ± b, where b is the width of beach from the permanent landmark (a) (Tripathy & Rajasekhar, 2009). Finally, area available for nesting was calculated as average beach width (l) x total length of the beach.

RESULTS AND DISCUSSION

The effective nesting area above highest high tide at Nasi-I and Nasi-II was 22.4 and 29.6 ha during 2001 (Prusty & Dash, 2006). However in the 2009 and 2010 breeding seasons, the effective nesting areas of the current nesting beach (South beach; 900 m) was restricted to only 6.9 ha, which is newly formed at the southern end of Wheeler Island. During the 2011 and 2012 breeding years the effective nesting area was drastically reduced to 5.7 ha and 5.9 ha respectively. This is a

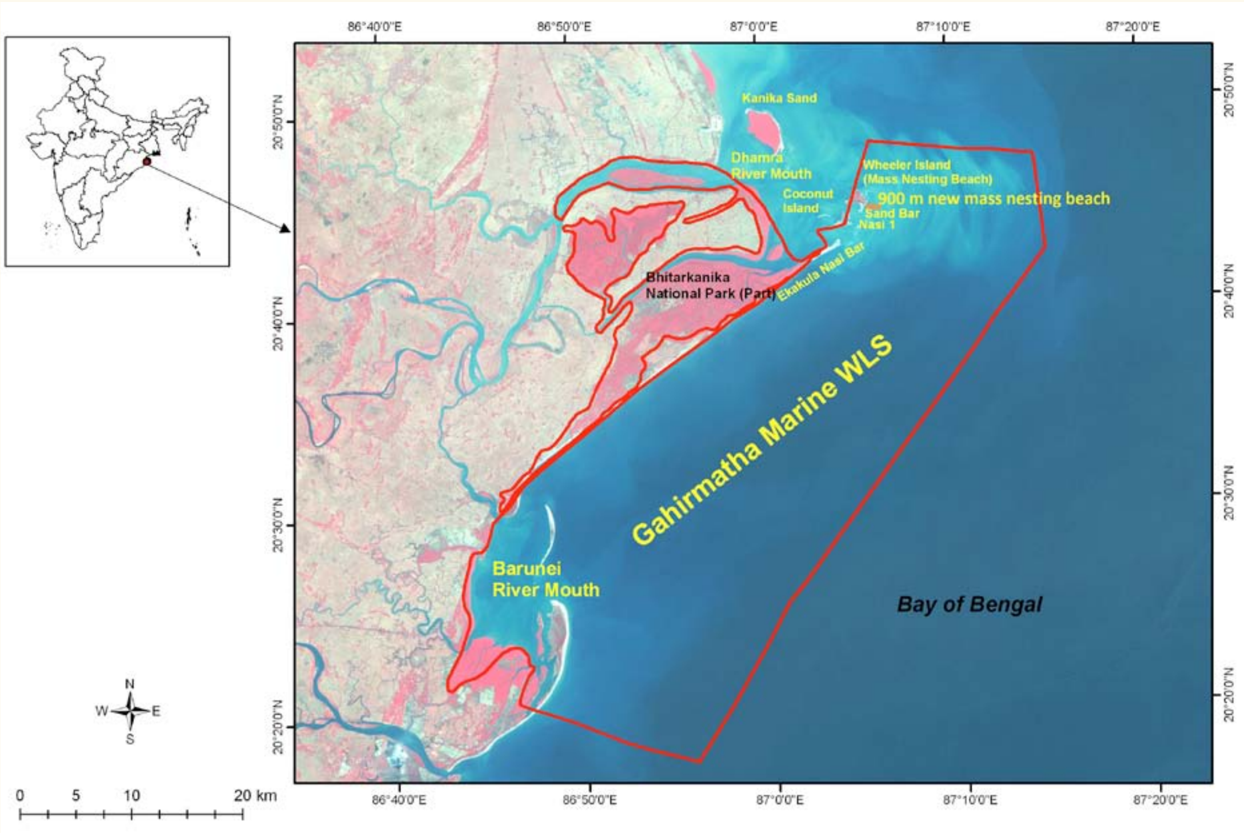

Figure 1. The newly formed mass nesting beach near the southern part of Wheeler Island at Gahirmatha rookery, Odisha coast, India.

huge loss of beach within a four year period. A study conducted by Prusty & Dash (2006) to assess the factors leading to the non-occurrence of mass nesting at Gahirmatha, indicates that the nesting beaches are eroding at a faster annual rate. During the 2009 and 2010 nesting season, mass nesting took place in new-formed extended sand spit < 1 km (900 m) south beach adjacent to the southern end of the Wheeler Island (Fig. 1).

Historically, nesting takes place within an interval of 45 to 50 days. However, in the last decade, the second nesting failed to take place and the exact reason for non-occurrence is not known. However, in 2010 Gahirmatha two nesting periods occurred within a period of 14 days. The estimated number of nesting females was 363,000 (Satyaranjan unpublished data.). Significant shrinkage of beach due to erosion and inundation exposes the majority of nests laid during the mass nesting. A mean of 57 % and 22 % of nesting beach has been lost at Gahirmatha within the incubation period during 2009 and 2010 nesting seasons, which has resulted in hatching success of 20.4 and 64 % respectively. Erosion of nesting beaches can result in partial or total loss of suitable nesting habitat and are influenced by dynamic coastal processes, including sea level rise (National Research Council, 1990). At Gahirmatha, the hatching success is largely governed either by erosion or predation (Dash & Kar, 1990; Pandav, 2000).

A larger portion of sand spit (South beach) where mass nesting took place at Gahirmatha was inundated by tidal waves during the month of March 2009 and 2010, which is likely to have 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 (Whitmore & Dutton, 1985). As a result, there has been a substantial loss of nesting habitat at Gahirmatha rookery (Draft Final Report WII, 2011). Earlier researchers (Dash & Kar, 1990; Choudhury et al., 2003; Mortimer, 1981; Cornelius & Robinson, 1986) have suggested that heavy loss of the post ovipositional eggs of Olive ridley could occur as a result of beach erosion at mass nesting sites. Erosion of the Gahirmatha beach after the 1970's was due to the planting of *Casuarina equisetifolia* along the coast. However, the mass nesting in recent years is affected not only by the presence of *C. equisetifolia* but to other factors including nearby coastal industrial developments (B.C. Choudhury, personal observation). Due to the constraint of nesting beach availability on the South beach of Wheeler Island, turtles may be shifting the mass-nesting to other nearby beaches. This is largely because of beach exchange, which is part of a complex phenomenon that *L. olivacea* use to colonise new areas or move to another beach altogether (Valverde et al., 1998; Tripathy & Pandav, 2008). Although mass nesting was absent or occurred in alternative years, the frequency of sporadic nests laid during the breeding season (November-May) showed a monthly peak in March (Fig. 2) when the nesting beaches are more vulnerable to erosion due to seasonal changes of sea currents (Prusty et al., 2007; Behera et al., 2013).

Over the years the mass nesting beach at Gahirmatha has been severely fragmented and reduced, possibly because of the changes in coastal geomorphology, the topography

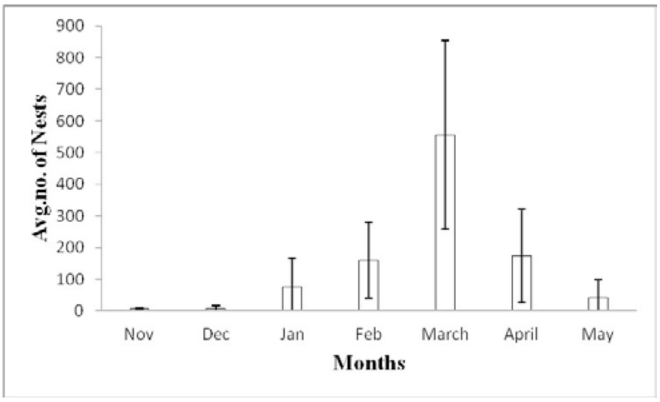

Figure 2. Annual nesting pattern of non-arribada *L. olivacea* at Gahirmatha beach, from 2007-2008 to 2009-2010. A total of 3046 nests were counted, averaging 145 (S.D. 193.3) nests per month.

of the land and seascape (Draft Final Report WII, 2011; Prusty et al., 2007). Mass nesting did not take place in 2014 during the turtle breeding season at the Gahirmatha rookery [Anonymous, 2014]. Therefore, the fate of this rookery is uncertain. Mass nesting at beaches on other sections of the Odisha coast may also be threatened unless fishing activities and predators of these regions are regulated. Additional research is now needed to determine potential or possible alternative nesting sites in and around the Gahirmatha turtle rookery so that conservation measures can be implemented to safeguard these potential valuable sites.

AKNOWLEDGEMENTS

We thank Director and Dean, Wildlife Institute of India. The Government of Odisha Forest Department for giving us permission to carry out this research. Mangrove Forest Wildlife Division provided support logistical support while in the field. We are grateful to our funding agency Director General of Hydrocarbon, Government of India. Lastly we are extremely thankful to our all field assistants who assisted us in this remote area that enabled us to carry out our study and anonymous reviewers for comments, including corrections to English grammar, on an earlier version of the manuscript.

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