ABSTRACT

Sea turtles are a large-shelled, oviparous animal, inhabiting tropical and subtropical seas throughout the world, except in polar-regions that plays a vital role in balancing the marine ecosystem. According to Hindu culture, they were called “Kurumavatara”, which were the incarnation of Lord Vishnu. Sea turtle populations in Tamil Nadu have been depleted, due to their overuse in trade and from accidental drowning in fishing gears such as gill nets and trawlers. During this review, 10 coastal districts were studied from literature sources and the review could identify more than 65 nesting sites for sea turtles along the coasts of Tamil Nadu, excluding islands of Gulf of Mannar.

Keywords: Turtle; nesting grounds; nesting sites; Tamil Nadu.
1. INTRODUCTION

1.1 Evolution of Sea Turtle

Sea turtles are large shelled, oviparous [1,18] animals, inhabiting tropical and subtropical seas throughout the world except in polar-regions [7,8] which play a vital role in balancing the marine ecosystem [9]. Pritchard et al. and Pritchard noted that sea turtles are considered to have existed [75] and lived with dinosaurs such as the giant Plesiosaurus and Ichthyosaurus [76], have evolved over 130 million years ago with their fossil record being dated to the Triassic period approximately 199-251 million years ago [19]. Sea turtles are noted as mega vertebrates, and form an integral part of aquatic ecosystems [94-96]. According to Hindu culture, they were called “Kurumavatara”, which were the incarnation of Lord Vishnu [111,112].

1.2 Systematic Classification of Sea Turtles

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Animalia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-kingdom</td>
<td>Metazoa</td>
</tr>
<tr>
<td>Phylum</td>
<td>Chordata</td>
</tr>
<tr>
<td>Sub-phylum</td>
<td>Vertebrate</td>
</tr>
<tr>
<td>Super-Class</td>
<td>Tetrapoda</td>
</tr>
<tr>
<td>Class</td>
<td>Reptilia</td>
</tr>
<tr>
<td>Subclass</td>
<td>Anapsida</td>
</tr>
<tr>
<td>Order</td>
<td>Testudines</td>
</tr>
<tr>
<td>Family</td>
<td>Cheloniidae (6)</td>
</tr>
<tr>
<td></td>
<td>and Dermochelyidae (1)</td>
</tr>
<tr>
<td>Genus</td>
<td><em>Chelonia</em>; <em>Caretta</em>; <em>Eretmochelys</em>; <em>Natator</em>; <em>Lepidochelys</em> and <em>Dermochelys</em></td>
</tr>
</tbody>
</table>

Species:
- *Chelonia mydas* (Linnaeus, 1758);
- *Caretta caretta* (Linnaeus, 1758);
- *Eretmochelys imbricata* (Linnaeus, 1766);
- *Natator depressus* (Linnaeus, 1766);
- *Lepidochelys olivacea* (Eschscholtz, 1829);
- *Lepidochelys kempii* (Linnaeus, 1766) and *Dermochelys coriacea* (Vandelli, 1761)

1.3 Life Cycle, Biology, Breeding and Nesting of Sea Turtles in India

Musick et al. [60] reported that the sea turtles live in many different habitats from inshore reefs to open oceanic environments. Sea turtle eggs are laid by female turtles in nesting areas on the beaches of sea shore [4]. Musick et al. [60] also reported that the incubation period of sea turtles is 45-70 days, followed by the hatching of young turtles which enter the sea. The courtship period for sea turtles begins in the month of November, and ends in February [1]. The breeding takes place in the sea near the shore. Both participants remain together for several hours during mating period [4]. The female turtles move 40 to 60 m away from the shoreline high tide mark, where bushes and vegetation are present for her to lay her eggs. The arrival of retreating female sea turtles forms crawl tracks from their fore flippers moving towards the sandy beaches [80]. The turtle tracks were identified and classified as Crescent, Conical and False nesting crawls. Based on the literature review, the sea turtle’s nesting period occur from early January to late March [81,82] and peak nesting is observed to be in the month of February [36].

Bhasker [7,8] and Sridhar et al., [92] reported the phenomenon of synchronous mass nesting – the ‘arribada’ - exhibited by the Olive Ridley sea turtles (*Lepidochelys olivacea*) in Orissa on the eastern coast of India. The mass nesting beaches were located at three sites - Gahirmatha, Rushikulya and the mouth of River Devi. Olive Ridley turtles nesting at these locations are part of a distinct genetic population that nests along the east coast of India [9]. The failure of arribadas in 1997 and 1998 accompanied by the sharp decrease in size of adults, suggests a potential or imminent decline in the population, consistent with fishery-related mortality of at least 1,000,000 sea turtles since 1994, and 10,000-15,000 sea turtles per year since 1999 [64,70,72,74,77]. Much of the mortality is attributed to drowning in trawl nets, but recent accounts suggest that gill nets may also cause large scale sea turtle mortality [5].

2. BACKGROUND

2.1 Major Threats and Importance of the Sea Turtles

Sridhar et al. reported that the anthropogenic activities near Gahirmatha and the other turtle nesting sites in Orissa, India [92]; includes illegal aquaculture farms, proposed port construction and operation, industrial sand mining, proposed construction of facilities for offshore oil exploration and artificial illumination from industries, towns and other residential areas near the coast. In 1960, it was estimated that an average of approximately 3,000 to 4,000 turtles landed every year in the Gulf of Mannar area and 1,000 turtles in the Palk Bay. Green turtles comprised 75% of the landings. Olive Ridley and
Loggerheads comprised 20% of the landings. The sea turtle trade was halted in the early 1980s [11].

An accidental catch of Olive RIdleys, *Lepidochelys olivacea*, was reported at Pamban and off Dhanushkodi. The accidental catch of Leatherback turtles, *Dermochelys coriacea*, was reported at Dhanushkodi, Rameswaram and Mandapam. Due to recent attention paid to the conservation and management of sea turtles, the stranding of sea turtles has been reported more frequently. Regular and continuous dynamite fishing operations has caused the death of more than 10 sea turtles, which were washed ashore during the end of January 2004, along the Rameswaram – Dhanushkodi coast [44].

Sea turtle populations in this area have already been depleted due to their overuse in trade and from accidental drowning in the fishing equipments such as gill nets and fishing trawlers [10]. Boat propellers can also cause damage to the flippers and shells of sea turtles [12]. Dynamite fishing should be stopped during the turtle nesting season (from December to March), to save the sea turtles from this threat. The state fisheries department, forest department and its wildlife office, the Coast Guard and the local police should work together and take action to stop dynamite fishing and prevent further sea turtle deaths [44].

All four groups mentioned above reported that sea turtle eggs are sold for 5-10 Rupees (Rs) per egg, while teachers and businessmen reported that sea turtle meat is sold at up to Rs 30 per Kilogram (Kg). Most people who consumed sea turtle eggs did so for their taste. Almost all of the interviewed groups felt the need for the conservation of marine turtles. Fifty eight percent of teachers, 46% of students, 62% of laymen, and 57% of businessmen knew that marine turtles are legally protected. The lowest level of awareness was among teachers, while lay persons and the students were most aware [38].

Mast et al., reported that current status of Olive Ridley death is at a minimum of 10,000 adults killed each year for the past 10 years [53]. Trawl fisheries bycatch and coastal development were the most prevalent causes for the sea turtle kills [53]. Phillott et al. identified fisheries ‘bycatch’ as a major threat to sea turtles worldwide [74]. The coast of the Gulf of Mannar was known for the sea turtle trade in the 1960s. Targeted sea turtle fishing was carried out in this area during that period. Green turtles formed the majority of the catch and its blood was considered as a medicinal elixir in the Tuticorin area. Sea turtle meat is believed to cure piles and hemorrhoids though no authentic scientific proof exists. Death or injury due to poisoning has also been reported along the Tuticorin coast [59]. After the inclusion of all five species of sea turtles in Schedule I of the Indian Wild Life (Protection) Act of 1972, sea turtle exploitation was reduced to a great extent. The Gulf of Mannar region, including the islands, was reported to be a good sea turtle nesting ground in the past. However, in recent years, sea turtle nesting intensity has reduced substantially. Owing to many factors especially habitat degradation/disturbance, increased fishing pressure, incidental catch, use for meat, egg collection, etc., Incidental sea turtle catch is reported to be high on the east coast of India during the breeding season from October to February. The stranding or landings of sea turtles have been sporadically reported in the Gulf of Mannar area [59].

### 2.2 Importance of Sea Turtles

Turtle meat (Calipee) traditionally eaten in many cultures, was served as a local delicacy to guests / tourists [44]. Sea turtle eggs were sold as a delicacy and touted to promote longevity and virility [45,46]. The fatty tissue in sea turtle meat was processed to make oil and creams for lubrication of wrist watches, fuel for lamps, boat varnish, cosmetics and as medicines or for use as an aphrodisiac on the black market. Sea turtle blood is believed to cure anemia and to improve fertility. Hawksbill shells were prized as ornamentation and decorative objects [28-30]. Various studies across the globe have indicated a declining trend in sea turtle populations, due to the above mentioned major hazards and threats [13-16] and climatic or monsoon impacts [30,34,38,48].

### 3. LITERATURE REVIEW

Tamil Nadu has 591 marine fishing villages scattered across 13 coastal districts. These villages have a population of 1.05 million. Of this population, 0.20 million is actively engaged in fishing. In the offshore waters, the fisheries potential is harvested using about 45,181 traditional wooden water crafts and 5,596 mechanized boats. The infrastructure includes three major fishing harbors, three medium fishing harbors and 363 fish landing centres [52]. Kar
and Bhaskar; Bhupathy and Saravanan reported the occurrence of all five species of sea turtles namely, *Chelonia mydas* (Linnaeus, 1758); *Caretta caretta* (Linnaeus, 1758); *Dermochelys coriacea* (Vandelli, 1761); *Eretmochelys imbricata* (Linnaeus, 1766) and *Lepidochelys olivacea* (Eschscholtz, 1829) along the Indian coast being most significant in Odisha and Tamil Nadu [39-41]. Pandav studied the sea turtle nesting pattern and reported that part of the migratory corridor for Olive Ridley’s that mass nest exists in Odisha [69].

Kar and Bhaskar reported the nesting of four species of sea turtles, namely Olive Ridley, Hawksbill, Green and Leatherback [39]. The most recent literatures indicate the nesting of Olive Ridley’s along the Tamil Nadu coast was high [10]. An increase in mortality was documented from a few thousand in the early 1990s, to more than 10,000 per year by the mid 1990s [40]. A review of data suggested that this population may be on the verge of a decline, based on evidence from the failure of arribadas in recent years, a decline in adult sizes and high fishery related mortality [87]. Nearshore surveys have shown that sea turtles are found in discrete locations which have been named ‘reproductive patches’ [17,18]. These reproductive patches have been located off the coasts of Gahirmatha and Rushikulya; and are expected to occur in the offshore waters off other mass nesting beaches, such as the mouth of the River Devi. The patches are about 50 – 75 km² in size, and extend to a distance of approximately 5 – 6 km offshore [87].

The Wildlife Institute of India tagged 10,000 nesting sea turtles and 1,600 mating pairs in offshore waters from 1995 – 1999. Results showed that Olive Ridley sea turtles migrate between mass nesting beaches. Tagged sea turtles were recovered from southern Tamil Nadu and Sri Lanka, indicating that at least some of the Olive RIdleys that nest in Orissa migrate to these areas [87]. In satellite telemetry studies conducted in 2001, 3 of 4 sea turtles being tracked and remained in the offshore waters of Orissa between April and July, 2001, moving to within 50 and 200 km of the coast. A fourth sea turtle migrated to the coast of Sri Lanka in August 2001 [85]. Genetic studies confirmed the results of tagging and showed that there is no genetic difference between nesting populations in each of the mass nesting beaches. More significantly, the results revealed the distinctiveness of the population on the east coast of India, and suggested that they may be the ancestors of populations in the Atlantic and Pacific oceans [98-105]. Satellite imagery studies suggest that the failure of mass nesting at Gahirmatha in 1997 and 1998 is due to natural causes such as erosion and reduction in the nesting habitat, due to the impacts of successive cyclones [85].

There should be an increased effort to identify and monitor reproductive patches. Identification and protection of these reproductive patches from fishing trawlers and other harmful fishing practices will significantly reduce sea turtle mortality [19-23]. Protection of the reproductive patches (rather than the entire marine sanctuary) is a more effective and efficient way of utilizing the limited manpower resources of the state and can involve local fishing communities [87]. Monitoring of sea turtle nesting and sea turtle mortality should also be undertaken by independent agencies, to evaluate the success of management measures. Research and conservation of sea turtles along the coast of Tamil Nadu was undertaken by several government and non government organisations [10,42-46].

The Vasant J. Sheth Memorial Foundation has funded Sahyadri Nisarga Mitra, an organization working for the conservation of marine turtles on the Konkan coast of Maharashtra [31]. Although Maharashtra does not witness arribadas like Orissa, sporadic nesting takes place throughout the coast. In the year 2006, more than 50 sea turtle nests were protected in hatcheries erected at the selected beaches and more than 300 hatchlings have been released into the sea. In the mid 1990s, the United States of America modified Section 609 of Public Law 101-162, the Endangered Species Act of 1973 and made it mandatory for countries exporting shrimp to the US to set in place a marine turtle conservation program comparable to that of the US (Bache and Frazier, in press). However, the US has been insistent in recognising only the usage of Turtle Excluder Devices (TEDs) as suitable conservation measures in order to permit shrimp imports from India. Compelled to use TEDs, shrimp exporting trawlers from India, particularly from Orissa, have been issued free TEDs by the Marine Products Export Development Authority, an institution under the Ministry of Commerce. Some attempts at popularising TEDs in Orissa have also been undertaken, with assistance from local NGOs like Project Swarajya. The OMFRA mandates that all fishing trawlers in Orissa must
use TEDs in their nets [107-108]. All trawlers insist that the accompanying catch loss, from the use of TEDs is too high (for a review of TED implementation see in Lal, Mohanty-Hejmadi, Seney and Landry, Lewison et al., Shanker, Shankar et al., Lewison and Crowder, Sahu, Shanti Priya Pandey, and Shivbhadrasinh et al. [47,49-50,54-57, 61-63,73,79,83-89]. This rule is blatantly violated throughout the state and not a single trawler is known to use a TED in their nets [92, 93].

4. NESTING GROUNDS OF SEA TURTLES

The Central Marine Fisheries Research Institute (CMFRI) had studied aspects of marine turtle biology and fishery related mortality [1,90]. Saravanan et al., conducted a survey covering 205 km of coastline spreading over 8 districts of Tamil Nadu and about 530 km of coastline was identified to be suitable for Olive Ridley nesting [82]. From the available literature the nesting spots were found to be identified and listed as follows:

<table>
<thead>
<tr>
<th>S.No</th>
<th>District</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chennai</td>
<td>From Napier Bridge to Thiruvanmiyur Regional Transport office backside Marina Beach Besant Nagar Neelankarai and Uthandi</td>
</tr>
<tr>
<td>2</td>
<td>Kanchipuram</td>
<td>Kottivakkam to Kovalam Beach Satras Kalikuppam Paramakazhani Kadapakkam Kaipanikkuppam and Komanachavadi</td>
</tr>
</tbody>
</table>
Similarly, sea turtle nesting grounds were identified by Sudhan along the southeast coast of Tamil Nadu. The new nesting grounds were identified by regular beach surveying and proper monitoring of existing beaches [97]. Sudhan identified five new nesting grounds along the southeast coast of Tamil Nadu [97].

5. CONSERVATION, PROTECTION AND MANAGEMENT OF SEA TURTLE

According to the Tamil Nadu Marine Fisheries Regulation Act of 1983 (Tamil Nadu Act: 8 of 1983), fishing by mechanized fishing vessels, motorized country craft and those using mechanized fishing techniques within a 5 Nautical Mile (NM) radius around the identified potential nesting and breeding sites of sea turtles, should be prohibited [6,25,32].

Human activities like night driving near shore, artificial lighting, use of recreational equipment, coastal armouring structures and disposal of municipal waste on beaches should be regulated during the breeding and nesting season [26-29]. Extensive patrolling near turtle nesting grounds should be conducted by state government, NGO/research institutions / volunteers during nesting periods. Awareness should be created among the local fishing communities and local people [35]. Nesting sites should be monitored [36-37,53,62] and mapped [33,51] using geospatial techniques and the relevant beaches should be identified as sensitive zones, using signs in appropriate locations. Sudhan (2017) conducted inclusive awareness programs to the stakeholders by distributing the folders and booklets [97]. The school students were educated about the turtle facts, importance, threats faced [3] by the animal and their conservation measures initiated through audio-visual aids [97].
6. CONCLUSION

Availability of reliable data is particularly problematic for artisanal fisheries in developing countries, where basic data for the number of fishers, types of gear used and species of marine turtles captured, are often unreliable, unavailable, or not collected. With artisanal fisheries comprising >95% of the world’s fishers, this knowledge gap presents a major challenge to threatened sea turtle species conservation and sustainable fisheries initiatives [56]. Since 2010, The TREE Foundation, India (@treefoundationindia) has rehabilitated 35 turtles and nursed back to health and successfully released 11 Olive Ridley sea turtles, two Green sea turtles, and two Hawksbill sea turtles [24]. The findings of future studies should reflect the profile of fishermen and the level to which they are complying with sea turtle conservation. The results would give an overview of the nesting grounds of South east coast of Tamil Nadu and the various problems attributed in sea turtle conservation and protection [5].

ACKNOWLEDGEMENT

The first author would like to thank and sincerely acknowledge Marine Biological Association of India (MBAI) for providing financial assistance in the form of small grant programme (2016-17). At this flash of achievement, first author would like to thank advisory committee members: Dr. G. Sugumar, Dr. S. David Kingston and Dr.P. Jawahar who generously gave their time to offer valuable comments towards improving the work and to construct report and also extremely indebted to Vice Chancellor, TNFU; Tamil Nadu State Fisheries Department and Forest Department, Fishermen and local stakeholders of the study area for their support, guidance and encouragement during nesting survey.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES


41. Kar CS, Peters M. Marine turtles of Odisha: Status, issues and threats. In: Marine Turtles along the Indian Coast:
Distribution, Status, Threats and Management Implications, Annie Kurian (Ed.), WWF-India. 2013:45-84.


43. Kiran B. Effectiveness of fisheries training programmes conducted by Fisheries College and Research Institute, Thoothukudi, Unpub. M.F.Sc. Thesis Submitted to Fisheries College and Research Institute, Tamil Nadu Fisheries University, Thoothukudi: 1992:100.


79. Sahu G. Environmental studies on olive ridley turtles and other sensitive marine species in Bay of Bengal off Orissa coast with special reference to the offshore exploratory and development operation. Project final report, Berhampur University; 2006.


82. Saravanan S, Swamy K, Tampal F. Status of sea turtle habitats and nesting in Andhra Pradesh. In: Marine turtles along the Indian coast: Distribution, Status, Threats and Management Implications, Annie Kurian (Eds.). WWF-India. 2013b;31-44.


89. Shivbhadrasingh J, Jadeja Gole SS, Apte DA, Jabestin. First nesting record of leatherback sea turtles on The west coast of Galathea Bay, Great Nicobar Island,
after the 2004 Indian Ocean tsunami with notes on nest predation. Indian Ocean Turtle Newsletter. 2016; 23:7-10.


© 2018 Sudhan et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/23239