An overview of some biological aspects and the nesting status of sea turtles along the Indian coasts

ABSTRACT

India's vast coastline is a crucial nesting ground for various species of sea turtles, including olive, green, hawksbill and leatherback turtles. The main nesting sites range from Gujarat to Odisha and the Andaman and Nicobar Islands. However, human activities such as coastal development, pollution, and fishing pose significant threats to sea turtle populations. Conservation efforts, including beach protection, hatchery programs, and community involvement, are essential to saving these species. This review examines nesting patterns, reproductive behavior, and challenges faced by sea turtles along the Indian coasts. It highlights the importance of specific nesting sites in different states for the conservation of sea turtles. Also discusses the impacts of climate change, human-caused threats, and the importance of genetic diversity and population dynamics. Comparative analyses with global nesting sites provide insight into improved sea turtle conservation efforts around the world. India's diverse and essential nesting habitats are vital for the survival of sea turtles and the health of marine ecosystems. The protection of these nesting sites is crucial for the conservation of sea turtles and the overall well-being of marine biodiversity.

Keywords: Bycatch; India; nesting areas; management; at the state level.

1. PRESENTATION

Sea turtles are ancient marine animals that have inhabited the oceans for more than 100 million years. The extensive beaches and diverse marine environments along the Indian coastline provide important nesting sites for various species of sea turtles, including the green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), and leatherback turtle (*Dermochelys coriacea*). Olive ridley turtles (*Lepidochelys olivacea*), famous for their mass nesting events called "arribadas", are the most prolific breeding species on the Indian coast (~~Tripathy, 2008~~ Absent from bibliographic references). They are found mainly in the eastern regions, particularly on Gahirmatha Beach in Odisha and at the mouth of the Rushikulya River (Pandav et al., 1994). Gahirmatha is home to one of the world's largest nesting sites for olive ridley turtles, where hundreds of thousands of turtles come to lay their eggs every year. Although Green Turtles are rare, they inhabit the waters off the coast of India and have important nesting sites on the Andaman and Nicobar Islands (Andrews and Shanker 2002). Hawksbill turtles, which are critically endangered, prefer the rocky areas of Lakshadweep Island to nest. Leatherback Sea Turtles, the largest of all sea turtle species, are found primarily on the Andaman and Nicobar Islands, with Little Andaman and Great Nicobar Islands being their main nesting sites (Bhaskar 1993).

Human actions such as coastal development, pollution and fishing pose significant dangers to sea turtle populations (Shanker and Pilcher, 2003). Conservation efforts, including beach protection, hatchery programs, and community involvement, are essential to the protection of these species (Namboothri et al. 2012). Organizations such as the Madras Crocodile Bank Trust and the TREE Foundation play an active role in the conservation of sea turtles along the Indian coastline (Shanker, 1996). India's coastline, which stretches for more than 8118 km, offers diverse and crucial nesting habitats for sea turtles, making it a key area for their

conservation. The protection and understanding of these nesting sites is essential to the survival of sea turtles and the overall health of marine ecosystems around the world (~~Mazda, 1997~~ Absent from reference lists).

2. BIOLOGICAL ASPECTS OF SEA TURTLES ON THE INDIAN COASTS

2.1 Identification of sea turtles

Identification of adult sea turtles relies primarily on external features such as carapace length, number of prefrontal scales, and configuration and number of coastal scales (Shanker 2003). To confirm trace identification, concrete evidence such as newborn remains and eggshell sizes must be examined (Shanker and Pilcher 2003). The types of body pools vary from species to species: loggerheads, hawksbill turtles, and wrinkled turtles create shallow pools, while green and leatherback turtles produce larger, deeper pools (Andrews and Shanker 2002).

2.2 Track characteristics

The type of tracks also differs; symmetrical tracks are formed when the front fins move in unison, while asymmetrical tracks occur when the fins move alternately (~~Tripathy, 2008~~ Absent from reference lists). Although other animals, such as crocodiles and monitor lizards, can leave tracks on the beach, these are easily distinguished by their shape and size (Namboothri et al., 2012).

2.3 Reproduction

Male and female sea turtles begin their reproductive cycle by migrating from feeding grounds to breeding grounds, which can be several thousand kilometres apart (Shanker and Pilcher 2003). Mating takes place mainly in the offshore waters of breeding sites; The male mounts the female, grabbing her with his claws on the front fin during copulation. Males and females may mate with multiple partners (Shanker 2003).

2.4 Imbrication

A few weeks after mating, the females return to land to nest, usually at night. They crawl above the high tide line, locate a suitable nesting site, clear surface sand, and dig a flask-shaped nest using their hind flippers (~~Tripathy 2008~~ Absent from reference lists). This nest can reach depths of two to three feet, depending on the size of the turtle. Once egg-laying begins, the turtle enters a "nesting trance" that makes it less reactive to disturbance (Andrews and Shanker 2002). They usually lay about 100 to 150 eggs in the nest and cover it with sand; Some species press the nest with their bodies to compact it. Then they camouflage the nest by throwing sand around it and return to the ocean. Factors that influence beach selection include accessibility, elevation, and substrate type. Olive ridley and leatherback turtles prefer large beaches and sandbars at the mouths of rivers, while hawksbill turtles and green turtles are more prone to small island beaches. Most turtles nest several times during a season, usually with about two weeks between each clutch (Pandav et al. 1994).

2.5 Philopatrie

Adult Sea Turtles have long been known to return to their designated nesting areas to lay their eggs (Bhaskar 1993). Usually, during the nesting season, most turtles lay all their eggs in a small, localized area (between 0

and 10 km). However, some species, such as the Orissa Olive Turtle, are known to travel greater distances to find suitable nesting sites (Shanker 1996).

2.6 Determination of sex as a function of temperature

Temperature during incubation affects the sex of sea turtle hatchlings. Cooler temperatures tend to produce more males, while warmer temperatures result in a higher proportion of females. Each species and population has an optimal temperature range to achieve a balanced sex ratio, typically between 28 and 32°C (Namboothri et al. 2012). The sex of newborns is determined during the second stage of development (REF). Changes in nest temperature, particularly due to climate change, can lead to an imbalance in sex ratios, which could affect future reproductive success (Shanker and Pilcher 2003).

2.7 Hatching

During the incubation period, which typically ranges from 45 to 70 days for most sea turtle species, the eggs are exposed to heat and sunlight. Eggs typically hatch at about the same time over a period of several days, with hatchlings emerging from the nest together at night to escape predators (Shanker 1996). Predators such as crabs, birds, dragons, wild dogs, and various fish pose a threat to hatchlings until they reach the sea.

2.8 Distinction of newborns

Hatchlings can be identified using characteristics similar to those of adults, such as the number of coastal scales, although coloration can vary. During the hatching season, it is essential to track the footprints of hatchlings, as they lead to nests where further examination can determine hatching success (Namboothri et al. 2012).

2.9 Newborn Development

Once hatched, the young turtles undergo a vigorous swimming period, using their stored energy to move towards the ocean. They spend several years in juvenile habitats before moving to their adult feeding grounds (Shanker 1996). During this initial pelagic phase, they are commonly transported by ocean currents and often feed in sargassum beds and fish aggregating devices (FADs) (Pandav et al. 1994).

2.10 Adult Migration

The maturation process of sea turtles, from hatchlings to adults, typically takes 10 to 15 years for most species, with green turtles sometimes requiring up to 30 years. As they grow, turtles migrate to their breeding grounds (Bhaskar 1993). After mating, males usually return to their feeding areas, while females return to their nesting sites. Migration patterns can vary greatly between species and populations; some may nest and feed in the same area, while others undertake long migrations (~~Tripathy 2008~~ Absent from reference lists).

2.11 Identification of the Adult

In Indian waters, adult sea turtles can be identified by external features such as carapace length, number of frontal scales, and pattern and number of coastal stripes. Five species are particularly distinguished by a detailed study (Shanker and Pilcher 2003).

2.12 Identification of tracks and nests

To differentiate between sea turtle species based on their tracks, it is important to consider factors such as track width, burrow depth, and track configuration (symmetrical or asymmetrical). Identifying traces can be difficult, even for experts, due to variations between populations and individuals. Field workers should directly observe nesting turtles and analyze trace characteristics, confirming identifications with additional evidence like newborn remains and eggshell size (~~Tripathy 2008~~ Absent in reference lists).

I. Types of body pits: Loggerheads, hawksbill turtles, and ridley turtles create shallow body pits, while green turtles and leatherback turtles produce larger, deeper pools.
II. Types of caterpillars: Symmetrical caterpillars indicate synchronized front fin development, while asymmetrical or erratic caterpillars suggest alternate development. These tracks can be distinguished from those of other animals based on their pattern and size (Pandav et al., 1994).

3. DISTRIBUTION OF MARINE TURTLE NESTING AREAS ALONG THE INDIAN COASTAL STATES

3.1 Gujarat

Gujarat, which has the longest coastline in India at 1,650 km, has 520 km and the main nesting species are olive ridley turtles and green turtles (~~Sunderraj, 2002~~ Absent in the bibliographic references). The coastline is divided into the Kachchh, Saurashtra and mainland regions, and is further classified into five subregions based on intertidal characteristics (Patel, 1997; ~~Sunderraj et al., 2006~~ Absent from the bibliographic references). The Saurashtra Coastal Study Area, which stretches from Jamnagar (Okha) to Bhavnagar, stretches for more than 450 km and includes the districts of Junagadh, Amreli and Porbandar. The surveys revealed a variety of beach compositions: 62% sandy, 25% a mixture of sand and rocks, and 13% muddy and rocky. Central Saurashtra has the highest concentration of sandy nesting beaches, while the eastern and western areas have rocky and sandy stretches, and the eastern and western extremities have muddy and sandy stretches. Twenty-two potential nesting sites have been identified in three main sections: (1) Dwarka to Madhavpur; (2) From Madhavpur to Chorwad; and (3) Adri in Santeshwar. The nesting season for sea turtles was from June to January (Patel 1997). The main nesting beaches along the 1,600 km of coastline include Kantela-Kachha, Mangrol-Bara and Navadra-Lamba (~~Sunderraj, 2002~~ Absent in the bibliographic references).

3.2 Le Maharashtra

Maharashtra, which has the second longest coastline on the west coast of India, with breeding records of mainly olive ridley turtle habitats that have been monitored by Sahyadri Nisarga Mitra (SNM) since 2002 (Katdare and Mone 2003). Although Green Turtles have been observed occasionally (Gole 1997). The SNM has not recorded any nesting of this species since 2002. Comprehensive surveys of the Maharashtra coastline conducted by the Government of India project UNDP between 2000 and 2001 and by UNEP-CMS IOSEA between 2004 and 2005 identified 15 important nesting sites, mainly in Ratnagiri and Sindhudurg districts (Giri and Chaturvedi

2006). These districts, as well as Raigad, continue to host the majority of olive ridley turtle nesting activities, with occasional sightings reported on 13 key beaches (~~Katdare, 2010~~ Absent from reference lists).

3.3 Goa

Goa, located on the west coast of India, is an important nesting area for olive ridley turtles. The nesting season in Goa runs from October to February along its 160 km coastline (Giri and Chaturvedi 2006). The main nesting beaches in Goa are Morjim, Kerim, Galgibaga, and Agonda (~~Shanker, 2016~~ Absent from reference lists). Extensive surveys have been conducted along the coastline of Goa to monitor sea turtle nesting activities. Early studies identified olive ridley turtles nesting along the coasts of Maharashtra and Goa (Giri 2000). Monitoring surveys have confirmed ongoing nesting activities and provided detailed information on the distribution and status of sea turtles in the area (Giri, 2001; Bhaskar, 1984).

3.4 Karnataka

Karnataka's 260 km of coastline is a crucial nesting site for olive ridley turtles, with the nesting season running from October to February (Sharath 2006). Important nesting areas are found in the districts of Udupi and Mangalore (Madhyastha et al., 1986; McCann, 2007). Early research on sea turtle hatcheries at Bengre Beach in Mangalore highlighted the region's early conservation efforts (McCann, 2007) that laid the groundwork for subsequent conservation projects along the Karnataka coast. Notably, conservation activities have been particularly vigorous in the Udupi district, with many documented initiatives (McCann, 2007). Local communities and researchers have played an important role in conservation efforts, including monitoring nesting sites, protecting nests, and studying newborn success rates (Appayya, 1985; Frazier, 1989). Nevertheless, the incidental capture of sea turtles in fishing nets remains a significant problem, highlighting the need for conservation and awareness programmes (Rajagopalan et al., 1996).

3.5 Kerala

Kerala's 590 km of coastline is a vital nesting ground for olive ridley turtles, with the nesting season running from October to February (Dileepkumar and Jayakumar, 2006). Major nesting beaches include Alungal, Kolavipalam, and Thaikkadappuram (~~Shanker 2016~~ Absent from reference lists). Initial studies established the presence and distribution of sea turtles along the coast of Kerala, setting the stage for future conservation work (Bhaskar, 1981). Ongoing monitoring has led to a better understanding of nesting patterns and the effectiveness of conservation efforts (Bhupathy 2007). Various projects have facilitated field studies and promoted the establishment of turtle conservation networks in Kerala, emphasizing the need for coordinated protection measures for these endangered species (Dileepkumar and Jayakumar, 2006). Community involvement, particularly in Kolavipalam, has been crucial to conservation efforts, including the release of turtles accidentally caught into the sea, demonstrating the community's commitment to protecting sea turtles (~~Kutty, 2001~~ Absent from reference lists; ~~Pillai et al., 2004~~ Absent from the bibliographic references).

3.6 Tamil Nadu

Tamil Nadu and Pondicherry, with a combined coastline of 1,076 km, provide an important nesting habitat for olive ridley turtles. Nesting occurs from December to April (Bhupathy and Saravanan 2006). The main nesting sites in the region include Nallavadu, Marina-Neelankarai, Mamallapuram-Pondicherry, Nagapattinam, Alikuppam and Neelankarai-Uthandi (Arun, 2011; Bhupathy et al., 2006). Early studies examined the biology and nesting behaviour of sea turtles in this area, highlighting the need for conservation measures (Agastheesapillai and Thiagarajan, 1979; Banugopan and Davidar, 1998). Ongoing monitoring and conservation efforts are essential to saving these endangered species (Shanker, 2003; ~~Subramanian, 2005~~ Absent from bibliographical references). The involvement of local communities has been key to the success of conservation (Arun, 2011). Support from local groups and international collaborations underscores the importance of coordinated conservation approaches (Bhupathy et al., 2006; ~~Pandav, 2000~~ Absent in the bibliographical references).

3.7 Andhra Pradesh

Andhra Pradesh, with its 980 km of coastline, is an important nesting area for olive ridley turtles, nesting from December to April (Tripathy et al., 2006). The main nesting sites in the area are Sacremento Island, Neelarevu, Elichetladibba and Kapaskudi (Sekhar and Rao 1993). Early research highlighted the presence of sea turtles in northern Andhra Pradesh and highlighted the need for conservation efforts (Bhaskar, 1982; Dutt, 1979). Conservation measures include on-site protection and the use of turtle exclusion devices (~~Sankar and Pilcher 2003~~ Absent from reference lists). However, large-scale mortality of Olive ridley Turtles has been reported along the coast of Andhra Pradesh (Murthy and Murthy 2011). Ongoing efforts are focused on monitoring nesting activities and implementing effective conservation strategies (~~Rajasekar and Rao 1993~~ Absent from references; Rao et al., 1987).

3.8 Odisha

Odisha's 480 km of coastline is a crucial nesting site for olive ridley turtles, nesting from December to April (Pandav and Choudhury 2000). The main nesting sites are Rushikulya, Gahirmatha, and the mouth of the Devi River (~~Shanker 2016~~ Absent from reference lists). Early research focused on sea turtle conservation and management efforts in Odisha, with a focus on habitat monitoring and conservation strategies (Kar and Bhaskar, 1982; Kar and Dash, 1984; Pandav et al., 1994; Pandav et al., 1995). Efforts have also addressed threats such as incidental capture in fishing nets and used remote sensing to study nesting patterns (Rout and Behera 2006). The coastline is known for its important mass nesting events (arribadas), which are a notable natural phenomenon (~~Kar and Dash 1984~~ Absent from bibliographic references).

3.9 Bengale occidental

West Bengal, with its 950 km of coastline, is an important nesting area for Olive ridley Turtles from December to April (Chowdhury et al. 2006). The main nesting sites in the area are Dadanpatra, Digha, Junput and Shankarpur (Chowdhury 2001). Early research highlighted the need for marine turtle conservation and management efforts in West Bengal, with a focus on monitoring nesting habitats and implementing effective

conservation strategies (Sen, 1978; ~~Raut and Nandi, 1988~~ Absent from bibliographical references; ~~Chowdhury et al., 2001~~ Absent from the bibliographic references). Initiatives also address threats such as incidental capture in fishing nets (Raut and Nandi 1986) and use remote sensing to study nesting dynamics (Mukherjee 2006). The coastline is known for its mass nesting events (arribadas), which are important natural events (~~Biswas 1982~~ Absent from bibliographic references).

3.10 Andaman and Nicobar Islands

The Andaman and Nicobar Islands, with a coastline of 1,962 km, are vital nesting sites for four species of sea turtles: olive ridley turtles, leatherback, green and hawksbill turtles. Nesting seasons differ by species: leatherback and olive ridley turtles nest from November to March, while green and hawksbill turtles nest from April to September (~~Shanker and Namboothri 2012~~ Absent from reference lists). The main nesting sites are Cuthbert Bay, South Reef Island, Great Nicobar Island, Little Nicobar Island, and Little Andaman Island (~~Shanker and Namboothri 2012~~ Absent from reference lists). Research by Andrews and Shanker (2002) identified a large population of Leatherback Sea Turtles in the Indian Ocean. Conservation genetics studies by Pandav and Choudhury (2000) have provided a better understanding of the genetic diversity of marine turtle populations along the Indian mainland coast and offshore islands, which are essential for effective conservation strategies. Surveys conducted by Bhaskar in the late 1970s and early 1980s documented in detail the distribution and status of sea turtles in the region (Bhaskar 1979; 1981; 1993).

3.11 Lakshadweep

The Lakshadweep archipelago is a key nesting area for hawksbill, green, and olive barley turtles. Nesting seasons vary, with Leatherback and Olive Ridley Turtles nesting from November to March, while Green and Hawksbill Turtles nest from April to September (Tripathy et al. 2006). Important nesting beaches in Lakshadweep include Suheli Island, Agatti Island, Kalpitti Island, and Bitra Island (Tripathy et al. 2006). Early researchers documented sea turtles in the Lakshadweep Islands, offering a first glimpse into their presence and nesting behaviors. A comprehensive study provided detailed information on sea turtles and their nesting habitats in Lakshadweep, the results of which were published as part of the Government of India/UNDP Sea Turtle Project (Tripathy et al., 2002).

4. CHALLENGES AND CONSERVATION STRATEGIES FOR SEA TURTLE NESTING ALONG THE INDIAN COASTLINE

4.1 Impacts of climate change

Climate change is profoundly affecting sea turtles around the world, including those nesting along the Indian coast. Key impacts include changes in nest sex ratios due to rising temperatures, changes in ocean currents that affect migration and food availability (Poloczanska et al. 2016), and sea level rise that threatens nesting beaches (Hawkes et al. 2009).

4.2 Conservation Strategies

Effective strategies are essential to mitigate threats and ensure the survival of sea turtles. These include protecting nesting beaches from development and erosion (Wallace et al., 2013), mandating the use of turtle exclusion devices (TEDs) in fisheries to reduce bycatch (Hamann et al., 2013), establishing marine protected areas (MPAs) as safe habitats (~~Tomillo et al., 2019~~ Absent from reference lists) and to involve local communities in conservation efforts (Mazaris et al., 2017).

4.3 Human-Induced Threats

Human activities pose significant risks to Indian sea turtles, including habitat loss due to coastal development (Hawkes et al. 2009), plastic pollution leading to ingestion and entanglement (Schuyler et al. 2016), bycatch in fishing gear (Wallace et al. 2013), and illegal trade in turtle products (Shanker and Pilcher, 2003).

4.4 Genetic diversity and population dynamics

Understanding genetic diversity and population dynamics is essential to effective conservation. Genetic studies focus on maintaining genetic diversity for population resilience (~~Fitz Simmons et al. 2012~~ Absent from reference lists), population assessments reveal varying trends across nesting sites and species (López-Castro et al. 2014), and the study of connectivity helps to understand migration patterns (Shamblin et al. 2014).

4.5 Comparative Analysis with Global Nesting Sites

Comparative studies with global nesting sites provide insight into regional nesting behaviours, threats and conservation strategies. Comparison of nesting sites across regions highlights regional conservation challenges and successes (Troëng and Chaloupka 2007), while analysis of conservation strategies globally identifies best practices to strengthen marine turtle conservation efforts (Wallace et al. 2013).

5. IN CONCLUSION

India's coastline, which stretches for more than 8,118 km, provides vital nesting grounds for several species of sea turtles, including olive, green, hawksbill and leatherback turtles. This large and diverse habitat is essential to the reproductive success and survival of these species. However, significant threats such as climate change, land use planning, pollution and bycatch are putting their populations at risk. Addressing these challenges requires a comprehensive approach, including habitat protection, the implementation of turtle exclusion devices (TEDs), and the establishment of marine protected areas (MPAs). It is also essential to involve local communities in conservation efforts and to advance scientific research on genetic diversity and population dynamics. Comparative studies with global nesting sites highlight the importance of adopting best practices and improving conservation strategies. Ensuring the protection of India's sea turtle nesting sites is not only essential for these species, but also for the overall health of marine ecosystems. Collaborative and sustained efforts are essential to ensure the future of sea turtles and preserve the ecological balance of our oceans.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

The author hereby declares that NO generative AI technologies such as large language models (ChatGPT, COPILOT, etc.) and text-to-image generators were used in the writing or editing of this manuscript.

REFERENCES

Agastheesapillai, A., & Thiagarajan, R. (1979). Biology of the green turtle Chelonia mydas (Linnaeus) in the Gulf of Mannar and Palk Bay. *Journal of the Marine Biological Association of India*, 21, 45-60.

Andrews, H., & Shanker, K. (2002). A large population of leatherback turtles in the Indian Ocean. *Kashhapa*, 6, 19.

Appayya, M. K. (1985). Conservation of sea turtles, especially in Karnataka. My Forest, 21(2), 89-90.

Arun, V. (2011). Student Network for the Conservation of Sea Turtles: a victory for volunteering! *Indian Ocean Turtle Newsletter*, 14, 21-25.

Banugopan, K. and Davidar, P. (1998). Status of sea turtles along the coast of Pondicherry, India. *Hamadryad*, 24, 43.

Bhaskar, S. (1979). Sea turtles in the southern Andaman Islands. *Hamadryad*, 4(1), 3-5.

Bhaskar, S. (1981). Preliminary report on the status and distribution of sea turtles in Indian waters. *Indian forester*, 107(11), 707-711.

Bhaskar, S. (1984). The distribution and status of sea turtles in India. In E. G. Silas (Ed.), *Proceedings of the Workshop on the Conservation of Sea Turtles* (pp. 21-35). Publication of the CMFRI.

Bhaskar, S. (1993). The status and ecology of sea turtles in the Andaman and Nicobar Islands. ST, 1(93), 1-37.

Bhupathy, S. and Saravanan, S. (2006). Sea turtles of Tamil Nadu. In Sea turtles of the Indian subcontinent (pp. 58-67).

Bhupathy, S. (2007). Monitoring of sea turtles along the coasts of Kerala and Tamil Nadu. *Indian Ocean Turtle Newsletter*, 5, 1-6.

Bhupathy, S., Vijay, M., Nixon, A. M. A., Subramanian, J., Karunakaran, R., & Gokulakrishnan, J. (2006). The state of sea turtle populations on the coasts of Tamil Nadu and Kerala in India. In Towards an Integrated and Collaborative Conservation of Marine Turtles in India, UNEP/CMS-IOSEA Project, 55.

Biswas, S. (1981). A report on the olive ridley, *Lepidochelys olivacea* (Eschscholtz) [Testudines: Cheloniidae] of the Bay of Bengal. *Archives of the Zoological Survey of India*, 275-302.

Choudhury, B. C., Sharma, S. C., & Mukherjee, S. K. (2002). India's Sea Turtle Conservation Program. In N. J. Pilcher and G. Ismail (Eds.), *Marine Turtles of the Indo-Pacific: Research, Conservation and Management* (pp. 100-106). ASEAN Academic Press.

Chowdhury, B. R., Das, S. K., & Ghose, P. S. (2006). West Bengal sea turtles. In K. Shanker and B. C. Choudhury (Eds.), *Sea Turtles of the Indian Subcontinent* (pp. 107-116). University Press.

Chowdhury, R. B. (2001). Study of sea turtles on the coasts of West Bengal. In K. Shanker and B. C. Choudhury (eds.), *Proceedings of the National Workshop for the Development of a National Action Plan for the Conservation of Sea Turtles*, Bhubaneshwar, Orissa (pp. 50-52). Wildlife Institute of India.

Dileepkumar, N., & Jayakumar, C. (2006). Sea turtles of Kerala. In K. Shanker and B. C. Choudhury (eds.), *Sea Turtles of the Indian Subcontinent* (pp. 137-140). University Press.

Dutt, S. (1979). Notes on the sea turtles of Visakhapatnam. *Hamadryad*, 4(2), 2-3.

FitzSimmons, N.N., and Limpus, C.J. (2014). Genetic stock of Indo-Pacific sea turtles: identifying limitations and gaps in knowledge. *Indian Ocean Turtle Information Bulletin*, 2-18.

Frazier, J. G. (1989). Study of sea turtle hatcheries in Karnataka. *Hamadryad*, 14:8-18.

Giri, V. (2000). A preliminary survey of sea turtles along the coast of Maharashtra and Goa. *Kashhapa*, 3:3-5.

Giri, V. (2001). Survey of sea turtles along the coasts of Maharashtra and Goa. *Kashhapa*, 4:14-16.

Giri, V. and Chaturvedi, N. (2006). Sea turtles from Maharashtra and Goa. *In Sea turtles of the Indian subcontinent* (pp. 147-155).

Gole, P. (1997). Conservation of the biodiversity of the west coast between Mumbai and Goa. Pune: *Ecological Society*.

Hamann, M., Fuentes, M.M., Ban, N.C., and Mocellin, V.J. (2013). Climate change and sea turtles. In *Biology of Sea Turtles* (Vol. 3, pp. 353).

Hawkes, L.A., Broderick, A.C., Godfrey, M.H., and Godley, B.J. (2009). Climate change and sea turtles. *Research on endangered species*, 7(2), 137-154.

Kar, C. S. and Bhaskar, S. (1982). Status of sea turtles in the eastern Indian Ocean. In *Biology and Conservation of Sea Turtles* (pp. 72-365).

Katdare, V., & Mone, R. (2003). Turtle conservation in Konkan, Maharashtra, India. *Kashhapa*, 9, 7-8.

Child, R. (2001) Revisiting the position. The Efort community is Kolavipalam, Kerala. *Kachapa*, 4, 13.

López-Castro, M.C., Bjorndal, K.A., Kamenov, G.D., & Bolten, A.B. (2014). Identification of ocean foraging areas of Atlantic sea turtles using lead isotopes. *Marine Biology*, 161, 2269-2278.

Madhyastha, M. N., Sharath, B. K., & Rao, I. J. (1986). Preliminary studies on the sea turtle hatchery at Bengre Beach, Mangalore. *Mahasagar*, 19(2), 137-140.

Mazaris, A.D., Schofield, G., Gkazinou, C., Almpanidou, V., & Hays, G.C. (2017). Global successes in sea turtle conservation. *Science Advances*, 3(9), e1600730.

McCann, P. (2007). Sea turtle conservation efforts in Udupi District, Karnataka. *Indian Ocean Turtle Information Bulletin*, 5, 10–13.

Mukherjee, M. (2006). Coastal pollution in West Bengal: implications for olive ridley turtles. In K. Shanker and B.C. Choudhury (Eds.), *Sea Turtles of the Indian Subcontinent* (pp. 393-400).

Murthy, K.L.N., and Ramana Murthy, K.V. (2011). Mass mortality of *Lepidochelys olivacea* observed on Kottapeta Beach in Srikakulam District on the east coast of Andhra Pradesh, India. *Indian Ocean Turtle Newsletter*, 14-15.

Namboothri, N., Swaminathan, A., & Shanker, K. (2012). A compilation of data from the Satish Bhaskar sea turtle surveys in the Andaman and Nicobar Islands. *Indian Ocean Turtle Newsletter*, 16, 4-13.

Nath, P.K. (2000). News from the United States- Andhra Pradesh - In situ conservation at Visakhapatnam. *Kashhapa*, 2-14.

Pandav, B., & Choudhury, B. C. (2000). Conservation and management of the olive ridley turtle (*Lepidochelys olivacea*) in Orissa. Final Report: *Wildlife Institute of India*, 68.

Pandav, B., Choudhury, B.C., & Kar, C.S. (1994). Discovery of a new colony of sea turtles in Orissa, India. *Sea Turtle Information Bulletin*, 67, 15-16.

Pandav, B., Choudhury, B.C., & Kar, C.S. (1995). A note on the presence of subadult olive ridley turtles along the coast of Gahirmatha. *Sea Turtle Information Bulletin*, 71, 15-17.

Pandav, B., Choudhury, B.C., & Kar, C.S. (1997). Mortality of olive ridley turtles *Lepidochelys olivacea* due to accidental capture in fishing nets along the coast of Orissa, India. *Oryx*, 6–32.

Patel, P.P. (1997). Eco-regions of Gujarat. Vadodara: *Gujarat Ecology Commission*, pp 146.

Pillai, K.S. (2004). Accidental capture of green turtle Chelonia mydas in a coastal seine in Kovalam near Vizhinjam, southern Kerala. *Fishing chimes*, 24(3), 57.

Poloczanska, E.S., Burrows, M.T., Brown, C.J., García Molinos, J., Halpern, B.S., Hoegh-Guldberg, O., Kappel, C.V., Moore, P.J., Richardson, A.J., Schoeman, D.S., and Sydeman, W.J. (2016). Responses of marine organisms to climate change across the oceans. *Frontiers of Marine Sciences*, 3, 62.

Priyadarshini, K.V.R. (1998). Status, ecology and management of olive ridley turtles and their nesting habitats along the northern coast of Andhra Pradesh. *WWF-India*, 2-52.

Rajagopalan, M., Vivekanandan, E., Pillai, S.K., Srinath, M., and Bastian, F. (1996). Incidental capture of sea turtles in India. *Marine Fisheries Information Service, Technical and Extension Series*, 143, 8-17.

Rao, S.M.V., Sekhar, R.P.S., and Rao, K.K. (1987). Ecology and management of Indian sea turtles. Final Technical Report, UGC, New Delhi, 1-99.

Rao, S.M.V., Sekhar, R.P.S., and Rao, K.K. (1987). Ecology and management of Indian sea turtles. UGC Project Report, Andhra University, Visakhapatnam.68-87.

Raut, S.K., and Nandi, N.C. (1986). Death linked to the net of the olive ridley turtle *Lepidochelys olivacea*. *Journal of the Natural History Society of Bombay*, 83(1), 223–224.

Schuyler, Q.A., Wilcox, C., Townsend, K.A., Wedemeyer-Strombel, K.R., Balazs, G., van Sebille, E., & Hardesty, B.D. (2016). The risk analysis reveals the existence of global hotspots for the ingestion of marine debris by sea turtles. *Biology of Global Change*, 22(2), 567–576.

Sekhar, R.P.S., and Rao, M.S. (1993). Conservation and management of the endangered olive ridley turtle *Lepidochelys olivacea* (Eschscholtz) along the northern coast of Andhra. *BCG Testudo*, 3(5), 35-53.

Sen, T.K. (1978). Record of a strange assemblage of sea turtle (*Lepidochelys* sp.) shells near the southernmost part of the Digha coast, West Bengal. *Bulletin of the Zoological Survey of India*, 1(3), 317.

Shamblin, B.M., Bolten, A.B., Abreu-Grobois, F.A., Bjorndal, K.A., Cardona, L., Carreras, C., Clusa, M., Monzón-Argüello, C., Nairn, C.J., Nielsen, J.T., & Nel, R. (2014). Geographic patterns of genetic variation in a widely distributed marine vertebrate: new insights into the structure of the loggerhead sea turtle stock from expanded mitochondrial DNA sequences. *PLOS ONE*, 9(1), e85956.

Shanker, K. (1996). Nature watch: Former sailors. *Resonance*, 1(4), 50−57.

Shanker, K. (2003). Thirty years of sea turtle conservation on the Madras coast: a review. *Kachhapa*, 8, 16-19.

Shanker, K. (2015). From soup to superstar: the story of sea turtle conservation along the Indian coast. *Harper Collins*.

Shanker, K. and Andrews, H.V. (1996). Towards an integrated and collaborative marine turtle conservation programme in India. UNEP/CMS-IOSEA Project, 3-17.

Shanker, K. and Choudhury, B. (2008). Sea turtles of the Indian subcontinent. *Conservation and Society*, 6(2), 208.

Shanker, K., & Pilcher, N.J. (2003). Conservation of sea turtles in South and Southeast Asia: a hopeless cause or a reason for hope. *Sea Turtle Information Bulletin*, 100, 43-51.

Sharath, B.K. (2006). Sea turtles along the coast of Karnataka. In K. Shanker and B.C. Choudhury (Eds.), Sea Turtles of the Indian Subcontinent (pp. 288-306).

Simha, S.S., and Choudhury, B.C. (2016). Ecological monitoring of sea turtles on Little Andaman Island. *Indian Ocean Turtle Newsletter*, 24, 23.

Tomillo, P.S., Wallace, B.P., Paladino, F.V., Spotila, J.R., & Genovart, M. (2021). Short-term gain, long-term loss: how a widely used conservation tool could further threaten sea turtles. *Biological preservation*, 261, 109260.

Tripathy, B. (2005). Migratory corridors and foraging habitats of olive ridley turtles along the eastern coast of India. *Coastal Management*, 33(1), 101-114.

Tripathy, B., Choudhury, B.C., & Shanker, K. (2002). Sea turtles of the Lakshadweep Islands, India. *Kashhapa*, 7:3-7.

Tripathy, B., Shanker, K., & Choudhury, B.C. (2006). The situation of sea turtles and their habitats in the Lakshadweep archipelago, India. *Journal of the Natural History Society of Bombay*, 103(1), 33.

Tripathy, B., Shanker, K., & Pandav, B. (2006). Nesting of the green turtle (*Chelonia mydas*) and sightings off Andhra Pradesh. *Sea Turtle Information Bulletin*, 113, 12-13.

Troëng, S. and Chaloupka, M. (2007). Variation in the probability of annual survival of adults and in the intervals of remigration of sea turtles. *Marine Biology*, 151, 1721−1730.

Wallace, B.P., Kot, C.Y., DiMatteo, A.D., Lee, T., Crowder, L.B., & Lewison, R.L. (2013). Impacts of fisheries bycatch on marine turtle populations around the world: towards conservation and research priorities. *Ecosphere*, 4(3), 1−49.