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Review on Sea Turtle Nesting Grounds of Tamil Nadu

C. Sudhan^{1*}, P. Jawahar¹, G. Sugumar¹ and S. David Kingston¹

¹*Fisheries College and Research Institute, Tamil Nadu Fisheries University, Thoothukudi, Tamil Nadu, India.*

Authors' contributions

This work was carried out in collaboration between all authors. Author CS collected the literatures, reviewed, tabulated and wrote the first draft of the manuscript. Authors PJ, GS and SDK critically evaluated the manuscript and assisted technical support in all aspects. All authors read and approved the final version of the manuscript.

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Review Article

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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 "Kurmavatara", 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.

*Corresponding author: E-mail: sudhankumaranbfsc@gmail.com;

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 marine vertebrates, and form an integral part of aquatic ecosystems [94-96]. According to Hindu culture, they were called "Kurmavataara", which were the incarnation of Lord Vishnu [111,112].

1.2 Systematic Classification of Sea Turtles

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

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 as 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 Ridley's, *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 Ridelys 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:

Existing turtle nesting grounds in Tamil Nadu		
S.No	District	Location
1	Chennai	From Napier Bridge to Thiruvanmiyur Regional [#] Transport office backside [#] Marina Beach [▲] Besant Nagar [▲] Neelankarai [▲] and Uthandi [▲]
2.	Kanchipuram	Kottivakkam [#] to Kovalam Beach [#]
3.	Pondicherry	Satras [▲] Kalikuppam [▲] Paramakazhani [▲] Kadapakkam [▲] Kaipanikuppam [▲] and Komanachavadi [▲]
4.	Cuddalore	1. Pillumedu – Chinna Vaikkal [#] 2. Chinna Vaikkal – Mudasalodai [#] 3. Chinoor – Saamiyar Pettai [#] 4. Saamiyar pettai – Aiyampettai [#] 5. Aiyampettai to Thamanapettai [#] 6. Thamanapettai to Sothikuppam [#] 7. Gori to Devanampattinam Beach [#] 8. Devanampattinam Beach [#] 9. Devanampattinam Village – Suba Uppalavaadi [#]
5.	Villupuram	1. Alagankuppam [#] 2. Vasavankuppam [#] 3. Kaipanikuppam [#] 4. Ekkiyarkuppam [#] 5. Anumandaikuppam [#] 6. Mudhaliyarkuppam [#] 7. Pudhukuppam [#] 8. Bommiyarkuppam [#]
6.	Nagapattinam	1. Kodyampalayam [#] 2. Madavamedu [#] 3. Kottaimedu [#] 4. Chinna Kottaimedu [#] 5. Koolaiyar [#] 6. Thoduvai [#] 7. Thirumullaivasai [#] 8. Keelamoovarkarai [#] 9. Madhthukuppam [#] 10. Pudhukuppam [#] 11. Vanagiri [#] 12. Chinnamedu [#] 13. Perumalpettai [#] 14. Kuttiyandiyur [#] 15. Chandrapadi [#] 16. Nagoorpattinacheri [#] 17. Samanthanpettai [#] 18. Velankanni [#] 19. Kameshwaram [#] 20. Viluhamavadi [#] 21. Vanavanmahadevi [#] 22. Vellapallam [#] 23. Pushpavanam [#] 32. Kodiakadu [#] 33. Kodiakarai [#]
7.	Ramanathapuram	1. Kannirajapuram [#] 2. Mookaiyur [#] 3. Opilan [#] 7. Arriyaman Beach [#] 8. Atrangarai [#] 9. Azhangankulam [#]

Existing turtle nesting grounds in Tamil Nadu		
S.No	District	Location
		4.Ervadi [#]
		5.Sethukarai [#]
		6.Pudumadam [#]
8.	Thoothukudi	1.Periyasampuram [#]
		2.Kombuthurai [#]
		3.Amalinagar [#]
		4.Alanthalai [#]
9.	Thirunelveli	1.Uvari [^]
10.	Kanyakumari	1.Kellamanakudi [#]
		2.Pallam [#]
		3.Puthandurai [#]
		4.Kesavan Puthandurai [#]
		5.Pozhikarai [#]
		6.Periyakadu [#]
		7.Rajakkamangalamthurai [#]
		8.Azhikkal [#]
		9.Kottilpadu [#]
		10.Kodimunai [#]
		10.Puduvalasai [#]
		11.Pamban [#]
		12.Kundukal [#]
		13.Danushkodi [#]
		5.Kulasekarapattinam [#]
		6.Manapadu [#]
		7.Periyathalai [#]
		8.Tharuvaikulam [^]
		2. Kootapuli [^]
		11.Keezhamidalam [#]
		12.Melmidalam [#]
		13.Enaiyam [#]
		14.Enaiyamchinnathurai [#]
		15.Eraviputhanthurai [#]
		16.Vallavilai [#]
		17.Marthandathurai [#]
		18.Neerodi [#]
		19.Kanyakumari [^]
		20.Kovalam [^]

[^]World Wildlife Fund (WWF) Report; India, 2013 [113]

[#]Government of Tamil Nadu, 2015-16 (Animal Husbandry, Dairying and Fisheries Department) [2]

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].

To protect the sea turtles in Tamil Nadu, the following was recommended by Rajesekhar, 1987; Pandav, 2000; Shanker, 2003; Dharini and Shriram, 2015 and Sachithanandam et al., 2015; [24, 64, 77-78 & 86] 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. Operation of fishing trawler and gill nets, by-catch reduction, promotion of Turtle Excluder Devices (TEDs), and development and implementation of appropriate

combinations of hook design, type of bait, depth, gear specification and fishing practices should be orchestrated in association with the state government and relevant conservation societies [31]. 'No-fishing zones' should be determined by monitoring reproductive groups of sea turtles. All mechanized fishing boats should be prohibited within 5-20 km of nesting beaches during the breeding season from December to March [55, 58-59, 80,90-92,102-103,106,109].

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].

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Agastheesapillai A, Thiagarajan R. Biology of the green turtle *Chelonia mydas* (Linnaeus) in the Gulf of Mannar and Palk Bay. J. of the Marine Biol. Assoc. of India. 1979;21:45–60.
2. Animal Husbandry, Dairying and Fisheries Department. Standard operating procedure (SOP) for protection and conservation of sea turtles. Letter No. 1107/FS-3/2015. Dated: 24/11/2015 Secretariat, Chennai-600009. 2015;1-7.
3. Aruloli G. Effectiveness of selected extension teaching methods for educating the fisherfolk on sustainable marine fisheries development. Unpub. M.F.Sc. Thesis submitted to Fisheries College and Research Institute. Thoothukudi; 2004.
4. Avens L, Braun JB, Epperly SP, Lohmann KJ. Site Fidelity and homing behavior in juvenile loggerhead sea turtles, *Caretta caretta*. Mar Biolo. 2003;143:211–220.
5. Behera SK, Kar C. Solitary nesting and mortality of olive ridley sea turtles along the Ganjam coast of Odisha, India. Indian Ocean Turtle Newsletter. 2015;18:12-14.
6. Bhadury P, Kumar A, Maiti M. Nesting status of sea turtles in West Bengal -The East Midnapore scenario. In: Marine turtles along the Indian coast: Distribution, Status, Threats and Management Implications, Annie Kurian (Eds.). WWF-India, 2013;85-98.
7. Bhasker S. Preliminary report on the status and distribution of sea turtles in Indian waters. Forestry. 1981;107:707-711.
8. Bhasker S. Survey of sea turtles, World Wildlife Fund for India. 1983;47(4):5.
9. Bhupathy S. Monitoring of marine turtles along the Kerala and Tamil Nadu coasts. Indian Ocean Turtle Newsletter. 2007;5:1–9.
10. Bhupathy S, Saravanan S. Status of sea turtles along the Tamil Nadu Coast. Kachhapa. 2002;7:7–13.
11. Biswas S. A report on the Olive Ridley, *Lepidochelys olivacea* (Eschscholoz); (Testudines: Chelonidae) of Bay of Bengal. Record in Zoological Survey of India. 1982;79:275-302.
12. Bjorndal KA. The consequence of herbivory for the life history pattern of the caribbean Green Turtle, *Chelonia mydas*. In: Bjorndal, K.A. (Ed.). Biology and conservation of sea turtles. Smithsonian Institution, Washington, D.C. 1982;125-177.
13. Bowen BW, Bass AL, Chow SM, Bostrom, M, Bjorndal KA, Bolten AB, Ohuyama T, Bolker BM, Epperly S, LaCasella E, Shaver D, Dodd M, Murphy SRH, Musick JA, Swingle M, Baransky KR, Teas W, Witzell WN, Dutton PH. Natal homing in

- juvenile loggerhead turtles (*Caretta caretta*). Molecular Ecology. 2004;13:3797–3808.
14. Bowen BW, Karl SA. Invited review: Population genetics and phylogeography of sea turtles. Molecular Ecology. 2007;16:4886–4907.
 15. Bustard HR. World's largest sea turtles Rookery. Tiger Paper. 1976;3:1-3.
 16. Bustard HR. Temperature and water tolerance of incubating sea turtle eggs. Br. J. Aerpel. 1971;4:196-98.
 17. Carr AF. So excellent a Fish: A natural history of sea turtles. Cox and Wyman Ltd., Cassel, London; 1968.
 18. Carr AF. Some problems of sea turtle ecology. Amer. Zool. 1980;20:489-498.
 19. Chacko PI. A note on the nesting habits of Olive Loggerhead turtle, *Lepidochelys olivacea* (Eschscholtz) at Krusudai. Current Science. 1942;12:60–61.
 20. Chadha S, Kar CS. Bhitarkanika: Myth and reality. Natraj publishers. Dehradun. 1999;388.
 21. Daniel JC. Indian Reptiles. Bombay Nat. soi, Mumbai; 1983.
 22. Das MC, Kar CS. Conservation and management of sea turtle resource in Orissa coast. Journal of Environment and Ecotoxicology. 1987;303-316.
 23. Das MC, Kar CS. The turtle paradise - Gahirmatha. M/S Interprint Publishers, New Delhi. 1990;300.
 24. Dharini S, Shriram R. Tree foundation's rescue and rehabilitation centre for sea turtles in Chennai, Tamil Nadu, and Nellore, Andhra Pradesh, India. Indian Ocean Turtle Newsletter. 2015;22:30-32.
 25. Dongre SK. Sea turtle nesting status in Goa. In: Marine turtles along the Indian coast: Distribution, Status, Threats and Management Implications, Annie Kurian (Eds.). WWF-India. 2013;127-134.
 26. Drake D. A sea turtle study. MT News Lx. 1993;61:9-11.
 27. Frazier J. Subsistence hunting in the Indian Ocean. Proceedings of the World conference on sea turtles conservation. Bjorndal, K.A. (Ed.), Smithsonian Institution. Washington, D.C. 1982;391-396.
 28. Frazier J. Sea turtles faces extinct in India crying Wolf or saving sea turtles. Environmental Conservation. 1980;7:239-240.
 29. Frazier J. Exploitation of marine turtles in the Indian Ocean. Human Ecology. 1980a;8:329-370.
 30. Glen F, Morosvsky N. Antigua revisited: The impact of climate change on sand and nest temperatures at a hawksbill turtle (*Eretmochelys imbricata*) nesting beach. Global Change. 2004;10:2036–2045.
 31. Gore K. A brief update of sea turtle conservation activities of the Vasant J. Sheth Memorial Foundation. Indian Ocean Turtle Newsletter. 2005;4:14.
 32. Goswamy D, Gohil J, Shah S, Kurian A. Sea turtle habitats and nesting status in Gujarat. In: Marine turtles along the Indian coast: Distribution, Status, Threats and Management Implications, Annie Kurian (Ed.), WWF-India. 2013;155-172.
 33. Harrison, T., 1956. Tagging green turtles: 1951-56. *Nature*. 4, 178-179.
 34. Hayes GC, Broderick AC, Glen F, Godley BJ. Climate change and sea turtles: A 150-year reconstruction of incubation temperatures at a major marine turtle rookery. Global Climate Change Biology. 2003;9:642–646.
 35. Hendrickson JR. The Green Sea turtles, *Chelonia mydas* (Linn) in Malaya and Sarawak. Proc. Zool. Soc. London. 1958;130:455-535.
 36. Hirth HF. Nesting behavior and reproductive biology of sea turtles. Am Zool. 1980;20:507-23.
 37. Jones S, Bastian FA. Present status of turtle fishery in Gulf of Mannar and Palk Bay. In: Proceedings of the symposium on living resources of the seas around in India. CMFRI Special Publication, Mandapam Camp, Tamil Nadu, India. 1973;772-775.
 38. Kakodkar K. Perceptions of local stakeholders about marine turtles on the Sindhudurg coast of southern Maharashtra, India. Indian Ocean Turtle Newsletter. 2006;3:1-5.
 39. Kar CS, Bhaskar S. The status of sea turtles in the Eastern Indian Ocean. In: Bjorndal, K. (Ed.), The biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C. 1982;365-372
 40. Kar CS. Discovery of second mass nesting ground of the Pacific Olive Ridley sea turtle (*Lepidochelys olivacea*) in Orissa. Tiger Paper. 1981;9:6-7.
 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.
42. Katdare VD. Marine turtle habitats in Maharashtra (Distribution, status and threats). In: Marine turtles along the Indian coast: Distribution, Status, Threats and Management Implications, Annie Kurian (Ed.), WWF-India. 2013;135-154.
 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.
 44. Krishnapillai S. Threats to sea turtles on the Rameswaram – Dhanushkhodi Coast. Indian Ocean Turtle Newsletter. 2005;2:5-6.
 45. Kurian A. Environmental factors influencing turtle nesting along the Indian coast. Ph.D Thesis, Karnatak University, Karnataka, India; 2008.
 46. Kuriyan GH. Turtle fishing in the sea around Krusudai Island. J. Bom. Nat. Hist. Soc. 1950;49:509-512.
 47. Lal MRS. Dynamite fishing in Chaliyar river, North Kerala. Marine Fisheries Information Service T & E Series. 1991;1:21-23.
 48. Lazell DJ. Marine Turtle in India. Copeia. 1980;2:374-75.
 49. Lewison RL, Crowder LB, Read AJ, Freeman SA. Understanding impacts of fisheries by-catch on marine megafauna. Trends in Ecology and Evolution. 2004;19: 598–604.
 50. Lewison RL, Crowder LB. Putting long line by-catch of sea turtles into perspective. Conservation Biology. 2006;21:79–86.
 51. Mansfield KL, Saba VS, Keinath JA, Musick JA. Satellite telemetry reveals a dichotomy in migration strategies among juvenile loggerhead turtles in the Northwest Atlantic. Marine Biology. 2009; 156:2555–2570.
 52. Marine Fisheries census – Tamil Nadu. Published by Department of Animal Husbandry, Dairying and Fisheries, Krishi Bhavan, New Delhi; ICAR- Central Marine Fisheries Research Institute, Kochi. 2010;427.
 53. Mast RB, Hutchinson BJ, Pilcher NJ. The burning Issues for global sea turtle conservation, 2006: The hazards and urgent priorities in sea turtle conservation. Indian Ocean Turtle Newsletter. 2005;3: 29-31.
 54. Mohanty-Hejmadi P. A study of ecology, breeding patterns, development and karyotype patterns of the Olive Ridley, *Lepidochelys olivacea* (Eschscholoz). Pranikee. Zoological Society of Orissa (Monograph). 1993;IX.
 55. Mohanty-Hejmadi P. The history of sea turtle conservation in Orissa. In: Proceedings of National workshop, held during March 4-8, 2002 at Bhubaneswar, Orissa, GOI-UNDP sea turtle project, Wildlife Institute of India; 2001.
 56. Moore JE, Cox TM, Lewison RL, Read AJ, Bjorkland R, McDonald SL, Crowder LB. An interview-based approach to assess marine mammal and sea turtle captures in artisanal fisheries. Biological Conservation. 2010;143:795–805.
 57. Municipal Administration and Water Supply Department (M.C.I). G.O. No: 35. From the Principal Chief Conservator of Forests and Chief Wild Life Warden, Panagal Maaligai, Saidapet, Chennai – 600015. 2011;1-2.
 58. Murthy TSN, Menon AGK. The turtle resources of India. Sea Food Export Journal. 1976;2:1-8.
 59. Murugan A, Naganathan V. A note on the Green sea turtles rescued in Tuticorin, Gulf of Mannar, Tamil Nadu. Indian Ocean Turtle Newsletter. 2005;3:10-11.
 60. Musick JA, Limpus CJ. The biology of sea turtles. Boca Raton, FL: CRC Press; 1997.
 61. O’Coonor MC, Lymbery G, Cooper JAG, Gault J, Mckenna J. Practice versus policy- led coastal defense management. Marine Policy. 2009;33:923-929.
 62. Oliver JA. An aggregation of pacific sea turtle. Copeia 2. 1946;103.
 63. Palmer BJ, Elst RVD, Mackay F, Mather AA, Smith AM, Bundy SC, Thackeray Z, Leuci R, Parak O. Preliminary costal vulnerability assessment for KwaZulu-Natal, South Africa. Journal of Coastal Research. 2011;64:1390-1395.
 64. Pandav B. Conservation and management of Olive Ridley turtles along the Orissa coast. Ph.D. Dissertation, Utkal University, Orissa, India. 2000;116.
 65. Pandav B, Choudhury BC. An update on mortality of Olive Ridley sea turtles in Orissa, India. Marine Turtle Newsletter. 1999;83:10-12.

66. Pandav B, Choudhury BC. Conservation and management of Olive ridley sea turtle (*Lepidochelys olivacea*) in Orissa. Project final report, Wildlife Institute of India. 2000; 77.
67. Pandav B, Choudhury BC, Kar CS. Discovery of a new sea turtle rookery along Orissa coast. Marine Turtle Newsletter. 1994a;67:15-16.
68. Pandav B, Choudhury BC, Kar CS. Olive ridley turtle (*Lepidochelys olivacea*) and its nesting habitats along the Orissa coast, India: A status survey. Wildlife Institute of India; 1994b.
69. Pandav B, Choudhury BC, Kar CS. Mortality of Olive ridley turtles *Lepidochelys olivacea* due to incidental capture in fishing nets along Oriisa coast, India. *Oryx*. 2003;31:32-36.
70. Pandav B, Choudhury BC, Shankar K. The Olive ridley turtle (*Lepidochelys olivacea*) in Orissa: An urgent call for an intensive and integrated conservation programme. *Current Science*. 1998;75:1323-1328.
71. Pandit R, Soans R. Marine turtle habitats and nesting status in Karnataka. In: Marine turtles along the Indian coast: Distribution, Status, Threats and Management Implications, Annie Kurian (Ed.), WWF-India. 2013;113-126.
72. Panigrahy RC, Sahu G, Mohanty AK. Sea turtles of the Indian Ocean region. *Journal of Indian Ocean Studies*. 2005;13:281-302.
73. Pareparambil M, Mathew R. Sea turtles of Kerala: Status, issues and threats. In: Marine turtles along the Indian coast: Distribution, Status, Threats and Management Implications, Annie Kurian (Ed.), WWF-India. 2013;99-112.
74. Phillott AD, Mathew JM, Krishnankutty N, Ara SS, Shathy ST, Akter T, Khan ZI. Estimates of turtle bycatch in fisheries of Chittagong district, Bangladesh. *Indian Ocean Turtle Newsletter*. 2015;22:5-11.
75. Pritchard PCH, Bacon P, Carr F. Manual of sea turtles research and conservation techniques. Bjorndal, K.A., Balazas, G.H. (Eds.), Center for Environmental Education, Washington, D.C. 1983;1-107.
76. Pritchard PCH. *The Biology of Sea Turtles*. Boca Raton, FL: CRC Press; 1997.
77. Rajesekhar PS. Endangered olive ridley sea turtle of the N.A.P. Coast. Ph.D. Thesis, Andhra University, Andhra Pradesh, India; 1987.
78. Sachithanandam V, Mageswaran T, Sridhar R, Arumugam T, Ramesh R. A summary of sea turtle mortality along the Tamil Nadu coast of India and the need For Turtle-friendly fisheries. *Indian Ocean Turtle Newsletter*. 2015;22:13-14.
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.
80. SanjeevRaj PJ. Egg-laying habits of sea turtles described in Tamil Sangam literature. *J. of the Bombay Nat. Hist. Soc*. 1958;55:361-362.
81. Saravanan S, Gokulakrishnan J, Arun V, Balu A, Annapan M, Kurian A. Marine turtle habitats and nesting status in Tamil Nadu. In: Marine turtles along the Indian coast: Distribution, Status, Threats and Management Implications, Annie Kurian (Eds.). WWF-India. 2013a;13-30.
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.
83. Sarma PV, Bose KS. Socio-economic determinants of mechanized fishing boat operators: A case study of Visakhapatnam coast. *Fishing Chimes*. 2008;27(10):66-69.
84. Seney EE, Landry AM. Movements of Kemp's ridley sea turtles nesting on the upper Texas coast: implications for management. *Endangered Species Research*. 2000;4:73-84.
85. Shankar K, Pandav B, Choudhury BC. An assessment of the Olive Ridley turtles (*Lepidochelys olivacea*) population in Orissa, India. *Biological Conservation*. 2004;115:149-160.
86. Shanker K. Thirty years of sea turtle conservation on the Madras coast: A review. *Kachhapa*. 2003;8:16-19.
87. Shanker K, Tripathy B, Pandav B. Biological studies on sea turtles on the coast of Orissa. *Indian Ocean Turtle Newsletter*. 2005;1:10-11.
88. Shanti Priya Pandey. Conservation and Management of Olive Ridley Sea turtle in NAP Coast. Ph.D. Thesis. Andhra University; 2010.
89. Shivbhadrasinh 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.
90. Silas EG, Rajagopalan M. Recovery programme for the Olive ridley, *Lepidochelys olivacea* (Eschscholtz) along Madras coast. Bull. Central Marine Fish. Res. Institute. 1984;35:1-8.
 91. Spotila JR, Dunham AE, Leslie AJ, Steyermark AC, Plotkin PT, Paladino FV. Worldwide population decline of *Dermochelys coriacea*: are leatherback turtles going extinct?. Chelonian Conservation and Biology. 1996;2:209–222.
 92. Sridhar A, Tripathy B, Shanker K. A review of legislation and conservation measures for sea Turtles in Orissa, India. Indian Ocean Turtle Newsletter. 2005;1:1-7.
 93. Sruthi K. Knowledge gain among fisherwomen through video education. Unpub. M.F.Sc. Thesis submitted to Fisheries College and Research Institute, Tamil Nadu Fisheries University, Thoothukudi. 2015;100.
 94. Subba Rao MV, Raja Sekhar PS, KameswaraRao K. Ecology and management of the Indian sea turtles. University Grants Commission, New Delhi, Project Reports, I & II; 1987.
 95. Subba Rao MV. Captive rearing of the Olive Ridley Sea Turtle hatchlings for conservation purpose Int. Congress, Gongaron, Nice, France; 1995.
 96. Subba Rao MV. Endangered sea turtles: Conservation and Management. B.R. Publishing Corporation, New Delhi, India. 2012;78.
 97. Sudhan C. Sea turtle nesting grounds identification and its conservation along the southeast coast of Tamil Nadu. Small grant programme (2016-2017), Project report submitted to the Marine Biological Association of India (MBAI), Kochi, Kerala. 2017;69.
 98. Sujathkumar NV. Women in small scale fisheries, their status, problems and prospects. Unpub. Ph.D. Thesis submitted to VC & RI, TANUVAS, Nammakkal; 2000.
 99. Sujathkumar NV. Women in small scale fisheries, their status problems and prospects. Ph.D. Thesis, VC & RI, TANUVAS, Nammakkal. (Sujathkumar, 2000); 2000.
 100. Suraparaju S. Economics of fishery crafts: A comparative study in Andhra Pradesh. Jour. of Fish. Econ. Dev. 2003;5(1):1-14.
 101. Tamil Nadu Government Gazette, 2015. Part III- Section 1(a): General statutory rules, Notifications, Orders, Regulations, etc., issued by Secretariat Departments. G.O. Ms. No: 186, Animal Husbandry, Dairying and Fisheries (FS: 3-4), 30th September. 2015;1-2.
 102. Tripathy B. A study on the ecology and conservation of Olive Ridley turtles (*Lepidochelys olivacea*) at the Rushikulya rookery of Orissa coast, India. Ph.D thesis, Andhra University, Vishakhapatnam, India. 2005;168.
 103. Tripathy B, Pandav B, Panigrahy RC. Hatching success and orientation of Olive Ridley sea turtle (*Lepidochelys olivacea*) at Rushikulya estuary, Orissa, India. Hamdryad. 2003;27:185-192.
 104. Tuxbury SM, Salmon M. Competitive interactions between artificial lighting and natural cues during sea finding by hatchling marine turtles. Biological Conservation. 2005;121:311-316.
 105. Tyagi LK, Sarkar UK, Paul SK. People's perception about the conservation of fishery resources outside the protected water bodies: A case study in Lakhimpur Khiri district of Uttar Pradesh. Indian Res. J. Ext. Edu. 2007;7(1):36-38.
 106. Valliapan S, Whitaker R. Olive ridleys on the Coromandel coast of India. Herpetological Review. 1975;6:42–43.
 107. Vijayakumaran K. Management and exploitation of the fishery resources of the Indian EEZ – the need for a paradigm shift. Journal of Fisheries Economics and Development. 2001;4(1):45-56.
 108. Vijayan V, Edwin L, Ravindran K. Conservation and management of marine fishery resources of Kerala state, India. Naga, The ICLARM Quarterly report. 2000; 23(3):6-9.
 109. Waayers D. Potential for developing marine turtle tourism as an alternative to hunting in Bali, Indonesia. Indian Ocean Turtle Newsletter. 2005;4:12-14.
 110. Whitaker R. A note on sea turtles of Madras. Indian Forester. 1977;103(11): 733–734.
 111. Witherington BE. Behavioral approaches to conservation in the wild. Cambridge, UK: Cambridge University Press; 1997.

112. Witherington BE, Martin E. Understanding, assessing and resolving light-pollution problems on sea turtle nesting beaches. St. Petersburg, FL: Florida Marine Research Institute, Technical Report TR-2; 1996.
113. WWF-Report (World Wide Fund for Nature), Marine turtles along the Indian coast: Distribution, Status, Threats and Management Implications, Annie Kurian (Eds.). WWF-India, India Secretariat. 2013; 175.

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