Studies on the green turtle (*Chelonia mydas*) in the Gulf of Mannar Biosphere Reserve, Tamil Nadu, India

P. Kannan

Mandapam Regional Centre of Central Marine Fisheries Research Institute (ICAR), Mandapam Camp – 623 520, Tamil Nadu, India.
Present Address:
Chennai Snake Park, Raj Bhavan (Post) – 600 022, Chennai, Tamil Nadu, India.
Email: perukan@hotmail.com

Introduction

The globally distributed green turtle *Chelonia mydas* is primarily a tropical species, herbivorous in nature, known to feed on variety of marine algae and sea grasses (Russell & Balazs, 2000). In India, the distribution of green turtles includes the coastal waters of the mainland and the Lakshadweep and Andaman & Nicobar Islands (Kar and Bhaskar, 1982). On the Indian mainland, the coast of Saurashtra in Gujarat is a major nesting ground for green turtles (Sunderraj *et al.,* 2002; Kannan and Rajagopalan, 2007). Significant numbers also nest on the Lakshadweep and Andaman & Nicobar Islands. Comparatively significant feeding populations are also found in the Gulf of Mannar Biosphere Reserve on the east coast of India (Kuriyan, 1950; Agastheesapillai and Thiagarajan, 1979; Prabavathy, 1992; Kannan and Rajagopalan, 2004; Bhupathy and Saravanan, 2006). The Gulf of Mannar is severely exploited and the benthic habitat is adversely affected by fishing activities, the collection of curios and by other anthropogenic activities in addition to pollution caused by domestic and industrial waste. Due to unregulated fishing by trawlers and gill nets, many casualties of sea turtles have been reported in the last two decades (Rajagopalan *et al*., 1996; Kannan, 2004; Shanker *et al*., 2004). The shrimp trawl industry seems to capture more sea turtles than any other commercial fishery. Apart from trawling, the gill net is also a source of increasing concern with the increase in incidental catch. This traditional fishing practice has shown a spectacular increase in operation in recent years along the southeastern coast of India and land a large number of non-target species such as sea turtles. In spite of the legal protection given to the sea turtles by the Government of India, the nesting and feeding populations of sea turtles along the Indian coasts seems to have declined in recent years. Very few studies have been carried out on the status of green turtles in the Gulf of Mannar (Prabavathy, 1992; Bhupathy and Saravanan, 2006). With limited information on sea turtle bycatch, it is difficult to formulate conservation measures to mitigate these threats. It is essential for the managers to know when and where the turtle capture occurs, which species are affected, during which season and how many turtles are killed. Hence, the impact of incidental capture, clandestine trade and heavy metal accumulation in the tissues of green and olive ridley turtles were assessed in this investigation.

Study area

The Gulf of Mannar lies between the southern tip of India and the west coast of Sri Lanka between Tuticorin and Rameswaram ($8^0$55'-$9^0$15'N and 78^0-$79^0$16'E). The Gulf of Mannar harbours over 3,600 species of flora and fauna, including 117 hard coral species. However, there are nearly 50 villages in the park, with a total population of around 50,000, resulting in the over harvesting of marine species. Fish catch has declined over the years, as have pearl oysters, gorgonian corals, and acorn worm populations. Local fishermen rely on the reef to feed their families, but destructive fishing methods combined with the stress of pollution and coral mining have resulted in the decline of both nearshore and offshore catches. Several species are also listed as endangered, including sea turtles, marine mammals like dolphins, dugongs, and whales and sea cucumbers. In 1986, a group of 21 islets lying off the Tamil Nadu coast between Tuticorin and Dhanushkodi were declared as the Gulf of Mannar Marine National Park; the region was declared a Biosphere Reserve in 1989. The Gulf of Mannar Biosphere

Reserve covers an area of 10,500 sq. km., with a larger buffer area that includes the adjoining coastline. The islets and coastal buffer zone encompass beaches and estuaries, while the marine ecosystems include algal communities, sea grass communities, coral reefs, salt marshes and mangroves. The area under the Indian Exclusive Economic Zone (EEZ) is about 15,000 sq. km., and commercial fishing takes place in about 5,500 sq. km. (up to 50 m. in depth).

Methods

The study was conducted during December 1998, March 1999, July 1999 and December 2000. Fish landing centres such as Tuticorin, Kilakarai and Mandapam were observed from six a.m. to 12.00 p.m. and from 15.00 p.m. to 18.00 p.m. Data about incidentally catch – sea turtle species, locations where the turtles were caught, number of turtles landed, craft and gear and details of fishing were collected. The landed turtles were identified and morphometric measurements such as Curved Carapace Length (CCL) and Width (CCW), plastron length and width were also collected (Bolten, 1999). During the study period, observations were carried out for 48 days. Observations on the trade of sea turtles were also made in these areas. Fish markets around these areas were surveyed every Sunday, which is the usual market day. During each visit, information on the number of turtles found in the market, and species, size, and sex of each individual were collected. Sex of the turtles was determined by using external characteristics. Males were characterised by the presence of a long and muscular prehensile tail, which extended well beyond the carapace in adult males and the strongly curved claws on the fore-flippers. Females had a shorter tail, which extended only slightly beyond the carapace with a small and straight claw on the fore-flippers. Individuals which had not developed secondary sexual characters were considered as sub-adults. All linear measurements were taken to the nearest 0.5 cm.

Tissue samples of muscle, liver, heart and kidney of green and olive ridley turtles, which were caught incidentally and sold in the markets were collected. The collected tissue samples were stored in polythene bags and kept at four degrees centigrade in the laboratory. During analysis, five grams of tissue was acid digested to a transparent solution with a mixture of nitric, perchloric and sulphuric acids in the proportion of 3:1 (Walting, 1981). The digested solution was filtered through a millipore filter and again diluted with deionised water. The samples were made up to 25 ml. with metal free distilled water. Digested and diluted samples were then subjected to metal quantification. Zinc, cadmium, copper and lead were directly determined by inductively coupled plasma spectrometer (model ICA-AES; Model Jobin Yvon-J7 24) after calibrating the instrument with suitable blank and a series of known standards for zinc, copper, cadmium and lead. The accuracy of the instrument (detection limits was five ng) was verified and equated by analysing the reference standards. Mercury analyser was used to determine mercury levels (Model ECIL MA 5800D1). All metal concentrations are expressed in μg/g dry tissue weight.

Results

Captures of the green and olive ridley turtles

A total of 35 green turtles and 15 olive ridleys were recorded as incidental catch in Tuticorin and Mandapam areas during the study period. Of these, 10.7% were caught by trawl nets, 51.8% by drift gill nets, 3.6% by hook and line and 33.9% by other fishing gear.

Clandestine trade

In the Tuticorin fish market, a total of 33 turtles were recorded during the study period. Green turtles constituted 63.6% of the total, which included seven males (33.3%), 11 females (52.3%) and 3 sub-adults (14.4%). A total of 12 olive ridleys (36.4%) were traded of which 58.4% were females, 25% males and 16.6% were sub-adults. The CCL of green turtles ranged from 60-104 cm and the weight from 26-88 kg. The CCL of olive ridleys ranged from 52-71.5 cm and weight from 30-46 kg.

In the Tuticorin fish market, live green turtles were priced at Rs. 250-350 (US$ six-nine) and olive ridleys at Rs. 175-300 (US$ four-eight). The head, flippers and eggs were also sold. The price of meat

varied according to the turtle species and its availability in the market. Turtle trade was under cover due to vigilance by the Wildlife Department since this area falls under Gulf of Mannar Biosphere Reserve. Consumers preferred turtle meat, as it is cheaper than goat and chicken. There was also a belief among coastal communities that consuming turtle meat gives more energy than other meat.

Heavy metal accumulation in sea turtles

The overall accumulation of zinc in olive ridleys ranged from 3.53 to 15.2 μg/g (mean = 8.08±3.69 μg/g) and from 1.53 to 40.4 μg/g (mean=11.5 ±11.07 μg/g) in green turtles. The accumulation of lead varied from BDL (Below Detectable Limit) to 0.226 μg/g (mean + 0,052±0.083 μg/g) in olive ridleys and from BDL to 1.39 μg/g (mean=0.273 ±0.481 μg/g) in green turtles. Very low concentrations of lead were recorded in both the species and the concentration was below the detectable limit in most of the tissues. The concentration of cadmium in olive ridleys ranged from 0.056 to 29.1 μg/g (mean=6.97 ±8.79 μg/g) and from 0.011 to 37.5 μg/g (mean=5.54±10.56 μg/g) in green turtles. In olive ridleys, copper ranged from 0.241 to 3.18 μg/g (mean= 0.81±0.776 μg/g) and from 0.06 to 17 μg/g (mean 3.761±5.481 μg/g) in green turtles. Mercury levels ranged from BDL to 130 μg/g (mean=26.25±38.81μg/g) in olive ridleys, and from BDL to 50 μg/g (mean=4.167 ±14.43 μg/g) in green turtles.

Discussion

Gill nets seem to be the major threat for the sea turtles in this region. Large-scale conversion of traditional craft into mechanised boats as well as the proliferation and wide use of gill nets prevent gravid females from emerging onto nesting sites. The fishing activities in this area were very intense throughout the year and hence the probability of the nesting and feeding adults encountering in fishing gear was high, resulting in high incidental catch. The gill nets are soaked either in the evening and hauled the following morning or soaked in the morning and hauled in the evening. The live turtles entangled in the net are also brought to the shore for sale. The long duration for which the nets are soaked in the sea gives ample time for the turtles to get entangled. Hook and line is also operated throughout the year since it requires minimum capital expenditure. Despite the wide belief that trawls cause more deaths of sea turtles than that of any other gear type, from the present study it can be seen that the mortality of sea turtles by drift gill nets is of serious concern. Gill nets are categorised as potentially dangerous since their use is widespread and mortality rates of the entangled turtles are generally quite higher than that of any other type of fishing gears (Rajagopalan *et al*., 1996; Kannan, 2004). Entanglement of hatchlings, sub-adults and adults in gill nets in near shore coastal waters was more when the mesh size was small. In view of the regular consumption of turtle meat in these areas, the present study on the estimation of heavy metals in the tissues of green and olive ridley turtles is of relevance. Awareness needs to be created among the public on the consumption of turtle meat with high levels of heavy metals.

Incidental take of sea turtles in gill nets can be avoided by setting nets in areas where turtles are unlikely to be present, limiting the length of the nets, reducing the soak time of nets and using mesh sizes that are less likely to take turtles. These factors have to be given due consideration by the maritime state while formulating regulatory measures on fishing. Further, awareness programmes are required on the importance of sea turtles, including information for the proper release of incidentally caught turtles and restricted immersion time during the nesting season.

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