



Sea turtle nesting grounds identification and its conservation status of Southern Tamil Nadu

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Five non reported new nesting grounds of Olive ridley turtles were recognized by beach surveying along the coast of southern Tamil Nadu covering 201.75 km. The survey indicates that the study areas have apposite beaches for turtle nesting however; the nesting incidences were declined due to predation and habitat alterations. The observed nest site temperature; perpendicular distance from high tide line; egg diameter and weight at Kanyakumari was well suited than the other study sites. The conservation awareness among stakeholders was found to be 41.7 % and mass awareness program has been created through 16 field visits to various fish landing centers and folders and booklets were distributed to 150 stakeholders. Similarly, 650 students belonging to eight schools were enlightened about the importance of sea turtles and their conservation awareness through audio visual aids. From the study it could be concluded that the turtle nesting grounds are found along the southern coast of Tamil Nadu and conservation initiatives need to be strengthened to protect them.

[**Keywords:** Awareness, Beach survey, Olive ridley]

Introduction

Sea turtles are large shelled oviparous¹ reptile populated along tropical and subtropical seas of the world² excluding in polar region³ that plays a crucial role in balancing the marine food web^{4,5}. Sea turtles live in many different habitats from inshore reefs to open oceanic environment⁶. The eggs are laid by female turtles on open sandy beaches of the shore after mating⁷. The incubation period of sea turtles varied between 45-70 days; followed by hatching of young ones; then hatchlings enter into the seawater and left to mature⁶. The courtship commences during the month of November and ends in February. Both male and female turtles stay mutually upon each other for several hours as a mating behavior⁷. After this event, the female turtles travel to 40 to 60 m away from the shoreline to lay her eggs which are identified by crawl tracks on the sandy beaches⁸. The turtle tracks were identified and classified as Crescent, Conical and False crawl. Based on the literature review, sea turtle nesting was found to be from early January to late March⁹ and peak nesting was observed in the month of February¹⁰.

The phenomenon of synchronous mass nesting – the ‘arribada’ –was displayed by the olive ridley turtles (*Lepidochelys olivacea*) in Odisha¹¹ on the east

coast of India and the same were located at three sites - Gahirmatha, Rushikulya and River Devi mouth¹¹. Olive ridley turtles nesting at these locations were part of a distinct genetic population that nest along the coast of India¹². The collapse of arribada's in 1997-1998 indicated a sharp decline in turtle population¹²⁻²¹. A large amount of mortality is ascribed to drench in trawl nets, although recent accounts suggest that gill nets may also cause large scale mortality demanding large-scale in-depth studies²².

Accessibility of essential data which includes, number of fishers per boat, number/types of craft/gear used and species of sea turtles caught as by catch are often unreliable, unavailable, or not collected due to lack of study. With artisanal fisheries comprising > 95 % of the world's fishers, this knowledge gap presents a major challenge to threatened species conservation and to sustainable fisheries initiatives²³. Other Non-Governmental Organizations (NGO's) are also involved in release of sea turtles back to the ocean/medicate them (if necessary)/operate eco-friendly hatchery to create awareness among the fishers and also to enhance the stocks of turtle species²⁴. The study would present an overview of nesting grounds off southern Tamil Nadu coast and various problems accredited in sea turtle conservation

and protection. Hence, the study was carried out with the following objectives:

- 1 To identify the turtle nesting grounds in southern Tamil Nadu; and
- 2 To assess the present conservational status of turtles among the stakeholders by the structured field survey along the Southern Tamil Nadu.

Materials and Methods

Coastal walk was carried out during early morning 3 to 7 am with the help of local fishers and friends during September 2016 to April 2017 to find out the turtle nesting grounds along the selected districts in Tamil Nadu including Kanyakumari, Nagapattinam, Ramanathapuram and Thoothukudi. The identified nesting grounds were plotted in map along with geo co-ordinates by using GPS Garmin – 72 and the counterpart were checked with the GPS Coordinates and GPS Reader android application installed in the mobile phones for higher accuracy and verification. When turtle nesting was spotted, turtle nesting behavioral responses were noted after adult female returned to shore; a quantum of 500 g of sand samples were collected at a depth of 10-15 cm from the nest sites, packed in zip-lock polythene bags and carried to lab for further analysis. The soil samples were collected and analyzed to create baseline information about the preferential nesting grounds of sea turtles. During nesting ground identification, nesting survey was conducted with the field equipment like scale and weighing machine to measure egg diameter and egg weight. Other parameters like nest location, date, time, distance from high tide level (HTL) and clutch size were also recorded. Turtle mortality was assessed through direct observation of dead turtles washed ashore (beach surveying) and also from newspaper reports. Length and width of the turtles were measured as Curved Carapace Length (CCL) and Curved Carapace Width (CCW). Attempts were also made to decide the sex of the turtle based on the tail length. The turtle nesting intensity for the study areas were calculated by number of nests recorded during the study period/length of the beach surveyed.

Other information such as ministry, acts, vernacular name for turtle, marine biodiversity in respondent village, punishment and penalty about turtle export or hunting activities, mode of catch, catch details, source of information obtained about the conservation of sea turtles, purview of stakeholders in this issue, organization involved in conservation of

turtles, major role played by organization, reasons for decline, number of turtle encounters, details of indigenous traditional knowledge (ITK) adopted by fishermen to avoid catching sea turtles, awareness on turtle excluder device (TED), turtle meat preference, egg consumption, conservation ideas to save turtles, effect of natural predation and human hindrance, details of expectation of awareness programmes in future and community based management groups pertaining to the sea turtle conservation were collected to test the knowledge level of fishermen inhabiting southeast coast of Tamil Nadu.

Results

Pre-Nesting survey was conducted among various stakeholders involved in sea turtle conservation in the four districts of Tamil Nadu. Pre-Nesting survey revealed the nesting grounds of sea turtles i.e., 10 spots from Kanyakumari; 20 spots from Nagapattinam; 8 spots from Ramanathapuram and 6 spots from Thoothukudi distinct.

During the survey, a total of five nesting grounds were identified along study area. Among the observed nesting grounds, highest number of nesting grounds ($n = 3$) were recorded in Manakkudy ($8^{\circ}05'29.06''$ N; $77^{\circ}28'06.09''$ E), Rajakkamangalam ($8^{\circ}07'17.68''$ N; $77^{\circ}21'22.32''$ E) and Veerabagupathi ($8^{\circ}05'34.77''$ N; $77^{\circ}27'33.11''$ E) from Kanyakumari district; least number of nesting ground ($n = 1$) was identified in Kodyakarai ($10^{\circ}22'58.78''$ N; $79^{\circ}52'11.51''$ E) from Nagapattinam and Manapad ($8^{\circ}21'56.24''$ N; $78^{\circ}02'53.11''$ E) from Thoothukudi districts. There was no nesting ground in Ramanathapuram district of Tamil Nadu (Table 1 & 2).

The estimated turtle nesting intensity for the localities studied was found to be 0.025 [Number of nests recorded during the study period (5) / Length of the beach surveyed (201.75 km)].

During coastal walk ten turtle carcasses were recorded at following locations: Chothavilai ($8^{\circ}05'41.23''$ N; $77^{\circ}26'45.10''$ E) and Pallam ($8^{\circ}05'56.99''$ N; $77^{\circ}25'47.95''$ E) in Kanyakumari district; Vedaranyam ($10^{\circ}21'09.39''$ N; $79^{\circ}52'27.61''$ E) and Velankanni ($10^{\circ}40'33.87''$ N; $79^{\circ}51'11.92''$ E) in Nagapattinam district; Dhanushkodi ($9^{\circ}10'32.24''$ N; $79^{\circ}25'10.60''$ E), Mandapam ($9^{\circ}16'06.85''$ N; $79^{\circ}07'03.70''$ E) and Pamban ($9^{\circ}16'26.72''$ N; $79^{\circ}12'16.78''$ E) in Ramanathapuram district; Manapad ($8^{\circ}22'39.02''$ N; $78^{\circ}03'41.06''$ E), Periyathalai ($8^{\circ}20'27.64''$ N; $77^{\circ}59'11.47''$ E) and

Table 1 — Characteristics of nesting ground and its related threats

Nesting ground	Egg diameter (cm)	Egg weight (g)	Clutch size (Nos.)	Threats observed
Manakkudy (8°05'29.06" N; 77°28'06.09" E)	3.8±0.56	15±0.82	85	Disturbance from fishing boats & Sea wall
Rajakkamangalam (8°07'17.68" N; 77°21'22.32" E)	4.9±0.31	16±0.34	102	-
Veerabagupathi (8°05'34.77" N; 77°27'33.11" E)	3.6±0.52	14±0.23	45	Casuarina plantation & Artificial lighting
Kodiyakarai (10°22'58.78" N; 79°52'11.51" E)	3.5±0.23	12±0.45	*	Predation by dogs
Manapad (8°21'56.24" N; 78°02'53.11" E)	4.1±0.62	10±0.39	*	Human disturbance at night

*Damaged eggs

Table 2 — Physical properties of Olive ridley sea turtle nest substrates along southeast coast of Tamil Nadu

Observation	Manakkudy (8°05'29.06" N; 77°28'06.09" E)	Rajakkamangalam (8°07'17.68" N; 77°21'22.32" E)	Veerabagupathi (8°05'34.77" N; 77°27'33.11" E)	Kodiyakarai (10°22'58.78" N; 79°52'11.51" E)	Manapad (8°21'56.24" N; 78°02'53.11" E)
Perpendicular distance from high tide line to the nest (m)	6±3.4	10±1.2	10.5±2.3	8±4.5	4.5±2.3
Nest site temperature at 25 cm (°C)	27.3±0.5	28.3±0.3	27.9±0.7	29.3±0.2	30.3±0.6
Nest site air temperature (°C)	29.6±0.3	30.6±0.3	29.6±0.7	31.6±0.4	32.6±0.8
Sand grain size (sample weight 500 gms)	Split up details in percentage				
2.0 mm	11	9	4	32	24
1.0 mm	18	15	13	21	15
0.5 mm	9	7	11	7	6
0.25 mm	41	38	36	8	8
0.12 mm	13	19	17	12	22
Remaining	8	12	19	20	25

Threspuram (8°49'49.53" N; 78°09'56.23" E) in Thoothukudi district of Tamil Nadu. Among 10 carcasses of turtles, 7 were found to be female having short tail and 2 were identified as male having long tail. All turtles were dead and washed ashore 3-8 m from low tide except 1 turtle that remained unidentified for the reason that the turtle was spotted out in the sea just about 10 m far from the terrestrial land and identified to be dead since there was no movement for about 3 hours of time at Dhanshkodi, Ramanathapuram district.

A total of 16 perfect carapace shells were recorded with the measurements of CCL and CCW in different sites of Southern Tamil Nadu and their geo coordinates were marked to locate the places by hand held GPS and the places were found to be: Colachel (1), Puthanthurai (1) and Vattakottai (1) in

Kanyakumari district; Kodiyakarai (1) and Velankanni (1) in Nagapattinam district; Dhanushkodi (1), Mandapam (2), Pamban (1) and Sethukarai (1) in Ramanathapuram district; and Alanthalai (1), Manapad (3), Periyathalai (1) and Veerapandiyapattinam (1) in Thoothukudi district of Tamil Nadu (Table 3). Of the 16 carapaces, 6 carapaces were found to be damaged one in which curved carapace length and width cannot be accounted. The survey depicted the need of conservation awareness to be initiated to strengthen the conservation activities of turtle nesting along the study area. Various photographs taken during the study period included dead carcasses, turtle nest, turtle eggs, turtle hatchlings and locations of the nesting grounds were depicted and represented in Figures 1-10.

Table 3 — Carapace measurements (CCL & CCW)

Sampling Site	CCL (cm)	Mean \pm Standard deviation (CCL)		CCW (cm)	Mean \pm Standard deviation (CCW)	
Kanyakumari	47.2*	70.4176	17.7408	40.4*	63.2167	17.5537
	67.3 [#]			58.3 [#]		
	65.4 \diamond			59.1 \diamond		
	59.8 \diamond			53.2 \diamond		
	89.6 [#]			83.1 [#]		
	93.2 \diamond			85.2 \diamond		
Nagapattinam	29.9 \diamond	45.4350	17.3467	24.9 \diamond	39.7250	16.4949
	32.4 [#]			27.3 [#]		
	53.2 \diamond			47.4 \diamond		
	66.2 [#]			59.3 [#]		
Ramanathapuram	34.4 \diamond	52.4261	23.9995	29.3 \diamond	44.4917	20.5995
	27.8 \diamond			24.2 \diamond		
	103.0 [#]			83.0 [#]		
	56.0 \diamond			47.5 \diamond		
	45.3 [#]			39.8 [#]		
	56.8 \diamond			49.5 \diamond		
	78.3 [#]			69.1 [#]		
	89.3*			79.5*		
	69.9 \diamond			59.1 \diamond		
	74.3 \diamond			68.3 \diamond		
Thoothukudi	74.7 \diamond	42.3611	38.0619	69.2 \diamond	37.2854	30.2847
	66.4 \diamond			53.1 \diamond		
	45.6 [#]			30.0 [#]		
	89.3 \diamond			69.8 \diamond		
	78.5 [#]			70.3 [#]		
	47.3 \diamond			40.1 \diamond		
	78.1 \diamond			68.8 \diamond		

*Live Turtle [#]Dead turtle \diamond Carapace shells found along the study area

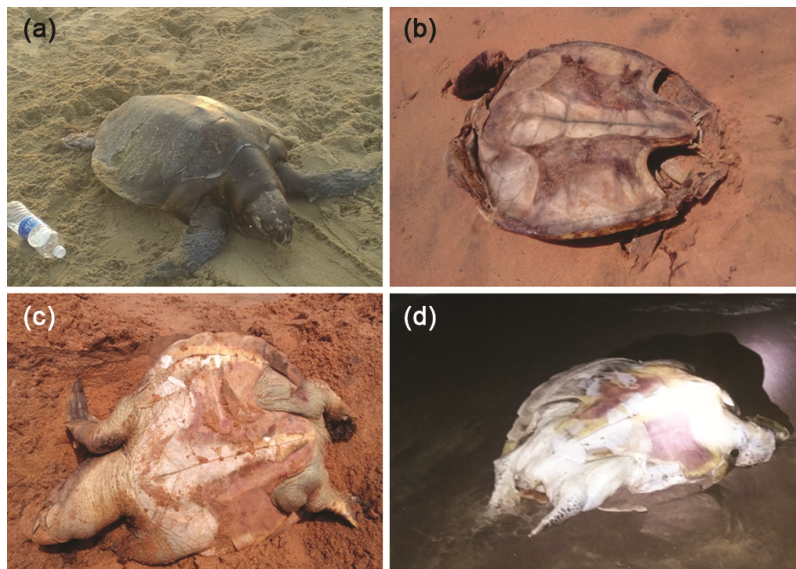


Fig. 1 — Dead carcasses of Olive Ridley sea turtles observed at: a) Nagapattinam Coast; b) Thoothukudi Coast; c) Kanyakumari Coast; and d) Ramanathapuram Coast

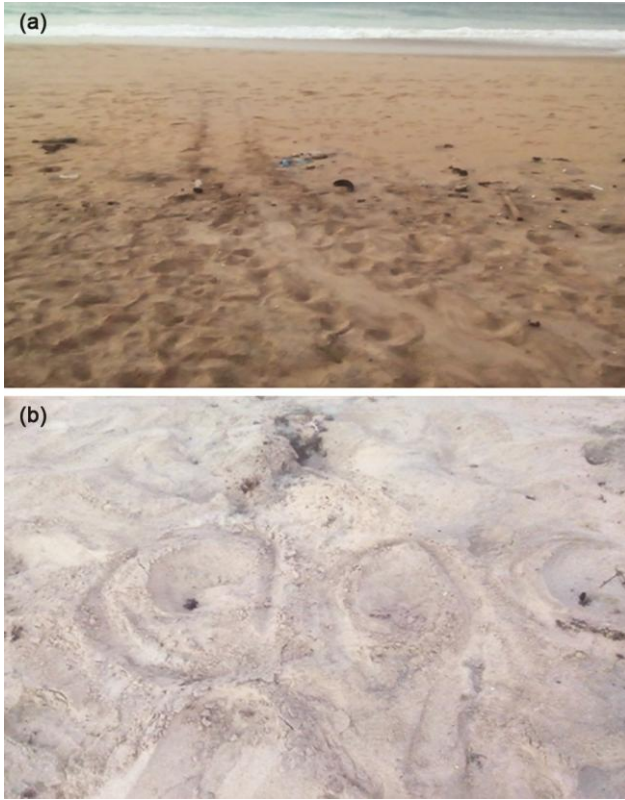


Fig. 2 — Identification of sea turtle track at: a) Manappad, Thoothukudi district; and b) Rajakkamangalam, Kanyakumari district



Fig. 3 — Impact of predation on turtle eggs by feral dogs and birds at Chothavilai, Kanyakumari district



Fig. 4 — Partially exposed turtle eggs in nest at Veerabagupathy, Kanyakumari district



Fig. 5 — Hatchlings of olive ridley's at Kanyakumari



Fig. 6 — Shell remains of turtle eggs at Nagapattinam coast

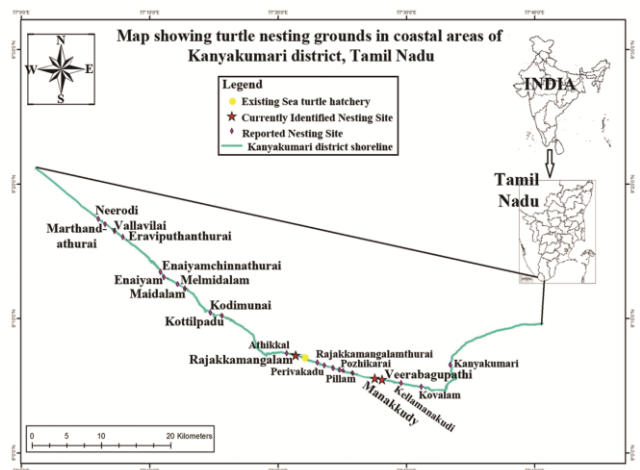


Fig. 7 — Map showing turtle nesting grounds in coastal areas of Kanyakumari district, Tamil Nadu

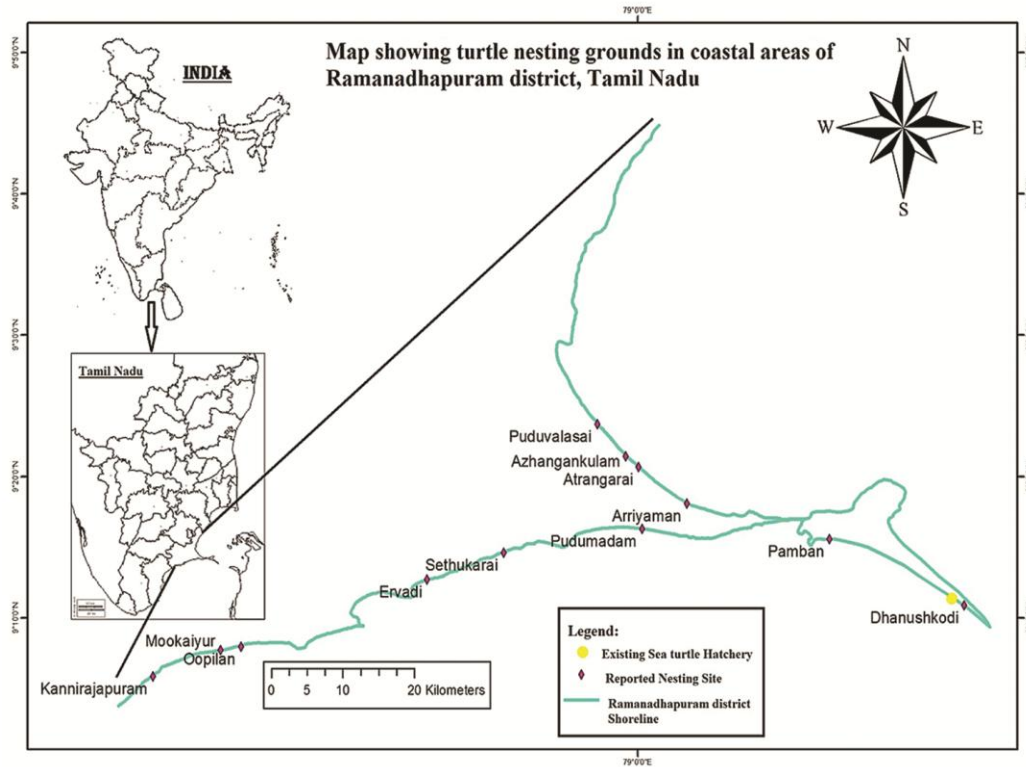


Fig. 8 — Map showing turtle nesting grounds in coastal areas of Ramanathapuram district, Tamil Nadu

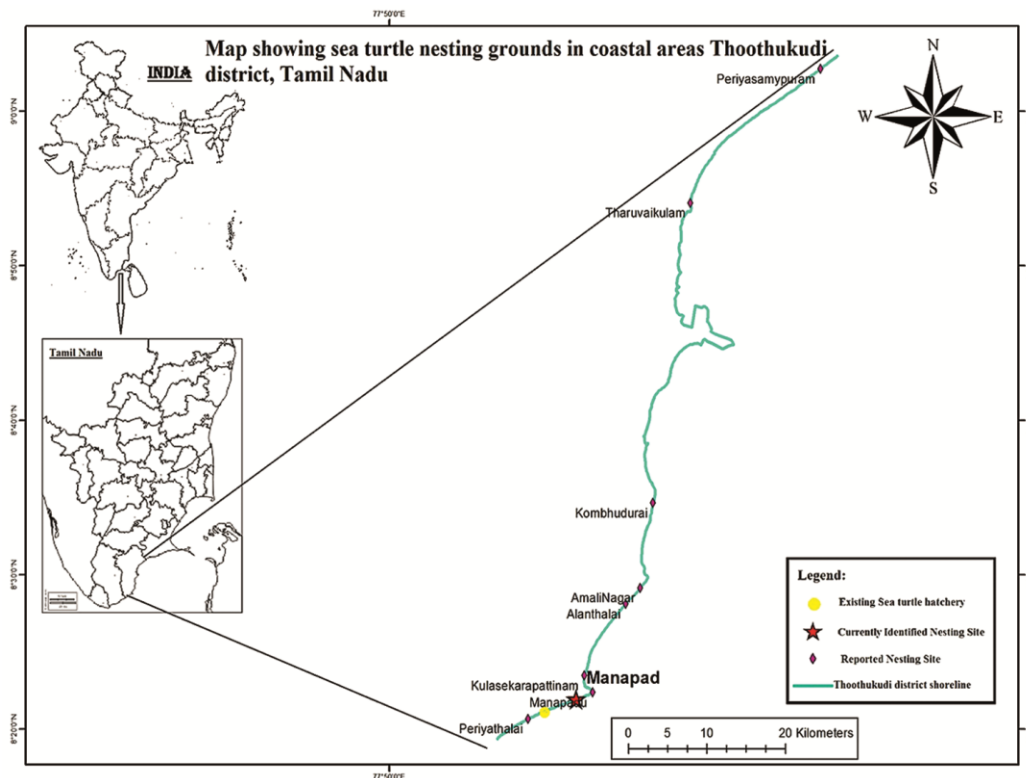


Fig. 9 — Map showing turtle nesting grounds in coastal areas of Thoothukudi district, Tamil Nadu

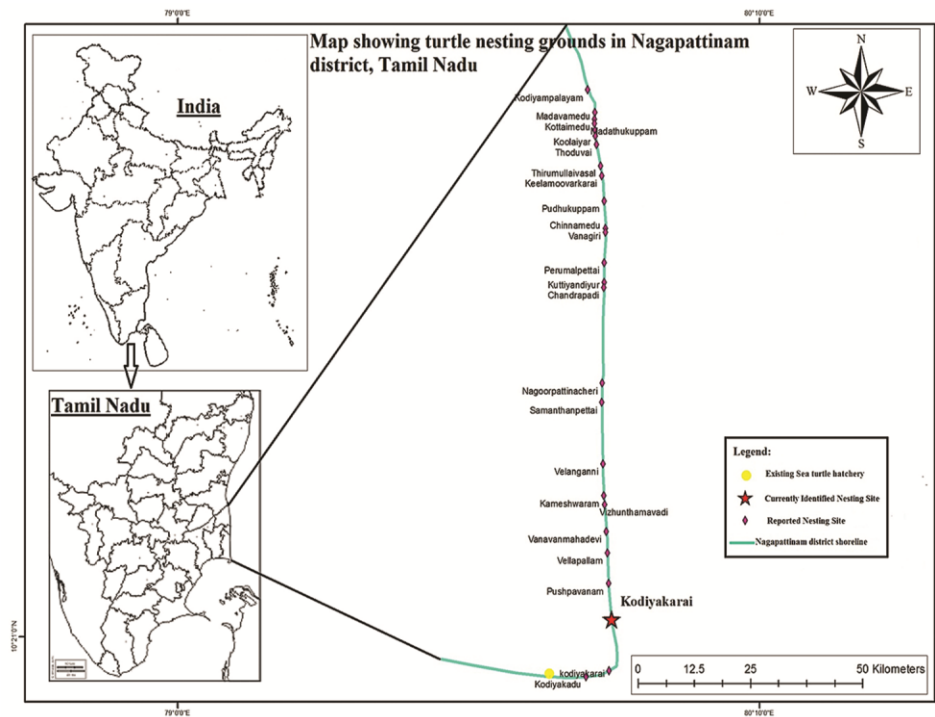


Fig. 10 — Map showing turtle nesting grounds in coastal areas of Nagapattinam district, Tamil Nadu

Discussion

Sea turtle especially Olive ridley turtle, an IUCN threatened category species come to sea shore of Bay of Bengal that includes, Marina, Neelankarai, Elliots beach during breeding season for laying eggs between January to April every year²⁵. Two nesting sites from Kanyakumari district (Kanyakumari and Kovalam); 3 nesting sites from Nagapattinam district (Pazhaiyar, Poombuhar and Tarangambadi); 3 nesting sites from Thoothukudi district (Vembar, Vaipar and Tharuvaikulam) were located among the 23 nesting sites covering a distance of 205 kms along the regions of Tamil Nadu⁹; 10 nesting sites from Andhra Pradesh²⁴; 27 nesting sites from Orissa²⁷; 4 nesting sites from West Bengal²⁸; 7 frequent nesting sites from Kerala coast²⁹; 33 nesting sites from Karnataka coast³⁰; 3 nesting sites from Goa³¹; 13 nesting sites from Maharashtra³² and 39 nesting sites from Gujarat³³ were located by the coastal walk and surveying methodology adopted in the present study was found to be same. Therefore, the present investigation revealed 5 new nesting sites along the southeast coast of Tamil Nadu which will helps in creation of baseline data for turtle population and stock assessment studies. 16 carapace shells were recorded in different sites of South East Coast of Tamil Nadu. The estimated turtle nesting intensity

was less as compared to the nesting intensity reported by Saravanan *et al.*⁹.

Conclusion

To ignite the conservation status, awareness has been created among the local fishers by personal visits made to fish landing centers along the study area, to the fisherwomen's from various places of Kanyakumari district that include Kezhamanakudy, Colachel and Puthalam during exposure visit to FC&RI, Thoothukudi from FT&RC, Parakkai through scheme operated under NABARD and school students in Kombudurai village by distributing the prepared folders (No: 1000) and booklet (No: 250).

Mass awareness has been created among school students and publics through power point presentations, video clippings on sea turtle conservation and protection measures followed by self-explaining wall poster has been displayed through open day celebration conducted at FC&RI, Thoothukudi on 19th June 2017. Hence, the present study revealed that the creation of mass awareness to local fishers, publics and school students of four districts were comparatively higher than the previous studies and awareness programmes conducted by various researchers pertaining to sea turtle conservation along the coast of southern Tamil Nadu, India.

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Conflict of Interest

Authors have declared that no competing or conflict of interest.

Author Contributions

This work was carried out in collaboration between all authors. Author CS collected the literatures, reviewed, conducted survey, 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.

References

- Agastheesapillai A & Thiagarajan R, Biology of the green turtle *Chelonia mydas* (Linnaeus) in the Gulf of Mannar and Palk Bay, *J Mar Biol Ass India*, 21 (1979) 45–60.
- Carr A F, *So excellent a Fish: A natural history of sea turtles*, (Cox and Wyman Ltd., Cassel, London) 1968.
- Bhasker S, Preliminary report on the status and distribution of sea turtles in Indian waters, *Forestry*, 107 (1981) 707-711.
- Bhasker S, Survey of sea turtles, *WWF-India*, 47 (4) (1983) pp. 5.
- Bhupathy S, Monitoring of marine turtles along the Kerala and Tamil Nadu coasts, *IOTN*, 5 (2007) 1–9.
- Musick J A & Limpus C J, *The biology of sea turtles*, (Boca Raton, FL: CRC Press) 1997.
- Avens L, Braun J B, Epperly S P & Lohmann K J, Site Fidelity and homing behavior in juvenile loggerhead sea turtles, *Caretta caretta*, *Mar Bio*, 143 (2003) 211–220.
- SanjeevRaj P J, Egg-laying habits of sea turtles described in Tamil Sangam literature, *J Bombay Nat Hist Soc*, 55 (1958) 361–362.
- 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*, edited by Annie Kurian, (WWF-India) 2013a, pp. 13-30.
- Hirth H F, Nesting behavior and reproductive biology of sea turtles, *Am Zool*, 5 (07) (1980) 20-23.
- Sridhar A, Tripathy B & Shanker K, A Review of Legislation and Conservation Measures for Sea Turtles in Orissa, India, *IOTN*, 1 (2005) 1-7.
- Pandav B, Choudhury B C & Kar C S, Discovery of a new sea turtle rookery along Orissa coast, *MTN*, 67 (1994a) 15-16.
- Pandav B, Choudhury B C & Kar C S, *Olive ridley turtle (Lepidochelys olivacea) and its nesting habitats along the Orissa coast, India: A status survey*, (Wildlife Institute of India, India) 1994b.
- Pandav B, Choudhury B C & Shankar K, The Olive ridley turtle (*Lepidochelys olivacea*) in Orissa: An urgent call for an intensive and integrated conservation programme, *Curr Sci*, 75 (1998) 1323-1328.
- Pandav B, Choudhury B C & Kar C S, Mortality of Olive ridley turtles *Lepidochelys olivacea* due to incidental capture in fishing nets along Orissa coast, India, *Oryx*, 31 (2003) 32-36.
- Pandav B & Choudhury B C, An update on mortality of Olive Ridley sea turtles in Orissa, India, *MTN*, 83 (1999) 10-12.
- Pandav B & Choudhury B C, Conservation and management of Olive ridley sea turtle (*Lepidochelys olivacea*) in Orissa, (Project final report, Wildlife Institute of India, India) 2000, pp. 77.
- Pandav B, *Conservation and management of Olive Ridley turtles along the Orissa coast*, Ph.D. thesis, Utkal University, Orissa, India. 2000.
- Panigrahy R C, Sahu G & Mohanty A K, Sea turtles of the Indian Ocean region, *JIOS*, 13 (2005) 281-302.
- Phillott A D, Mathew J M, Krishnankutty N, Ara S S, Shathy S T, Akter T & Khan Z I, Estimates of turtle by-catch in fisheries of Chittagong district, Bangladesh, *IOTN*, 22 (2015) 5-11.
- Rajeseckhar P S, *Endangered Olive Ridley Sea turtle of the N.A.P. Coast*, Ph.D. Thesis, Andhra University, Andhra Pradesh, India, 1987.
- Behera S K & Kar C, Solitary nesting and mortality of olive ridley sea turtles along the Ganjam coast of Odisha, India, *IOTN*, 18 (2015) 12-14.
- Moore J E, Cox T M, Lewison R L, Read A J, Bjorkland R, *et al.*, An interview-based approach to assess marine mammal and sea turtle captures in artisanal fisheries, *Biol Conserv*, 143 (2010) 795–805.
- Dharini S & Shriram R, Tree foundation's rescue and rehabilitation centre for sea turtles in Chennai, Tamil Nadu, and Nellore, Andhra Pradesh, India, *IOTN*, 22 (2015) 30-32.
- Municipal Administration and Water Supply Department, *Government order (M.C.I)*, G.O. No: 35., (From the Principal Chief Conservator of Forests and Chief Wild Life Warden, Panagal Maaligai, Saidapet, Chennai – 600015), 35 (2011) 1-2.
- 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*, edited by Annie Kurian, (WWF-India) 2013b, pp. 31-44.
- Kar C S & Peters M, Marine turtles of Odisha: Status, issues and threats, In: *Marine turtles along the Indian coast:*

- Distribution, Status, Threats and Management Implications*, edited by Annie Kurian, (WWF-India) 2013, pp. 45-84.
- 28 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*, edited by Annie Kurian, (WWF-India) 2013, pp. 85-98.
- 29 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*, edited by Annie Kurian, (WWF-India) 2013, pp. 99-112.
- 30 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*, edited by Annie Kurian, (WWF-India) 2013, pp. 113-126.
- 31 Dongre S K, Sea turtle nesting status in Goa. In: *Marine turtles along the Indian coast: Distribution, Status, Threats and Management Implications*, edited by Annie Kurian, (WWF-India) 2013, pp. 127-134.
- 32 Katdare V D, Marine turtle habitats in Maharashtra (Distribution, Status and Threats), In: *Marine turtles along the Indian coast: Distribution, Status, Threats and Management Implications*, edited by Annie Kurian, (WWF-India) 2013, pp. 135-154.
- 33 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*, edited by Annie Kurian, (WWF-India) 2013, pp. 155-172.