Research Article **AJMRR (2018) 1:6**

American Journal of Marine Research and Reviews
(ISSN:2578-2126)

Total An Investigation into Light Pollution as a Limiting factor for shift of Mass nesting ground at Rushikulya rookery Ganjam Odisha

Subrata Kumar Behera* , Rajkishore Mohanta

Integrated Coastal Zone Management Project, Berhampur Forest Division, Berhampur, Odisha, India; Integrated Coastal Zone Management Project, Forest and Environment Department (Wildlife Wing), PMU, Sahidnagar,Plot.No-1459, Bbubaneswar, Odisha

ABSTRACT

Illumination due to artificial lights on nesting beaches and from nearby place to nesting beaches is detrimental to sea turtles because it alters critical nocturnal behaviors specifically, their choice of nesting sites and their return path to the sea after nesting. Illuminations perplex the hatchlings to find sea after emerging. Numerous studies conducted in other countries have demonstrated that artificial lights negatively impact on turtles, both female adults as they come to and go from their home beach to lay eggs, and to turtle hatchlings as they seek out the way to the open ocean. In this study we correlated the mass nesting intensity of 5years (2012 to 2018) at Rushikulya mass nesting site to the illumination zone. Illumination due to light conditions on nesting beaches are complex, and measuring light pollution in a way that effectively captures the impacts to sea turtles is difficult. But increase in intensity of illumination on selective mass nesting beaches showed gradual reduction in intensity of preferred nesting site during the mass nesting event. A gradual shift of nesting preference was also observed more toward darker zone.

Keywords: Illumination, light pollution, mass nesting, nest selection, olive ridley, Rushikulya

***Correspondence to Author:**
Subrata Kumar Behera
Integrated Coastal Zone Management Project, Berhampur Forest Division, Berhampur, Odisha, India

How to cite this article:
Subrata Kumar Behera and Rajkishore Mohanta.An Investigation into Light Pollution as a Limiting factor for shift of Mass nesting ground at Rushikulya rookery Ganjam Odisha. American Journal of Marine Research and Reviews, 2018; 1:6.

eSciPub LLC, Houston, TX USA.
Website: http://escipub.com/

Introduction

The Sea turtle populations had undergone decline globally, and their recovery largely depends upon managing the effects of expanding human populations on their habitat. Among numerous threats, one of significant threats is light pollution in developing country like India. Nesting numbers had shown to decline on beaches that are more brightly lit, and bright lights at nesting sites can disrupt the ocean-finding behavior of both adult females and hatchlings (Witherington 1997). Although turtle tends to prefer dark beaches, many nests on lighted shores, but when they do so, hatchlings' lives are jeopardize and artificial lighting disrupts a critical nocturnal behavior of hatchlings—crawling from their nest to the sea.

Illumination in Rushikulya rookery is chronological threat (Karnad, 2008) as rookery is very close to three fishing villages (Purunabandha, Gokhurkuda and Podumpeta). The Humma and Ganjam Townships are within 3km to the nesting beach. A Chemical Industry on the bank of River Rushikulya mouth at a distance of 2 km from nesting beach. The National Highway No.5 & 16 runs parallel to the mass nesting beach at a distance of about one km. A part of the beach is having *Casuarina* (*Casuarina equisetifolia*) vegetation just behind the fore dunes, mostly planted after the super cyclone of 1999 in Odisha. About 50% of this vegetation was mortified due to Super cyclone "Philine" in 2013. Soon after "Philine" the large numbers of human development activity like expansion of Chemical plant, Development of Street light (High raised towers) in township and the three villages, Expansion and development of Shrimp/Prawn farms just behind the fore dunes from Purnabandha to Podumpeta which is parallel to the nesting beach add the illumination to the nesting beaches.

Although hatchlings disorientation at Rushikulya beach stretches were studied (Karnad 2009, Tripathy 2009) but how the effect of illumination on olive ridley nest selection was least evaluated for this region.

Trends in light levels and nesting beach:

Olive ridley Sea turtles prefers to nest in en-mass in few selected nesting site and decides where to emerge from the surf and where on the beach to put their eggs in the specified nesting area. Most of the studies on other region of turtles clearly demonstrated effect of artificial lighting on nesting is to deter turtles from emerging from the water, Raymond (1984b), who reported reduction in nesting attempts by loggerheads at a brightly lighted beach site in Florida. Else-where in Florida, Mattison et al. (1993) showed that there were fewer loggerhead nesting emergences at locations at which lighted piers and roadways were close to beaches. Mortimer (1982) described nesting green turtles at Ascension Island as shunning artificially lighted beaches. Salmon et al. (1995a) found that loggerheads that do nest on beaches where the glow of urban lighting is visible behind the dune tend to prefer the darker areas where buildings are silhouetted against the artificial glow. Mazor et al., 2013; Talbert et al., 1980 described about the other contributing factors such as increased human activity near developed areas may also have an impact on nesting. Karnad, (2009); showed the disorientation of the Olive ridley hatchling due to the artificial light, and most of the disorientation were found in Purnabandha - Gokharkuda beach stretch due to artificial illumination. In this study we here evaluated the illumination in sea turtle nesting beaches can be considered a form of habitat loss. When lighting deters sea turtles from approaching nesting beaches, they may select less appropriate nesting sites and shifting might takes place to nearby suitable area.

Historically, turtle's breeds all along the Rushikulya coast, and they still congregate in northern areas, but development has led to major reduction of the breeding range. Monitoring of turtle mass nesting on the Rushikulya coast has records of Olive ridley

turtles nesting from Purnabandha to Podumpeta, mostly on dark stretches of beach. Recently, volunteers have observed lower mass nesting numbers on the southern Rushikulya Coast at Purnabandha to Gokharkuda Beach, coinciding with more lighting from dwellings there.

Methods:

Nesting Data

Mass nesting data from 2009 to 2018 were analyzed and the beach stretch were categorized according to the preference of turtles nest selection during mass nesting events of various years. The Data prior to 2009 was filled up and considered with the view of expertise in field.

Analysis of light proximity to nesting locations

Mass nesting beach sites, overlaid onto the night-light images, and a buffer was drawn around each nesting site. The data downloaded from NASA corresponded to an area greater than that of actual light sources on the ground due to the phenomenon of 'sky glow', which refers to the dome of light projected upwards and outwards from urban areas at night (Chalkias et al. 2006). Sky glow was considered to contribute significantly to ecological impacts from light pollution (Rich & Longcore 2006, Kyba et al. 2011). Accordingly, to take potential effects of sky glow from urban areas we have consider the sky glow into account. We calculated the radial distance of three zones photo pollution zone (High, Medium & Low) from each nesting zone.

Results:

Change in Nesting Patterns: The mass nesting of Olive ridley has being recoded every year except very few instances when mass nesting failed at Rushikulya since 1994. Earlier mass nesting of olive ridley sea turtles at Rushikulya rookery was mostly confined from Purnabandha - Podumpeta stretch. The densities of nesters were all time higher from Purnabandha - Gokharkuda stretch until 2006, although the illumination was the major threats for disorientation of hatchlings (Tripathy 2009).

Ganjam Township is having brightest coastal illumination in the Mass nesting area, which is less than 3km from the River mouth. The major developmental activities in the township and nearby coastal area compounded to increase the illumination after 2007 (Kar & Behera 2013). During season 2009 there was a decrease in the nesting at Purnabandha-Gokhurkuda stretch due to low illumination (Fig 1a, 2). As turtles preferred the darker beach stretch Gokharkuda-Podumpeta similar observation was reported by Karnad 2009. Although during 2012, mass nesting nesters preferred to nest in Purnabandha - Gokharkuda stretch but most of the turtle's selected to nest in the darker stretch Gokharkuda - Podumpeta stretch (Fig-1 b, 3a).

After 2013 super cyclone "Philine" the casurina plantation on backside of beach were affected along with the geo-morphological changes (Behera 2014) and light was directly exposed to the beach stretch Purnabandha - Gokharkuda. Although mass nesting occurred on beach stretch from Purnabandha to Podumpeta but the Olive ridley turtles preferred to nest from Gokharkuda - Podumpeta soon after "Philine" (Fig 1c, 2). During the next season i.e. 2015 a shift was observed of more towards the north, 500m beyond previous nesting site were observed. There was no mass nesting event during 2016. In the year 2017, nesters although nested in Purnabandha – Gokharkuda stretch, but nesting was very low (Fig-1d, 2) and it was observed that the nester preferred to nest beyond the historical beach stretch i.e. up to Bataswar which is 1km north of Podumpeta. Similarly a shift of 800 meters north of Batswar was observed during 2018. The density of nesters at Purnabandha - Gokharkuda was relatively lower to all season 2008, 2012, and 2017 (Fig-1e, 2). As the nesting turtles avoided to emerge from the surf to lay eggs in the higher value of illumination area, the beach stretch Purnbandha - Gokharkuda (Fig 3).

Illumination as a detritus factor for mass nesters: The radial distance of each nesting beach stretches to three Illuminations zones to its nearest point was calculated and evaluated. Which was further correlated with mass nesting nester preference to the site of various years. It ascertain that coastal urbanization increased in Ganjam during 2012 to 2016 period (Fig 3); nearly two-thirds of the mass nesting beaches exhibited increasing light level. Nest densities for all the season

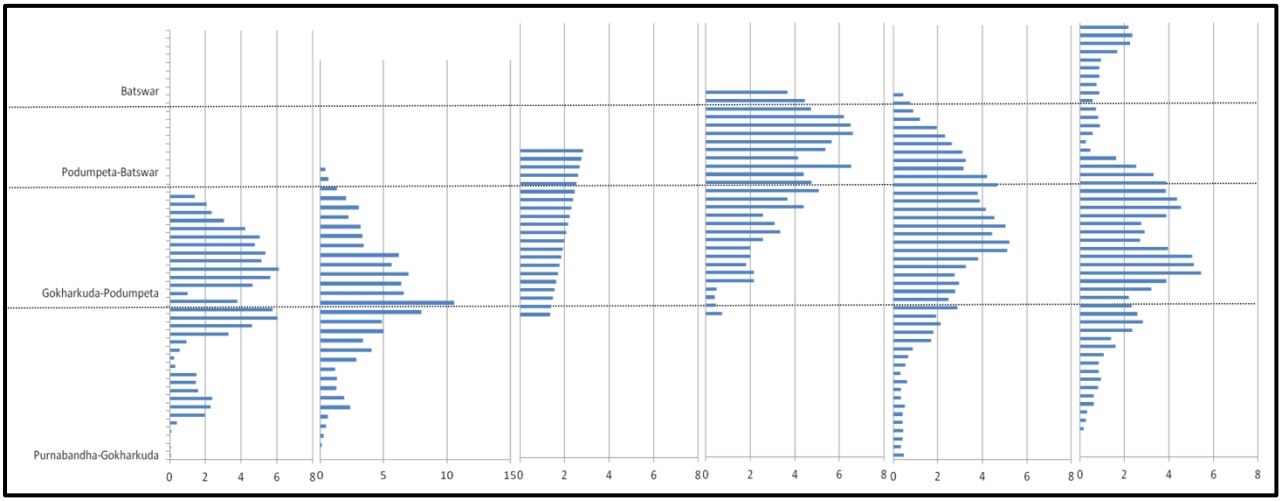

Fig 1 Showing the Percentage of nesters preferred in each 100m of segments during the mass nesting in different beach stretches during 2009, 2012, 2014, 2015, 2017 and 2018.

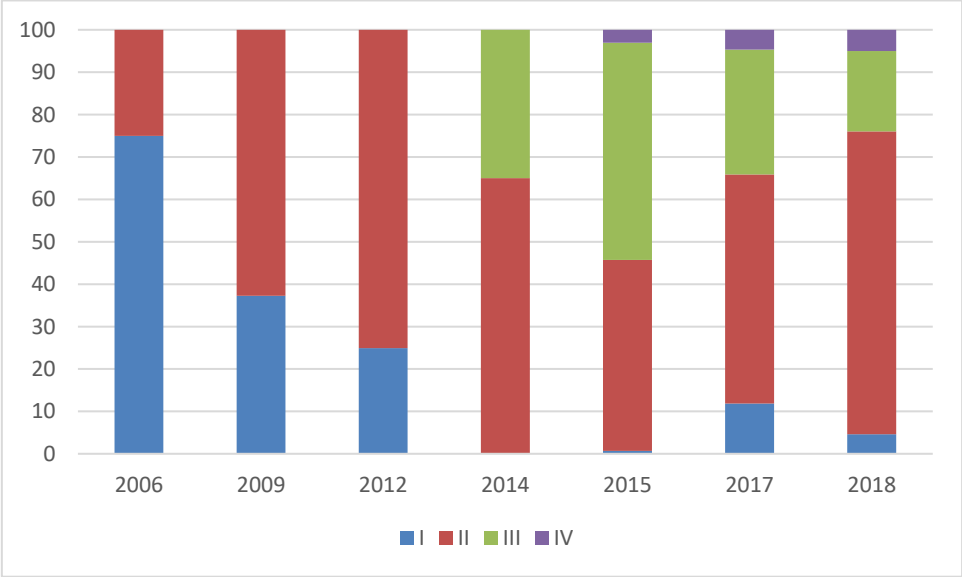

Fig 2 Showing the total Percentage of nesters preferred during the mass nesting in different beach stretches during year 2006, 2009, 2012, 2014, 2015, 2017 and 2018.

showed negatively influence by artificial light to neighborhood as the nesters preferred darker beach and moved more towards north of river mouth with the increase in illumination in the stretch.

The area of high illumination zone was 0.82 Sq.km and it was beyond 2.5 km from Rushikulaya mouth (i.e. Purnabandha - Gokharkuda stretch) and 4km from (Gokharkuda- Podumpeta stretch) during 2012.

Similarly Moderate illumination was 2 km from Rushikulaya mouth (i.e. Purnabandha - Gokharkuda stretch) and 4.5 km from (Gokharkuda- Podumpeta stretch). Gokaharkuda- Podumpeta stretch was nearly darker during 2009 and Purnabandha-Gokharkuda had low illumination. Due to increase in illumination turtles avoid the beach stretch Purnabanda –Gokharkuda and preferred the darker beach stretch i.e. Gokharkuda-Podumpeta stretch

However, during 2016 high illumination zone was measured to be 4.24 sq km and it was very closer to mouth area (Purnabandha to Gokharkuda) it was only 1 km, and similarly higher illumination zone came closer to Gokharkuda (Gokharkuda to Podumpeta) which was 3 km. Moderate to Low illumination was found in the beach stretch Purnabandha-Gokharkuda (Fig 3) resulted in further reduction in nesting preference. The Podumpeta to Batswar stretch was beyond 6km from High illumination zone in both the year 2012 and 2016, the shift pattern on nest selection site of mass nesting turtles towards the dark beach showed a positive trend towards the darkness.

Like the development of port which is 13 km south of Rushikulya rookery. Most of the low line villages were upland, the sodium-vapor lamps were replaced by LED, High light towers were increased after “Philine”. Apart from this the development of shrimp farms parallel to mass nesting ground has caused the illumination. All These human development activities have increased the illumination in area from 2012 to 2014 (Fig 2).

Discussion:

All turtle species nesting are negatively impacted by artificial light, because the impact on the turtles is not the lights, but the perceived light horizon – they are unable to locate the true ocean horizon because of bright lights. Turtles are not attracted to bright lights, but are disrupted from locating the horizon in the presence of bright lights, because the glow of the horizon is less intense than that of the closer and brighter lights. In this study we found the Light intensity is a vital issue for turtles and this may also a function on wavelength. Illumination, that intensity is proportional to the square of the distance, and the number of light sources has a cumulative impact. This is extremely significant for nesting turtles, which locate their nest destination by the glow of the distant horizon during mass nesting event. This “altered light horizon” encourages female adults returning to the ocean. Collective lighting, from multiple dwellings, street lights and other lighting, have a cumulative effect. (Worth and Smith 1976) reported that loggerheads deterred from nesting re- emerged onto beaches outside their typical range. (Murphy 1985) found that loggerheads, repeatedly turned away as they made nesting attempts, chose increasingly distant and inappropriate nesting sites in subsequent nesting attempts. Similarly this study showed the shifting of mass nesting area from “Purnabandha –Podumpeta” to “Purnabandha – Bateswar”.

Understanding how sea turtles interpret light cues in choosing nesting sites has helped conservationists develop ways of identifying and minimizing problems caused by light pollution. Light conditions on nesting beaches are complex, and measuring light pollution in a way that effectively captures the impacts to sea turtles is difficult. But quantifying light pollution is not necessary to the diagnosis of a problem.

Illumination is a crucial factor of Light pollution, which contributes to the degradation and reduction the critical nesting habitat of sea turtles. Nocturnally nesting and hatching sea turtle species are particularly sensitive to artificial light near nesting beaches. So regular Satellite monitoring would show promising for light management of extensive or nesting areas. As the temporal resolutions of the satellite data are coarse, ground measurements are suggested to confirms that artificial light

levels on beaches during the nesting season correspond to the annual nightlight measures.

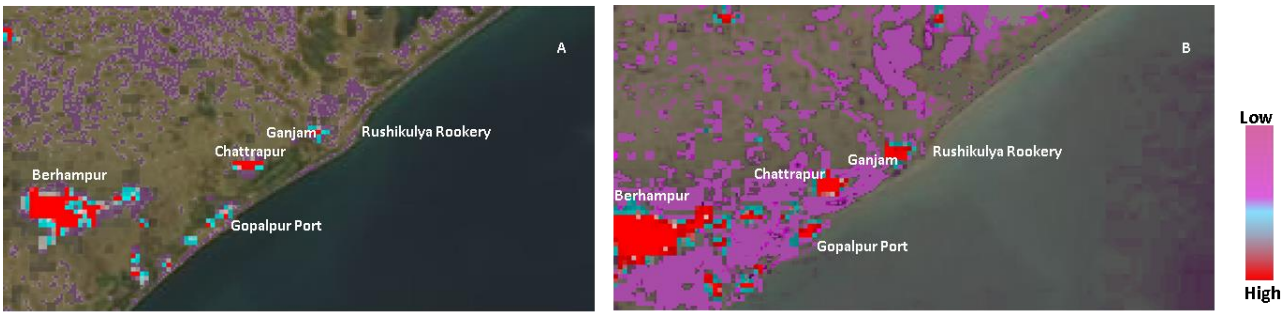

Fig 3 showing the illumination zones in rushikulya rookery during a) 2012 and b) 2016

ACKNOWLEDGMENTS

We are thankful to PCCF (WILDLIFE) Odisha, M.Biswal, IFS (Nodal cum Conservator of Forest), Late (Dr.) Chandrasekhar Kar (Senior Research Officer) Dept. of Forest, Odisha. Dr. A.K Sahu, Ecologist ICZMP, Bhubaneswar. We are also grateful to the World Bank for providing technical and logistical support during the fieldwork. We are thankfully acknowledging the Divisional Forest Officers, and all local and field staff members for their help during this study.

Reference:

1. Behera SK , Mohanta RK, Kar C and Mishra SS (2014) Impacts of the Super Cyclone Philine on Sea Turtle Nesting Habitats at the Rushikulya Rookery, Ganjam Coast, India Poult Fish Wildl Sci 2: 114. doi:10.4172/pfw.1000114
2. Chalkias C, Petrakis M, Psiloglou B, Lianou M (2006) Modelling of light pollution in suburban areas using remotely sensed imagery and GIS. J Environ Manag 79: 57-63
3. Fritsches KA (2012) Australian Loggerhead sea turtle hatchlings do not avoid yellow. *Marine*
4. *and Freshwater Turtle Behaviour and Physiology* 45: 79-89.
5. Kamrowski, RL, Limpus, C, Moloney, J and Hamann, M (2012). Coastal light pollution and
6. marine turtles: assessing the magnitude of the problem. *Endangered Species Research* 19: 8598.
7. Kar CS & Behera SK (2012) “Observations on the Geo-morphological changes and its impact on the olive ridley sea turtle mass nesting habitats at Rushikulya rookery of Odisha, India. In Coastal Erosion”, CES, Ministry of Environment and Forest, Bhubaneswar, Odisha.Chapter-4
8. Karnad D (2008) The effect of lighting and temperature on the eggs and hatchlings of olive ridley turtles at Rushikulya, India Master Thesis Submitted to Skkim Manipal University pp 25-26.
9. Karnad D, Isvaran K, Kar CS, Shanker K (2009) Lighting the way: Towards reducing misorientation of olive ridley hatchlings due to artificial lighting at Rushikulya, India
10. Biological Conservation 142 (10), 2083-2088
11. Kyba CCM, Ruhtz T, Fischer J, Holker F (2011) Cloud coverage acts as an amplifier for ecological light pollution in urban ecosystems. PloS ONE 6:e17307
12. Mazor, T, Noam Levin, Hugh P. Possingham, Yaniv Levy, Duccio Rocchini ,Anthony J.Richardson , Salit Kark (2013) Can satellite-based night lights be used for conservation? The case of nesting sea turtles in the Mediterranean Biological Conservation 159 (2013) 63–72
13. Mortimer JA, (1982) Factors influencing nesting sea turtles, of Florida, beach selection. In: Biology and conservation of sea turtles. K. A. Bjorndal (ed.). Smith-sonian Institution Press, Washington,D.C.
14. .Murphy, T.E. (1985) Telemetric monitoring of nesting loggerhead sea turtles subjected to disturbance on the beach. In Fifth Annual Workshop on Sea Turtle Biology and Conservation. Waverly, Georgia.
15. Rich C, Longcore T (2006) Ecological consequences of artificial night lighting. Island Press, Washington, DC
16. Salmon M, Reiners R, Lavin C and Wyneken J (1995) Behavior of loggerhead sea turtles on an urban beach. I. Correlates of nest placement. *Journal of Herpetology*, 29, 560–567.
17. Talbert Jr., O.R., Stancyk, S.W., Dean, J.M., Will, J.M., (1980). Nesting activity of the loggerhead turtle (Caretta caretta) in South Carolina I: a rookery in transition. Copeia 1980, 709–718.

18. Tripathy B and Rajasekhar PS (2009) Natural and anthropogenic threats to olive ridley sea turtles (Lepidochelys olivacea) at the Rushikulya rookery of Orissa coast, India Indian Journal of Marine Sciences 38: 439-443.
19. Worth, D. F. & Smith, J. B. (1976). Marine turtle nesting on Hutchinson Island, Florida, in 1973. *Florida Mar. Res. Publ.,* 18, 1 17.
20. Witherington BE (1997) the problem of photopollution for sea turtles and other nocturnal animals. In: Clemmons JR, Buchholz R (eds) Behavioral approaches to conservation in the wild. Cambridge University Press, Cambridge, p 303–328