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Turtle excluder device (TED) in trawl nets: applicability in Indian trawl fishery

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ABSTRACT

Turtle fishing was banned in India from 1977 as turtles were declared as protected animals under Schedule I of the Indian Wildlife (protection) Act 1972 as per the amendments made to the schedule in September 1977. Similar restrictions were observed in many other countries. In spite of these restrictions, there is illegal fishing for turtles in some countries. Apart from these illegal activities, there is considerable amount of incidental mortality of turtles due to fishing activities like trawling and gill netting. India, Australia and the USA are the major contributors to the mortality of turtles due to fishing activities, particularly the prawn fishing operations. In 1980, a unique separator trawl design called the Turtle Excluder Device (TED) was developed by the National Marine Fisheries Service (NMFS) of USA to reduce the incidental capture of endangered sea turtles by shrimp trawls. The NMFS developed a number of TED designs to improve their functioning. From 1993 shrimp season onwards, USA implemented revised federal TED regulations which are more effective in reducing turtle mortality. India also started testing different types of imported TEDs in view of the US embargo on imports from countries not implementing TEDs. Central Institute of Fisheries Technology (CIFT), Fishery Survey of India (FSI) and Central Institute of Fisheries Navigation and Engineering Training (CIFNET) conducted experiments with imported TEDs. These experiments could not impress the fishermen as there are no comparable data from the traditional trawl nets and trawl nets with TEDs simultaneously. Field trials of the CIFT-TED have been carried out off Cochin, Visakhapatnam and Paradeep. CIFT-TED is now being popularized in maritime states in collaboration with MPEDA and respective state fisheries departments. In spite of all the assurances of the government agencies in India, the USA, Australia and other shrimp trawling countries, fishermen still feel that there is considerable escapement of shrimp with TEDs attached trawl nets which is the major bottleneck affecting implementation of TEDs in India and elsewhere.

Keywords: Conservation, Sea turtles, Trawl fishery, Turtle excluder device

Introduction

Five species of marine turtles *viz*., olive ridley turtle (*Lepidochelys olivacea*), loggerhead turtle (*Caretta caretta)*, leather back turtle (*Dermochelys coriacea)*, hawksbill turtle (*Eretmochelys imbricata*) and green turtle (*Chelonia mydas)* are known to inhabit the Indian coastal waters. The most common species in Indian waters is olive ridley, which is also believed to be the most abundant marine turtle in the world. It is known for the mass reproductive aggregations, popularly known as *arribada* (means "arrival by sea" in Spanish). The largest known nesting aggregations of olive ridleys in the world are in Gahirmatha, Orissa, along the north-east coast of India. The rookeries at Devi and Rushikulya, to the south of Gahirmatha are comparatively smaller.

Traditional fisheries for these turtles exist along the coastal waters of Tamil Nadu, Orissa and West Bengal. The poorer segments of the population, consume the eggs and meat of sea turtles all over the country. An FAO study in 1974 showed that the legal trade of olive ridley eggs went up to an astronomic one-and-a-half million eggs in the 1970s. The Government of Orissa banned the trade of turtle eggs in 1975. Adult olive ridleys were also traded during the nesting season from Orissa to Calcutta. In the 1970s and 1980s, an estimated 50,000 to 80,000 olive ridleys, both male and female, were sold illegally.

All these activities of fishing and trading in turtle products were banned from 1977 as turtles were declared as protected animals under Schedule I of the Indian Wildlife (protection) Act 1972 as per the amendments made to the schedule in September 1977. The Code of Conduct for Responsible Fisheries (FAO, 1995), which gives guidelines for sustainable development of fisheries, prescribes the need for protecting endangered species such as sea turtles. As a signatory to the Code, India is obliged to conduct research, develop appropriate devices and practices, and implement regulatory measures for the protection of endangered turtles. In India, 65,000 ha of Orissa coast was declared as wildlife sanctuary in 1975 (Rajagopalan, 2000). In spite of all these restrictions, trade in turtle products has been going on along

the east coast. Apart from these illegal activities, there is considerable amount of incidental mortality of turtles due to fishing activities like trawling and gill netting. The incidental death of turtles during trawling operations is said to be high off the east coast, particularly off Orissa, Andhra Pradesh and Tamil Nadu, where 75,000 deaths were reported during 1990-2002. Annually, 15,000 to 20,000 incidental turtle deaths are reported off the Indian coast.

The stranding figures for olive ridleys in Gahirmatha for 1982-83 were estimated at 7,500 (Silas *et al*., 1983). The main cause of death is believed to be drowning in bottom trawls as well as entanglement in gillnets. The mortality for the rest of India put together for all turtle species was 3,000, 2,600 and 1,900 for 1997, 1998 and 1999, respectively. About 99% of mortality was along the east coast of India. The mortality varied widely in different years and possible reasons for these variations are not yet established.

Turtle excluder device (TED)

The most important human cause of sea turtle mortality is due to incidental capture in fishing activities like trawling. Modifications were attempted on trawl nets to reduce the incidence of turtles leading to the idea of Trawling efficiency device or Turtle excluder device (TED). In 1980, a unique separator trawl design called the Turtle excluder device (TED) was developed by the National Marine Fisheries Service (NMFS) of USA to reduce the incidental capture of endangered sea turtles by shrimp trawls. The NMFS developed a number of TED designs to improve their functioning. The NMFS promulgated regulations which required the use of TEDs on offshore shrimp vessels which came into effect in June 1987, depending upon vessel size, geographic location, and fishing area. From 1993 shrimp season onwards, USA implemented revised federal TED regulations which are more effective in reducing turtle mortality.

TEDs can be separated into two different groups, active and passive, depending on how by-catch is excluded. Active TEDs use fish behaviour to separate target from non-target animals. Passive TEDs use physical sorting method to separate target from non-target animals. TEDs usually include a metal grid, much like a storm-water-drain grate (hard TEDs), or a panel of large mesh webbing (soft TEDs) that is installed at an angle between 40° and 60°. This creates a physical barrier that allows prawns and other animals smaller than the bar spacing of a hard TED or mesh webbing of a soft TED to pass through the TED into the cod end. Sea turtles and other large animals slide along the TED to an exit hole cut at the top (top opening TED) or bottom of the TED (bottom opening TED). The exit hole may be partially covered by a flap of webbing to reduce the possibility of losing prawns. TEDs come in many designs, no single design of TED is suitable for all fishing conditions. The most common is the NAFTED which consists of two oblong end hoops holding a diagonal deflector grid that are sewn into the trawl net ahead of the cod end. The device has a top-opening door. Hard TEDs are more popular than soft TEDs as soft TEDs are difficult to install properly in trawls under changing trawling conditions. The performance of soft TEDs is also inferior to hard TEDs as loss of shrimp is comparatively higher in their operations.

Sea turtle strandings and TED regulations

Caillouet Jr. *et al*. (1996) conducted experiments on the effect of TED regulations along the north-western Gulf of Mexico by comparing the data prior to TED implementation (1986-1989) and the TED regulated period (1990-1993). Significant positive correlations were detected between the log-transformed stranding rates and fishing intensities for shrimping landward of the 20 fathom (36.6 m) contour in 1990-93. TED regulations did not result in diminishing or eliminating the statistical relationship between sea turtle stranding rates and shrimp fishing intensities in the north-western Gulf.

In spite of all the serious attempts for the protection of turtles by implementing TEDs, strandings of turtles continued on a large scale along the beaches of Gulf of Mexico even after 1996. It was found that annually, a large proportion of stranded loggerhead turtles (33-47%) and a small portion of stranded green turtles (1-7%) are too large to fit through the required minimum size TED openings (Epperly and Teas, 2002). It is evident that to decrease the mortality on large turtles caused by trawling, the opening dimensions of TEDs need to be larger than the current minimum requirements. Based on these results the NMFS proposed the use of increased TED openings to provide escapement of all sizes of turtles. However, an increase in the TED openings will lead to proportionate increase in the escape of shrimp and big sized fish from the nets.

Escapement of shrimp in nets with TEDs

Although Seidel and Oravetz (1989) claim that the reduction in the shrimp catch is not considerable, the industry in the Gulf coast of USA was not ready to accept it. Observers from the NMFS collected information on catch rates of shrimp aboard commercial shrimp vessels during March 1988 - August 1990 (Renaud *et al*., 1993). Comparisons were made between nets equipped with TEDs and standard shrimp nets. Three types of TEDs were tested: Georgia TEDs with and without accelerator funnels and Super Shooter TEDs with funnels. Fishing areas, time of day and duration of tows were controlled by the captain of each vessel to simulate commercial conditions. A statistically significant ($p<0.05$) mean loss in shrimp

catch-per-unit-effort (CPUE) of 0.24 lb h^{-1} (3.6%) and 0.93 lb h^{-1} (13.6%) was exhibited by nets equipped with Georgia TEDs with and without funnels respectively, compared with standard nets. There was no significant difference in shrimp CPUE between standard nets (11.41 lb h^{-1}) and nets equipped with Super Shooter TEDs with a funnel (11.25 lb h^{-1}). Although Super Shooter TEDs exhibited the lowest reduction in shrimp catches, it accounted for more problems during trawling than the other TEDs.

Broadhurst (2000) summarized the results of some experiments conducted in different countries showing the effect on the by-catch reduction and shrimp catch loss (Table 1).

Almost all the TEDS were very effective in releasing the turtles, but they varied in reducing the other by-catch and loss of shrimp catch. Experiments with three types of NMFS TEDs off Mississippi coast although filtered out the turtles and other by-catch by about 51-53%, showed a variation in the shrimp catch. It varied from 5% reduction to 3% increase in the shrimp catch (Watson *et al*., 1986). More extensive investigations were conducted off Georgia-Florida coast with a number of TED designs. They are NMFS TED, Louisiana TED, Georgia TED and Texas TED. The results indicated a 97% escapement of turtles, 22-44% reduction in the other by-catch while there is 22% reduction of shrimp catch to about 4% increase (Christian and Harrington, 1987). Experiments with Morrison soft TED showed an 8% reduction in the shrimp catch and 24% by-catch reduction (Kendall, 1990). Similar experiments conducted with TEDs and other by-catch reduction devices all along the south-eastern USA showed reduction of 59% by-catch and 12% shrimp catch reduction to 8% increase (Harrington and Vendetti, 1995).

Experiments conducted in New South Wales and Queensland, Australia with different TEDs gave varying results. Application of Morrison soft TED in Quensland showed 32% reduction in by-catch and 29% reduction in prawn catch (Robins-Troeger, 1994). Experiments with Aus TED along the Queensland coast showed 11-59% by-catch reduction and 9% reduction in the prawn catch to 3% increase (Robins-Troeger *et al.*, 1995). It is evident from all these studies that there is considerable escapement of shrimp from the trawl nets attached with TEDs. Another

Table 1. Summary of the results of selected experiments conducted in different countries showing the effect of TED on the by-catch reduction and shrimp catch loss in trawl nets

Location of fishery	Name of TED	Effect on by-catch	Effect on prawn catch	References
Papua New Guinea	TED	Fish by-catch 38% reduction	20% reduction	Matsuoka and Kan, 1991
Southeastern USA	Hard and soft TEDs and fish eyes	Fish by-catch 11-60% reduction	Not specified	Harrington, 1992
Mississippi, USA	NMFS TEDs (3 designs)	Fish by-catch 51-53% reduction	*P. aztecus* 5% reduction to 3% increase	Watson *et al.,* 1986
Florida and	NMFS TED, LA TED,	Fish by-catch	*P. setiferus* 22%	Christian and
Georgia, USA	GA TED and TX TED	22-44% reduction	reduction to 4% increase	Harrington, 1987
Florida, USA	Morrison soft TED	Total by-catch 24% reduction	*Penaeus* spp. 12% reduction to 8% increase	Kendall, 1990
Georgia, USA	Parrish TED	Significant reduction	Significant reduction and increase	Rulifson *et al.*, 1992
Southeastern USA	TEDs, fish eyes and	59% reduction	12% reduction to	Harrington and
	Kiffe BRD		8% increase	Vendetti, 1995
Indonesia	BED similar design of NMFS TED	58-64% reduction	27% reduction	Naamin and Sujastani, 1984
NSW, Australia	Morrison soft TED	32% reduction	1% reduction	Andrew *et al.*, 1993
QLD, Australia	Morrison soft TED	32% reduction	29% reduction	Robins-Troeger, 1994
QLD, Australia	AusTED	11-59% reduction	9% reduction to 3% increase	Robins-Troeger *et al.*, 1995
QLD, Australia	AusTED II	15-49% reduction	61% reduction to 27% increase	Robins and McGilvray, 1999
Northern Australia	AusTED, NAFTED	0-39% reduction	50% reduction to 20% increase	Brewer *et al*., 1998

Source: Broadhurst, 2000

interesting feature of all these experiments either in the USA or in Australia is that most of the fish species excluded from nets with TEDs are of high value in the market.

US embargo on import of shrimp

The NMFS promulgated regulations which required the use of TEDs on offshore shrimp vessels, intermittently beginning in June 1987 depending upon vessel size, geographic location and fishing areas. These regulations were modified from time to time and gradually almost all the south-east and gulf states (North Carolina to Texas) were brought under this regulation by 1994 and at all times of the year and by all the shrimp trawlers either inshore or offshore (Epperly and Teas, 2002). Following complaints by American shrimp trawlers that the TEDs were adding costs and causing shrimp losses, which put them at a competitive disadvantage with foreign shrimpers, the American Congress enacted on an embargo programme. Under this embargo, certain shrimp imports are prohibited unless the harvesting nation is 'certified' as having either a 'comparable' regulatory programme to that in the USA, or a shrimping programme which does not pose a threat to turtles.

While interpretations and enforcement of the various measures differed, the US officials, the industry and animal protection groups continue to battle in court, for a precise and fair settlement of the issue. A conflict over the introduction and subsequent regulation of TEDs occurred because the 'problem' and the 'solution' were perceived differently by the various stakeholders. Attempts to negotiate and mediate the conflict broke down, resulting in litigation against the U.S. government by conservationists and shrimpers.

World Trade Organization ruling

The US government's insistence on the application of TED became one of the most bitterly fought regulations in the fishery trade. Mexico and 13 other Central and South American nations were the first to represent to the World Trade Organisation (WTO) followed by the four Asian countries: Thailand, India, Malaysia and Pakistan, challenging the US decision to ban imports from countries without TED application similar to the US methods. In spite of representations by the US, WTO did not agree with the US requirements.

US Section 609 on Indian shrimp exports

The US requirement for certification under Section 609 shocked the Indian fishing industry. Although a 1994 study done by the Ministry of Commerce, Government of India for United Nations Conference on Trade and Development (Bharucha, 1994) had estimated a loss of U.S. $23 million, if TEDs were to be made mandatory to Indian shrimp trawlers, it proved to be wrong. Since 1996, when Section 609 was made applicable to India, the US, after Japan, continued to be the second largest market for the Indian frozen shrimp as in the past. In fact the quantum of exports to US increased from 16,000 t in 1996-97 to about 20,000 t in 1997-98 and reduced to 18,000 t in 1998-99. The value increased from U.S. $94 million in 1996-97 to US $129 million in 1997-98 and declined to U.S. $111 million in 1998-99. The fall in quantity and value of shrimp exports to the United States in 1998-99 reflected the general trend in Indian shrimp exports to Japan and the EU. The impact of Section 609 was not significant even on exports of shrimp from Orissa to the US, although shrimp caught in bottom trawls constitute about 50 % of the exports from Orissa. It should be borne in mind that most of the shrimp exports to US from India in recent years are by production from culture operations.

Expert Scientific Panel on TEDs

In view of the US ban on import of shrimps from countries not having compliance of the use of TEDs in shrimp trawlers, the Marine Products Export Development Authority (MPEDA), Cochin, constituted a Committee of Experts to assess the effect of installation of TEDs in shrimp trawl nets. The Committee recommended that an Expert Scientific Panel (ESP) be set up to conduct a detailed study. The Government of India constituted the Expert Scientific Panel (ESP) on 10 July 1998. The Fisheries Development Commissioner functioned as the Member-Convener of the Panel with the Heads of Central Marine Fisheries Research Institute (CMFRI), Cochin; the Fishery Survey of India (FSI), Mumbai; the Central Institute of Fisheries Technology (CIFT), Cochin; the Central Institute of Fisheries Nautical and Engineering Training (CIFNET), Cochin; and a representative of the Wildlife Institute of India (WII), Dehradun as the other members. The terms of reference of the panel covered (i) distribution of sea turtle species in Indian waters, (ii) incidental catch of sea turtles by trawl nets, gillnets *etc*., (iii) study on the mortality of sea turtles due to factors other than fishing, (iv) trials/ demonstrations on the efficacy of established TED models, (v) loss of catch through the use of TEDs in trawl nets (cost-benefit analysis), and (vi) management measures for conservation of marine turtle species along the coastline of India.

A very important recommendation of the Expert Scientific Panel was the mandatory implementation of turtle excluder devices (TEDs) in all mechanised trawlers operating in areas of mass nesting where incidental mortalities have been recorded, in order to bring down incidental catch and mortality of sea turtles. The areas proposed to be brought under control included (i) entire coast of Orissa during the period from November to April, (ii) coast of Midnapore District in West Bengal during

December-March, (iii) coast of Srikakulam, Vizianagaram, Visakhapatnam and East Godavari districts in Andhra Pradesh during November-April, (iv) coast of Nagapattinam, Turticorin, Ramanathapuram and Tirunelveli districts in Tamil Nadu during December-April, (v) coast of Pondicherry, excluding areas off the coast of Mahe, Karaikal and Yanam, during December-April, and (vi) coast of Quilon and Trivandrum districts in Kerala, during December-March.

Experiments on TEDs in India

In view of the Expert Scientific Panel recommendation to conduct a detailed study on the distribution of sea turtles, their incidental capture in fishing nets and the use of TEDs in trawl nets, India also started testing different types of imported TEDs. As envisaged under the mandate, CIFT, CIFNET and FSI conducted experiments with the support of MPEDA and with the help of the gear technologists from the NMFS (USA).

Experiments with Super Shooter TED

Experiments were conducted by CIFT in 1995 with Super Shooter TED of 1030 x 850 mm attached to a 44 m headline shrimp trawl along the Andhra-Orissa coast on *Matsya Shikari* of FSI (Ramalingam and Pandian, 2002). In the five operations conducted in 45-55 m depth range, a total of 676 kg of fish was landed, of which 469 kg was retained in the main cod end showing an escapement of 30.8% of finfish. Catch retained in the main cod end included *Priacanthus* spp. (42.9%), carangids (15.2%), *Saurida* spp. (13.1%), *Parastromateus niger* (7.3%), *Leiognathus* spp. (6.4%), *Arius* spp. (4.1%) and others (1.3%). The excluded catch contained *Priacanthus* spp. (48.3%), *Leiognathus* spp. 12.1%), *P. niger* (10.1%), rays (5.8%), *Arius* spp. (4.8%), sciaenids (3.9%), goatfish (2.4%), carangids (1.9%), *Saurida* spp. (1.9%), perches (1.5%) and others (7.3%). Turtles were retained neither in the main cod end nor in the exit cod end. It is surprising to note that prawns were not observed in the catches of neither the main cod end nor the exit cod end.

As a part of this study, CIFNET Visakhapatnam Unit has taken up experimentation on the application of TEDs (Kirubakaran *et al.*, 2002). The study was aimed at finding out: 1) suitability of TEDs for exclusion of turtles, 2) proportion of escape of fish and prawns and 3) operational problems associated with the TEDs in trawl nets. Out of TED designs available from the USA, the Super Shooter-Georgia type with a single oval frame measuring 41" in height and 33" in width (Mitchell *et al*., 1995) was selected for experimentation on the training vessel *M.V. Skipper III*.

The experiment was conducted during October 1999 - January 2000 along the Andhra coast in the depth range of 36-50 m. Of the total hauls, 14 hauls (19.25 h) were made with the exit cod end at the lower side and 30 hauls (53.35 h) with the exit cod end on the upper side. A total catch of 1,884 kg was retained in the normal cod end and 819 kg in the lower exit cod end with an escapement of 43.4%. Two numbers of turtles encountered were found in the exit cod end showing 100% escapement of turtles along with other catch. The item-wise escapement was: prawns (35.3%), cephalopods (52.5%), pelagic fishes (50.6%), demersal fishes (40.7%) and trash fish (83.6%). Of the 30 hauls with the upper exit, a total of 4030 kg was caught of which 551 kg was recorded in the exit cod end with an escapement of 13.7%. The excluded catch in the outer cod end was composed of prawns (0.5%), cephalopods (8.4%), pelagic fishes (43.3%), demersal fishes (23.9%) and trash fish (11.3%). The pelagic fishes collected in the escapement cod end are pomfrets, seer fishes, perches, barracuda, mackerel, horse mackerel *etc*. The demersal fish component comprised of ribbonfish, sciaenids, nemipterids, upenoids, priacanthids, lizardfish, *etc*. Most of these collected in the escapement cod end were large sized ones demanding good price in the market. Of the 13 turtles encountered during these operations, all were filtered out into the exit cod end giving 100% escapement of turtles. Although TEDs are 100% effective in excluding turtles, cost analysis of escapement indicated that there is considerable loss in fishing with TED nets as most of the excluded items are marketable and form a major part of the earnings of the operators.

Experiments with CIFT- TED

Central Institute of Fisheries Technology became the nodal organization to develop TED designs suitable to Indian conditions under two ICAR funded projects entitled, *Performance evaluation of suitable selective devices for elimination of by-catch (BRD)* and Turtles *(TED) in shrimp trawling*, and *Development studies on responsible trawl systems* with focus on the design, fabrication, field-testing of TEDs, and training of trawler fishermen and other stake holders in their fabrication and use (Dawson and Boopendranath, 2001, 2002; Boopendranath *et al*., 2005, 2010).

After a lot of experimentation, CIFT developed a 1000 x 800 mm oval-grid TED, CIFT-TED for use by small mechanized trawlers which predominate in Indian waters (Dawson and Boopendranath, 2001; 2002). Five vertical grid bars of 8 mm diameter steel rods are welded inside the frame with a spacing of 142 mm. The TED frame is fixed at an angle of 45° inside the TED extension cylinder made of polyethyelene netting. TED extension is provided with an exit of standard dimensions on the upper side with a cover or flap. An accelerator funnel is incorporated in the design for reducing the shrimp loss. Experiments with

CIFT-TED were first conducted off Kochi from the research vessel *MFB Matsyakumari* (17.5 m) using a 32 m headline demersal trawl. TED designs with dimensions of 1000 x 800 mm and 900 x 800 mm and a deflector with a bar spacing of 144 mm were used for these operations. It was observed that the overall escapement was 2.4% in 39 operations. In the catch retained (693.6 kg) in the main cod end, prawns formed about 15.4% while they formed about 6.1% in the catch of excluder cod end (17.3 kg). However, the catch recorded was very low (19.2 kg per haul) indicating an overall disadvantage of fitting a TED in the trawl net.

When this device was tried out at Visakhapatnam, 90% of the turtles were able to escape. The results of 19 field trials conducted along the east coast in 2001 yielded a total catch of 544.3 kg. The mean catch rate in operation without TED was estimated to be 27.3 kg per haul while the mean catch rate in operation with a CIFT-TED installed trawl was 26.4 kg indicating a loss of 3.3% catch. Out of total 26.8 kg of shrimp landed only 0.5% was observed to have been excluded after the installation of TED. All the four turtles entered the net were excluded through the TED. On invitation of Orissa Fisheries Directorate, CIFT scientists demonstrated the fabrication and operation of TED to local fishermen, net makers, entrepreneurs, environmentalists and others (Boopendranath *et al.*, 2005). Trawler fishermen expressed concern about the large-scale loss of shrimp and fish because of TEDs. The new devices with exit cover cod end, reduced the loss of shrimp to 0.62 % and overall loss of total catch to 1.2 %. All the olive ridley turtles which entered the nets during the operations, off Agaranasi and Paradeep, escaped.

All these experiments conducted by the government agencies could not impress the fishermen owing to the following reasons:

- the catch per unit of effort reported for trawl nets with TEDs is too low when compared to the commercial operations;
- the experiments were not conducted simultaneously in traditional trawl nets and trawl nets with TEDs;
- most of the excluded fishes are of big size demanding very high price;
- the operations are cumbersome taking away lot of fishing time

Popularisation of TEDs

Before the use of TEDs, shrimp trawlers were killing around 11,000 sea turtles in the Gulf of Mexico and along the south Atlantic coast annually. Now, with the use of TEDs and an effective conservation strategy, there is hope of saving the turtle population for posterity. The NMFS was conducting a technology transfer program aimed at educating shrimp fishermen and demonstrating to them the benefits that can be realized using the TED. This promotional activity started in 1981 has introduced TEDs to shrimp fishermen in all shrimping states on the Atlantic and Gulf of Mexico coasts of the U.S and in 1983 had even begun distribution of TEDs free of cost. In spite of all the promotional activity, implementation of TEDs took a long time in the US.

Australia is another country strictly implementing the TEDs in trawl nets. In Australia, the name Trawling efficiency device for TEDs is used instead of Turtle excluder device to make it popular among fishermen. Australian researchers are trying to show that using TEDs is more profitable because of less accumulation of by-catch in the nets and it makes sorting the catch easier. Initially TEDs have been made compulsory in the following trawl fisheries of Australia:

- Queensland east coast trawl fishery in day time and inshore trawling (from January, 2000).
- Northern prawn fishery (Gulf of Carpentaria, Arnhem land coast and Joseph Bonaparte Gulf) (from April, 2000).
- Torres Strait prawn fishery (from March, 2001).
- Queensland east coast trawl fishery - all areas except river beam trawl (from January, 2002).

In Gahirmatha, which is one of the world's biggest nesting sites for the olive ridley, environmentalists and the Wildlife Institute of India have been pleading for the use of TEDs for some years. Unfortunately, the ecological concerns voiced in India, found support in the US which threatened to stop shrimp imports from India unless the fishing boats used TEDs.

Popularization of TEDs has been taken up by a number of government and non-government agencies. Initially two schemes were taken up for the distribution of TEDs in Orissa. One was an externally funded programme started in 1999 for US $100,000 to distribute 1,000 TEDs (Frazier and Tiwari, 1999) in Orissa alone. The second, based on the recommendations of the Expert Scientific Panel, was a national project (four maritime states on the east coast and one on the west coast) to fabricate and distribute TEDs and to train fishermen in its use. In the first phase, 600 TEDs (with a budget of U.S. $ 45,000) were distributed by the MPEDA, under the Ministry of Commerce, Government of India. Many other schemes came up for funding TED implementation. The trawler operators are reluctant to use TED because of its potential impact on their shrimp catch. Mainly three reasons were attributed to this reluctance. First, 30% of their catch is feared to get lost if TEDs are to be

fitted to their trawls. The fish would escape through the exit hole provided for turtles. It is further feared that turtles or ray fish, if caught in the grill of TEDs, might block the path of fish to the cod end. Second, use of TEDs would increase the drag on the net during trawling, and this would add to their fuel costs, which are already on the higher side due to price hike on diesel from time to time. And third, TEDs can destabilize the trawl gear in inclement weather conditions. Dr. Hajmadi, a turtle biologist attached to the Utkal University, Orissa, is of the view that TEDs are impractical in Orissa because of the massive number of olive ridleys that aggregate during the nesting season. She thinks TEDs could be of some use only for a smaller population size.

In a unique measure to save sea turtles from being entangled in fishing nets, and to check the increasing death rate of the species in the Gulf region along the Tamil Nadu coast, the Gulf of Mannar Biosphere Reserve Trust, a statutory body of the state government has embarked upon distribution of TEDs to fishermen (Anon, 2007). The devices would be distributed by the Trust to the fishermen of mechanized boats in the Gulf region, under the 'Conservation and sustainable use of Gulf of Mannar Biosphere Reserve' scheme. It was planned to distribute about 500 devices to the fishermen in the first phase and in the second phase all the mechanized boats of the region would be covered. The devices would be given to the fishermen on a subsidized rate.

Contradicting views

Although there is a hue and cry about the mortality of turtles due to fishing activities, some of the studies conducted on various turtle populations indicate no reduction in the turtle populations. For instance, studies conducted on olive ridleys contradict various popular notions. With regard to the nesting population of olive ridley, even methodologies to count its nesting during an *arribada* are quite complex and a reliable estimate would require the supervision of competent biologists. This aspect is highlighted in the Status Review of Sea Turtles listed under the Endangered Species Act of 1973 (Plotkin, 1995). There is also a need to better understand factors contributing to olive ridley mortality other than destructive coastal zone activities. For a species that undertakes transboundary migration, all factors that have an impact on its survival rate have to be carefully studied. The Indian Ocean has some of the busiest oil tanker routes in the world and the impact of oil pollution on these marine reptiles have to be looked into. It is also difficult to conclude if a mortality rate, on an average, of one turtle per 15 nesting ones is indeed of a higher magnitude. According to Mr. Guinea, a turtle expert consulted by the WTO panel on the shrimp-turtle dispute, "an annual mortality of 5,000 from fish trawls and set nets from a nesting population of 600,000 with a recruitment of 85,000 appears relatively minor" (WTO, 1998). Although the recruitment figures for olive ridleys in India are not available, perhaps what is most significant is that there does not seem to be any downward trend in the nesting population of olive ridleys in spite of the trade in olive ridley eggs and live animals for the past fifty years.

Unlike other sea turtles, olive ridleys have an annual nesting cycle and they migrate into the Indian coastal waters by November. The *arribada* often takes place twice a year, early January and early April (Das, 1998). According to turtle biologists, eggs that hatch in winter are predominantly male and those that hatch during the warmer temperature are mainly female hatchlings. According to the Expert Scientific Panel (Government of India, 2000), between 1976 and 1999, the highest number of nestings was in 1991 (610,000), and the lowest, in 1976 and 1977 (150,000 each). According to a Reuters dispatch dated 19 March 2001, over 1,000,000 turtles have nested in 2001, the highest recorded number in history. There were also years when no mass nesting took place. From the data on olive ridley nestings from 1976 to 1999, it is worth noting that there is no declining trend that can be observed in its population.

Conservation measures

Various governmental as well as non-governmental organizations and researchers highlighted the importance of conservation of the sea turtles (Silas *et al*., 1983; Pandav *et al*., 1998; Rajagopalan, 2000; Rajagopalan and Vijayakumaran, 2001; Vijayakumaran, 1996, 2005; Boopendranath *et al*., 2005, 2010). Special mention should be made on the efforts of *Operation Kachhapa*, a collaborative effort between the Orissa Forest Department and NGOs (Wildlife Protection Society of India, New Delhi and Wildlife Society of Orissa, Cuttack) in conserving the turtles. Apart from the mortality of turtles due to fishing there are many factors contributing to the mortality of turtles. The Visakha Society for Prevention of Cruelty to Animals (VSPCA) has highlighted various activities interfering with the nesting activities of the turtles along the Visakhapatnam coast such as: pollution from industries along the coast, sand mining in the beaches, entertainment on beaches and predation by stray dogs on the beach. While forest officials claim fishing as the major factor for the mortality of turtles, fisheries officials claim that casuarina plantations along the coast reducing the nesting areas are the major source of concern.

The various agencies concerned, such as the departments of fisheries, forest and wildlife, enforcing the conservation measures found it extremely difficult to perform their duties because of various legal, surveillance and monetary problems. In view of these issues it is better not to give too much importance to the implementation of TEDs.

In addition to the closed season for fishing observed by the east coast states during April 15 - May 30 since 2001, Orissa has imposed many restrictions on fishing activities to safeguard the turtle populations. These restrictions are already affecting the fishermen populations of this area. Gahirmatha was declared as a Marine (Wildlife) Sanctuary under the Wildlife Act of India, 1972 and fishing activities were banned in the sanctuary. The scope of the Orissa Marine Fishing Regulations Act (OMFRA) was expanded prohibiting all fishing within the seaward radius of 20 km from the Gahirmatha (June, 1997), off Devi River mouth (2001) and Rushikulya River mouth (2002). All these restrictions amount to a loss of Rs.1000 million to the fishing industry and to the fishermen involved in fishing. Application of TEDs further adds to the loss of fishery wealth. In fact, the mortality of turtles at sea is negligible as compared to the damage on land.

It is interesting to note the results of surveys made by CMFRI on the mortality of turtles in India. During 1985-1995, trawls accounted for 17.8% and gillnets accounted for 76.5% of the incidental catch of turtles. According to the survey conducted during 1997-98, barring Gahirmatha coast, gillnets accounted for 60% of the turtle catching followed by hooks and line (22.6%), trawls (13.1%) and seines (4.2%). Other gears like bagnets and stakenets accounted for the rest 22.6%. The situation along the Gahirmatha coast may not be different from this. It is evident from these surveys that trawls are responsible only for about 13% of the mortality of turtles while other fishing gears are responsible for about 87%. If we are really serious about saving the turtles we may have to ban fishing altogether at least along the upper east coast. In such a situation, the question posed is whether we are interested in the fisherfolk whose livelihood is solely depending on fishing or saving the turtles at the cost of fisherfolk. Already a section of the social scientists and Non-Governmental Organisations (NGOs) campaigning the cause of fisherfolk are opposing the so-called conservation measures imposed (Sridhar, 2004; 2005).

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