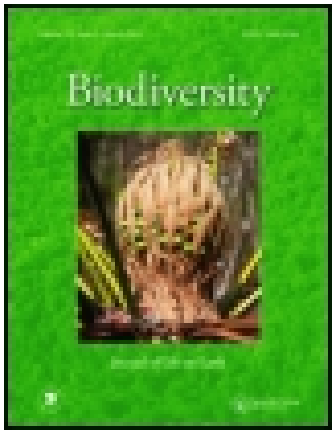

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Marine turtle mortalities along the Tamil Nadu coast of India and the need for turtle-friendly fisheries

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Marine turtle mortalities along the Tamil Nadu coast of India and the need for turtle-friendly fisheries

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In the past two decades, sea turtle mortality has increased due to a variety of anthropogenic activities along the Nagapattinam and Chennai coast region in Tamil Nadu, South India. Weekly field surveys were conducted over an eight-month period from December 2013 to July 2014 to monitor the mortality of turtles in these coastal areas, revealing a notable disruption in the nesting activity of the turtles during January–March; the worst affected were mature individuals. Anthropogenic activities like boat strikes and fishing activity were recorded as the major causes of turtle death within this region. This paper highlights the need for better turtle monitoring systems within this part of South India, particularly for endangered species like the olive ridley turtle (*Lepidochelys olivacea)*, whilst also suggesting suitable conservation measures to protect them.

Keywords: olive ridley turtle; turtle mortality; anthropogenic activities; conservation measures

Overview

Marine turtles are some of the oldest known reptile groups on planet earth, having lived for over 200 billion years and having seen the dinosaurs survive and die (Velasquez-Manoff 2007). Even though sea turtles have long lifespans, their survival is currently endangered where mortality rates have increased due to various environmental changes and anthropogenic activities along the coast. On a global scale, marine turtle species are currently listed as Vulnerable (olive ridley, *Lepidochelys olivacea*), Endangered (loggerhead, *Caretta caretta*; green turtle, *Chelonia mydas*), Critically Endangered (Kemp's ridley, *Lepidochelys kempii*; hawksbill, *Eretmochelys imbricata*; leatherback, *Dermochelys coriacea*), and Data Deficient (flatback, *Natator depressus*) within the International Union for Conservation of Nature (IUCN) Red List (IUCN 2010). There are five species of sea turtles reported from Indian waters, viz. olive ridley, green turtle, leatherback, loggerhead and hawksbill (Kar and Bhaskar 1982; Bhupathy and Saravanan 2002) which are listed as Endangered under Schedule I of the Indian Wildlife (Protection) Act, 1972. The olive ridley is the most abundant and widely distributed throughout the world and is best known for its synchronous mass-nesting behaviour, recorded on the Pacific coasts of Mexico at La Escobilla and Costa Rica (Ostional and Nancite) and Gahirmatha coast (Odisha). IUCN has indicated a globally declining trend in their populations due to factors such as trawling, destruction of habitat and the global warming of oceans. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) prohibits trade involving endangered sea turtles whilst India's Coastal Regulation Zone (CRZ) Notification of 2011 – notified under the Environment (Protection) Act of 1986 – also declared turtle nesting areas of the Indian coastline as Ecologically Sensitive Areas (ESAs) and prohibited human development activities in nesting grounds. In 2013, several reports emerged both within the Indian and international media relating to turtle carcasses, predominantly olive ridleys, that were washed ashore on the beaches of Tamil Nadu and Andhra Pradesh of the India's south east coast. In order to determine the causes for these turtle deaths, preliminary field surveys were undertaken immediately in the most dramatically affected coastal regions of Chennai and Nagapattinam from December 2013 to July 2014.

Habitat loss is a key factor for marine turtle population decline with the entire Chennai coastline coming under increasing pressure from human development needs. Beaches in many locations of the region serve as nesting grounds where sea turtles emerge from the sea to nest from December to April. It was observed that during this period, except April, a massive mortality of marine turtles occurred along the Tamil Nadu coast. The observations were made on the Chennai coast from Foreshore Estate (Long: 80°16''39.54"E; Lat: 13°0''49.41"N) to the Napier Bridge (Long: 80°17''19.46"E; Lat: 13°3''57.82"N) stretch and at Nagapattinam coast

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from Nagapattinam (Long: 79°51''5.20"E; Lat: 10°45'' 53.99"N) to the Nagore (Long: 79°51''4.18"E; Lat: 10°49'' 37.76"N) stretch. Sea turtles, the world over, face several anthropogenic threats such as fishing activities, dumping of debris into coastal waters, habitat loss, pollution, unsustainable development in the coastal areas and climate change. While determining the effects of sea level rise on nesting habitats in the Mediterranean, it was observed by Katselidis et al. (2014) that 0.2 m sea level rise would lead to a loss of about 38% of the total nesting beach area. Costello et al. (2010) stated that overfishing occurred throughout the National and Regional Implementation Committee (NRIC) regions (Antarctica, Atlantic Europe, Australia, Baltic Sea, Canada, Caribbean Sea, China, Indian Ocean, Japan, Mediterranean Sea, New Zealand, South Africa, South America, South Korea and the USA), resulting in the death of vast quantities of bycatch species such as turtles, albatrosses and other mammals (dolphins, porpoises). To put it into perspective, roughly 4.5 million sea animals are killed as bycatch in longline fishing every year, including 3.3million sharks, 1 million marlins, 60,000 sea turtles, 75,000 albatross and 20,000 dolphins and whales (Foer 2011). Overfishing has also meant a sizeable reduction of fish stocks and consequent indirect impacts on ecosystems through altered food webs.

In order to protect marine turtles, various strategies have been put forward, namely developing nested envelope models or Regional Management Units (RMUs), as well as information on marine turtle biogeography, including nesting sites, population abundances and trends, population genetics, and satellite telemetry (Wallace et al. 2010). The RMU framework (i.e. spatially explicit population segments defined by biogeographical data of marine turtle species) has been considered as a solution to the challenge of how to organise marine turtles into units of protection above the level of nesting populations, but below the level of species, within regional entities that might be on independent evolutionary trajectories. With the help of spatial information on distribution and intensity of human activities and the overlap of their impacts on marine ecosystems, it was observed globally that no area is unaffected by human influence and that a large fraction (41%) is strongly affected by multiple drivers (Halpern et al. 2008). One study carried out by Wallace et al. (2011) defined key risks and threats to all marine turtle RMUs, including identification of the world's eleven most endangered marine turtle RMUs based on highest risk and threat scores. The 'Top 11 most endangered RMUs' include well-documented cases of populations that have collapsed and are under high threat (e.g. *D. coriacea*, East Pacific Ocean; *C. caretta* and *E. imbricata*, Northeast Indian Ocean; *E. imbricata*, East Pacific Ocean). Wallace and his team developed a Conservation Priorities Portfolio system using categories of paired risk and threat scores for all RMUs (n = 58) and ranked globally, by species, by ocean basin, and by recognised geopolitical bodies to identify patterns in risk, threats, and data gaps at different scales. While evaluating how beach features influence suitability for nesting by endangered loggerhead marine turtles on Zakynthos Island, Greece, it was found turtles preferentially emerged on steeper sections of beach, with higher nesting densities occurring on the most environmentally stable beaches. Elevation was observed as a more reliable indicator of nest placement (1 m above sea level) than distance to shore (Katselidis et al. 2013).

Field survey

Weekly field surveys were conducted over an eight-month period from December 2013 to July 2014. The width of sampling locations from the High Tide Line towards landward side was 500 m and the length of the survey location at Chennai coast (Foreshore Estate – Napier Bridge stretch) and at Nagapattinam (Nagapattinam-Nagore stretch) was 6 km and 12 km, respectively (Figure 1). A Trimble Juno 3B hand-held global positioning system was used to mark geographical coordinates of carcasses and carapace length and injuries were noted.

Turtle mortality

Weekly collected data was converted into monthly measurements for illustration purposes, as shown in Figure 2. A total number of 96 carcasses of olive ridley were found along the Foreshore Estate Napier Bridge stretch and 134 carcasses were found along Nagapattinam Nagore stretch. All those found stranded on shore were photographed and measured for curved carapace length (CCL) with their possible cause of death determined. It was observed that the scale of die-off was continuous from December 2013 to March 2014 as these beaches witnessed turtle deaths constantly during this period. The weekly checks on turtle mortality for this eight-month period revealed that this was 75%, i.e. out of 24 weekly checks, 18 weekly checks showed turtle carcases with clear signs of fishing gear (hooks/net marks, entanglement). Approximately 120 nests were recorded along the Foreshore Estate Napier Bridge stretch and 270 in the Nagapattinam Nagore stretch. Based on the crawl width, pattern and season, the nests noticed were assumed to be that of olive ridley. The CCL of carcasses found in the Nagapattinam coast ranged from 60 to 68 cm (mean 65.5 cm), whereas in the Chennai coast were in the range of 71–78.5 cm length (mean 73.6 cm). Among the stranded turtles, females were seen more, as turtles usually visit the east coast for nesting during the period January through March. There was a notable disruption

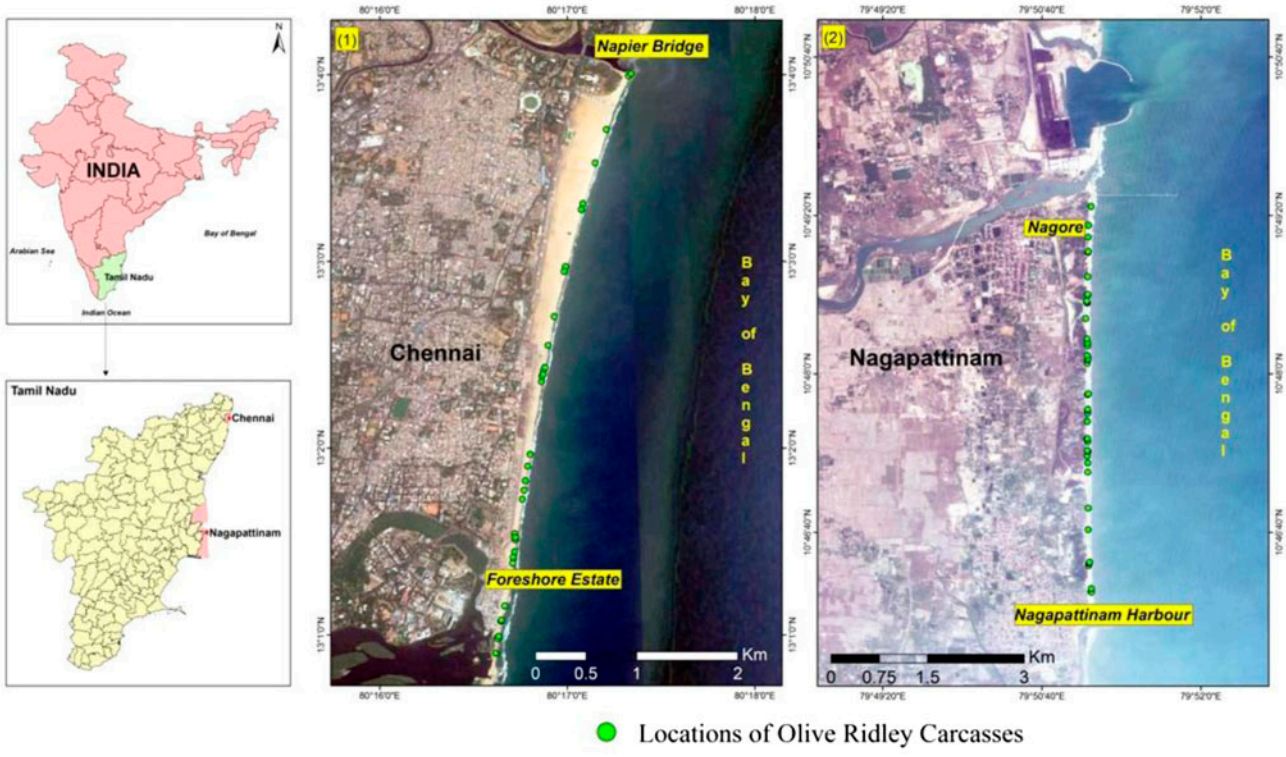

Figure 1. Study areas.

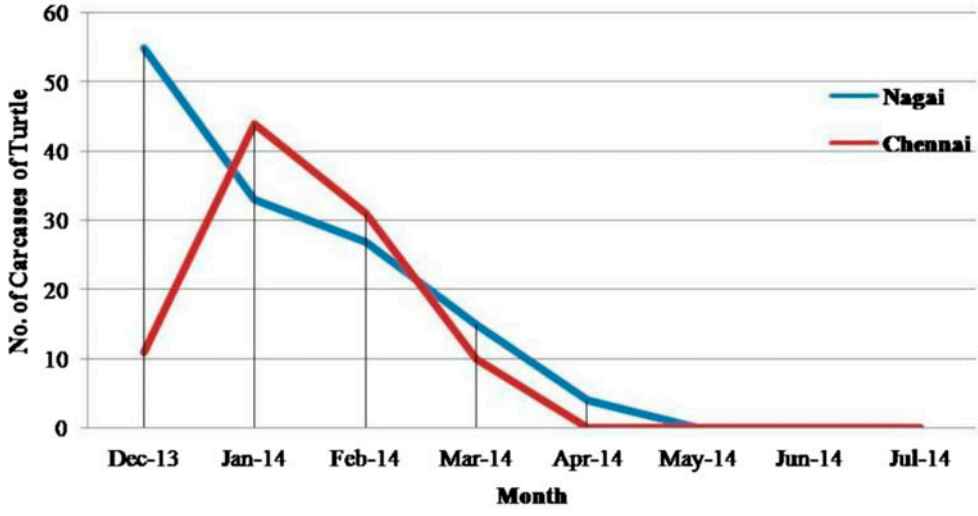

Figure 2. Monthly variation of mortality in Study Areas.

in the nesting activity of the turtles in these areas during this period, as described in further detail below.

Along the Chennai coast, the local municipal council has assumed responsibility for collecting the animal carcasses that were washed on shore and disposing of them by a burial method. In the case of the Nagapattinam coast, the animal carcasses were reportedly left to decay on beaches for up to five days resulting in a bad odour and many were found entangled in gill nets.

Several research institutions and non-government organisations (NGOs) have also reported turtle deaths during this period in different locations of Tamil Nadu and Andhra Pradesh coasts. It was reported that overall in this region of the south east coast of India, around 2100

Figure 3. Field observations of turtle mortality along Tamil Nadu coast; a. Turtle entangled in net; b. Dead female turtle; c. Wound caused by boat propeller; d. Turtle carcases washed ashore at Nagapattinam coast; e. Fisherman observing the dead turtle; f. Broken shell of turtle while fishing; g. A cut on flipper; h. Injury caused by propeller.

carcasses were reported from December 2013 to April 2014 (David 2014). During the month of January alone, in 2014, 1122 dead turtles washed ashore along the beaches of Tamil Nadu and Andhra Pradesh. Of which, more than 145 dead turtles were found on the stretch between Marina Beach and Neelankarai, while 226 were found between Neelankarai and Marakkanam areas. In Andhra Pradesh, Nellore coast recorded 547 carcasses (Saju 2014).

Factors causing mortality

Fishing activities within this area are a chief contributor towards marine turtle mortalities. The study revealed 80% of turtles were affected by fishing activities like trawling, gill nets and long line fishing in the offshore waters (Figures 3 and 4(a)). The carcasses showed clear signs where fishing gear (hooks/net marks) had attached/inserted themselves to the animal's body and many turtles were seen entangled in gill nets along the Nagapattinam coast. There was no indication of environmental pollution or any toxicity for turtle mortality. Earlier reports by Bhupathy and Karunakaran 2003; Bhupathy et al. 2007; Saravanan et al. 2012 also confirmed that due to fishing activities, turtle mortalities occurred in the Tamil Nadu (total length of coastline: 906.9 km) and Andhra Pradesh (total length of coastline: 973.7 km) coastal regions during the same period of nesting. It was recorded that around 200 carcasses of turtle (female dominated in number with male-female ratio being 1:3) washed ashore from December 2000 to April 2001 (Bhupathy and Karunakaran 2003) and Chennai coast witnessed 135 mortalities of olive ridley from incidental catch in fishing gears (Bhupathy et al. 2007) and 109 carcasses along Nagapattinam coast (Saravanan et al. 2012).

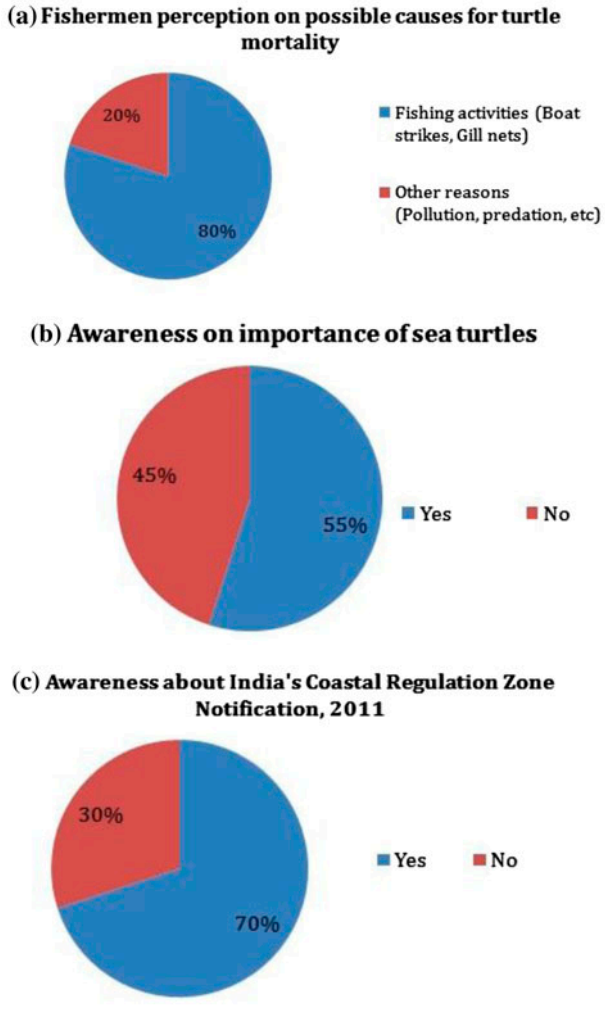

Figure 4. Fishermen's Perspective on turtle mortality.

Questionnaire survey and fishermen's perspective

Fishing is one of the primary livelihood streams for the local population. According to the Tamil Nadu Marine Fisheries Census 2010, there are 2800 trawl boats at Kasimedu and 3000 non-mechanised boats being operated in this region. Kasimedu fishing harbour and Chennai port are located in the northern side of the Foreshore Estate Napier Bridge stretch, which makes the sea coast always busy with movement of sea cargo vessels, fishing boats and passenger ships. As far as the Nagapattinam district is concerned, there are 1465 mechanised and 4129 non-mechanised crafts, with 32,652 fishing gears being operated. To further strengthen field observations on turtle mortality, a questionnaire survey and fishermen discussion groups were used to gain an insight into their perspectives regarding the mortality of sea turtles, as well as possible causes for their deaths, opinions on fishing practices and the importance of sea turtles in general, as well as the impact of pollution on fishing practices. The following ten questions were asked to fishermen from two areas:

(I) Are you aware of the turtle mortality occurring in this area?
(II) How long has this mortality been occurring here?
(III) What are the possible causes for turtle mortality?
(IV) What types of fishing nets are used?
(V) Have you found any sea turtles entangled in your fishing nets?
(VI) Do you know of any pollution which causes turtle death?
(VII) Do you think turtles are important?
(VIII) Are you aware of Coastal Regulation Zone (CRZ) Notification 2011?

(IX) Do you know that turtle nesting sites are protected?
(X) Did you find any other marine animals found dead during this period due to any pollution?

A total number of 80 respondents were chosen in both the Chennai and Nagapattinam region and interviews took place in net mending areas, at fisher's houses, boat landing areas and fish landing centres. All interviewees were males, ranging from 28–65 years old and for all of them, fishing was their chief source of income and their livelihood. Eighty-five per cent of fishermen declared that the turtle mortality was occurring along this coast especially during the months of December to March. Many believed the possible causes for mortality are fishing activities (boat strikes, gill nets) whilst around 20% were of the opinion that it may also be due to predation in the sea by larger fishes and marine animals. Gill nets, trawlers, dip nets, nylon dip nets, cotton drag nets, cotton shore seine and long lines are the most commonly used forms of fishing nets in this area. Sixty per cent of fishermen stated that they saw turtles entangled in fishing nets, especially during December to March 2014. Forty-five per cent of the fishermen declared that they are not aware of the importance of sea turtles and few of them believed that when a turtle is entangled in a net, it would bring bad luck, although sea turtles have spiritual or mythological importance in much of Indian Hindu culture within these regions of Southern India. When asked about the CRZ Notification 2011, 70% of fishermen stated that they are aware about the CRZ and most of the respondents replied that they are not aware that turtle nesting sites are protected.

Measures to protect sea turtles

As no laboratory analyses and dissections were undertaken on the tissues of the animals in question, this preliminary survey is consequently based purely upon field observations and fishermen's perspectives, confirming the possible causes (presented above) for this issue. To protect endangered olive ridley sea turtles from unsustainable fishing activities, the following suggestions are proposed:

(i) Regulation of fishing activities taking into consideration guidelines issued by the Food and Agriculture Organization of the United Nations (FAO) in 2005 to reduce sea turtle mortality in fishing operations. The guidelines, *inter alia*, specifies: the need for handling of bycatch (which includes accidentally caught sea turtles); the promotion of Turtle Excluder Devices (TEDs) to operate trawl and gill nets; the development and implementation of appropriate combinations of hook design, type of bait, depth, gear specification & fishing practices, all of which is to be orchestrated in association with the state government/ conservation societies involved.
(ii) The beach areas of Nagapattinam Nagore stretch and Foreshore Estate Napier Bridge stretch to be declared as turtle nesting sites after conducting a detailed study on turtle biogeography, including population abundances, trends and population genetics.
(iii) Human beach activities during the breeding season (December–March) should be highly regulated.
(iv) Extensive patrolling near turtle nesting grounds to be conducted by state government, NGO/ research institutions/volunteers during nesting periods.
(v) Creating awareness to the local fishing communities and general public on the need for, and processes behind, sea turtle conservation.
(vi) Other than preventive measures on fishing activities, there is also a need to assess changes in the existing nesting sites due to developmental activities using historical data.
(vii) The turtle nesting sites of Tamil Nadu need to be identified and mapped in cadastral scale and declared as ecologically sensitive areas.

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