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Design and Development of the TED for Indian Fisheries

M R Boopendranath, Percy Dawson, P Pravin, M P Remesan,
R Raghu Prakash, V Vijayan, P George Mathai, N Subramonia Pillai,
M D Varghese and S V S Ramarao

The incidental death of marine turtles has been reported to occur during mechanised fishing operations. Along the east coast of India, this problem has been aggravated by the rapid expansion of the mechanised trawler industry (James et al 1989, Pandav et al 1998, Pandav and Choudhury 1999, Rajagopalan et al 2001). Incidental catch is highest in Orissa due to the presence of large congregations of marine turtles, with a peak in mortality during January–March (Rajagopalan et al, 2001). It is estimated that fishing activities in Orissa have resulted in the death of over 90,000 olive ridley turtles in the last decade (Pandav 2000).

In Indian fisheries, shrimp is the major foreign exchange earner, contributing over 70 per cent to marine products export earnings. A US law (Section 609 of Public Law No. 101–162) introduced in May 1996, restricted the imports of shrimp harvested with fishing equipment, such as trawl nets, not equipped with turtle excluder devices (TEDs). The subsequent shrimp–turtle case brought environmental requirements in the WTO into the mainstream, through its interpretation of relevant WTO articles (Srivastava and Ahuja 2002, Oxley 2002). In view of these concerns, with respect to trade and the environment, the Department of Animal Husbandry and Dairying, Ministry of Agriculture, Government of India, constituted an Expert Scientific Panel to conduct detailed investigations on marine turtle distribution in Indian waters, their incidental mortality in fishing nets and use of TEDs in trawl nets.

The Central Institute of Fisheries Technology (CIFT) has collaborated closely in this study while pursuing concurrent investigations on the design, fabrication and field-

testing of turtle excluder devices, as well as training of trawl fishers and other stakeholders in their fabrication and use. In this paper, the research on TEDs is briefly reviewed, with particular reference to developments related to Indian fisheries.

The Turtle Excluder Device

Turtle excluder devices (TEDs) consist of panels of large mesh netting (soft TED) or a frame consisting of a grid of deflector bars (hard TED), installed before the codend of the trawl net, at an angle leading upward or downward into an escape opening. Small animals, such as shrimp, slip through the mesh lumen of the netting panel or gap between the deflector bars and are retained in the codend, while large animals such as turtles, large fishes and large elasmobranchs are stopped by the netting panel or the grid of deflector bars and can escape through the opening (Figure 1). Thus, the air-breathing marine turtles are prevented from capture and subsequent death after prolonged entrapment in the trawl.

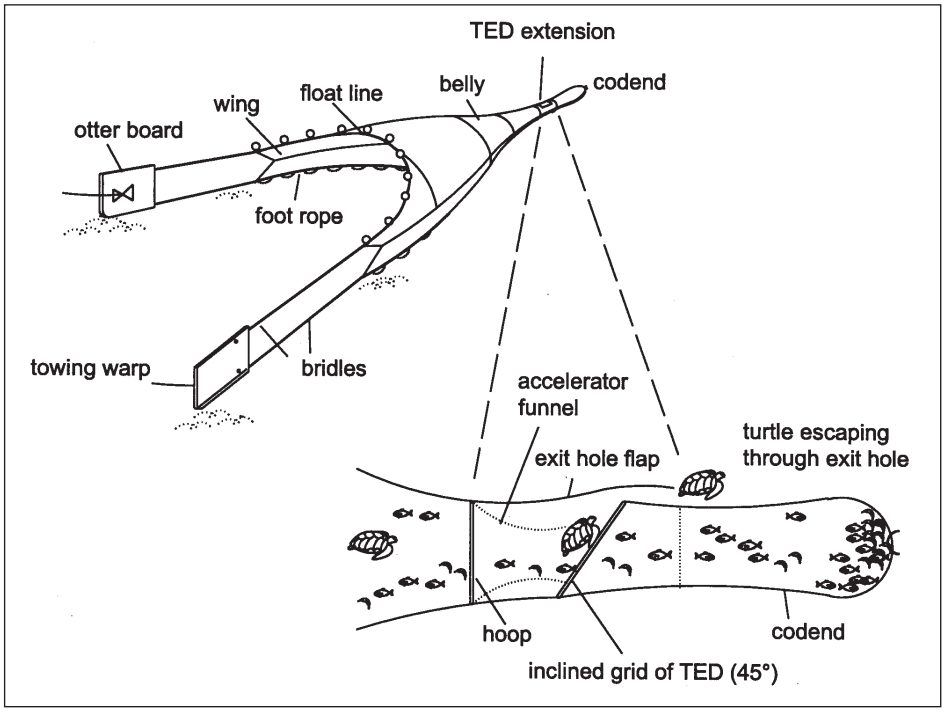

Figure 1. Principle of TED operation.

TEDs were introduced in US shrimp fisheries in the late 1980s. Since then, several improvements have taken place in TED design, fabrication and operational techniques (Committee on Sea Turtle Conservation 1990, Mitchell et al 1995, Anon. 2002a). Many TED designs have proved to be effective at excluding up to 97 per cent of sea turtles with minimal loss of shrimp (Seidel 1983, Seidel and Oravetz 1989, Mitchell et al 1995).

TEDs are recognised internationally as a convenient and effective measure for protecting sea turtles from trawling-related mortality; they have been acknowledged as an important

conservation tool by the FAO, fisheries biologists and marine turtle conservationists. Many trawl fisheries throughout the world are now required to use TEDs, and over 18 nations now have TED regulations for their shrimp trawlers. The Expert Scientific Panel in India recommended that use of TEDs be made mandatory for all mechanised trawlers operating in Indian waters where high incidental mortalities have been recorded (Anon. 2000). In India, the state governments of West Bengal, Orissa, Andhra Pradesh and Kerala have already introduced TED regulations for trawlers.

VARIATION IN TED DESIGN

There are a variety of TED designs available today, all of which vary with regard to construction, principle of operation and materials for construction, relevent to their target groups and conditions of fishing. There are primarily two types of TEDs—soft TEDs and hard TEDs. Hard TEDs are rigid frame devices installed ahead of the codend to separate and exclude turtles from trawl catch components.

There are several designs of hard TEDs in use (Mitchell et al 1995, Anon. 2002a) (Figure 2). In the first category—hooped hard TEDs—deflector bars are rigidly fixed in a framework, at the desired angle. The NMFS hooped TED, Cameron TED and fixed-angle TED fall under this category. The NMFS hooped TED design was the first TED design to be introduced (Seidel 1983). However, this TED is relatively cumbersome in terms of onboard handling when compared to recently introduced TED designs and is therefore not in common use.

The second category, namely single-grid hard TEDs, includes the Matagorda TED, Georgia Jumper, Super Shooter, Anthony Weedless and Jones TEDs. The Georgia Jumper TED is one of the simplest of hard TED designs, and is widely used in different fisheries. It consists of an oval frame with deflector bars and horizontal braces, constructed of stainless steel rods. The Super Shooter is a popular design of TED, originally designed for use in the Gulf of Mexico (Watson and Taylor 1988). The deflector bars are bent at an angle at a distance from the exit hole, in order to facilitate elimination of debris from the TED. The Anthony Weedless TED is designed to reduce the accumulation of debris and seagrass by a specially designed deflector bar, which is free at the bottom end and is kept at an appropriate angle. Flounder TEDs have a 102-mm-wide horizontal slot at the bottom end of the TED frame, which permits flounder and other fishes to pass into the codend.

Soft TEDs consist of a large mesh selective front panel, fitted at an angle to the trawl mouth, leading to an escape chute at the hind end. Examples of soft TEDs are the Morrison TED, Taylor TED, Andrews TED and Parker TED (Mitchell et al 1995, Anon. 2002a). However, soft TEDs are difficult to install properly in trawls oriented towards catching different species—the behaviour of each species requires the shape of the trawl opening to be changed by adjusting the rigging. Soft TEDs also produced higher shrimp losses (about 15 per cent) and their performance is reportedly inferior to hard TEDs (Watson and Seidel 1980, Committee on Sea Turtle Conservation 1990, Mitchell et al 1995, Oravetz 1999). Consequently, hard TEDs are more popular among trawler-operators than soft TEDs.

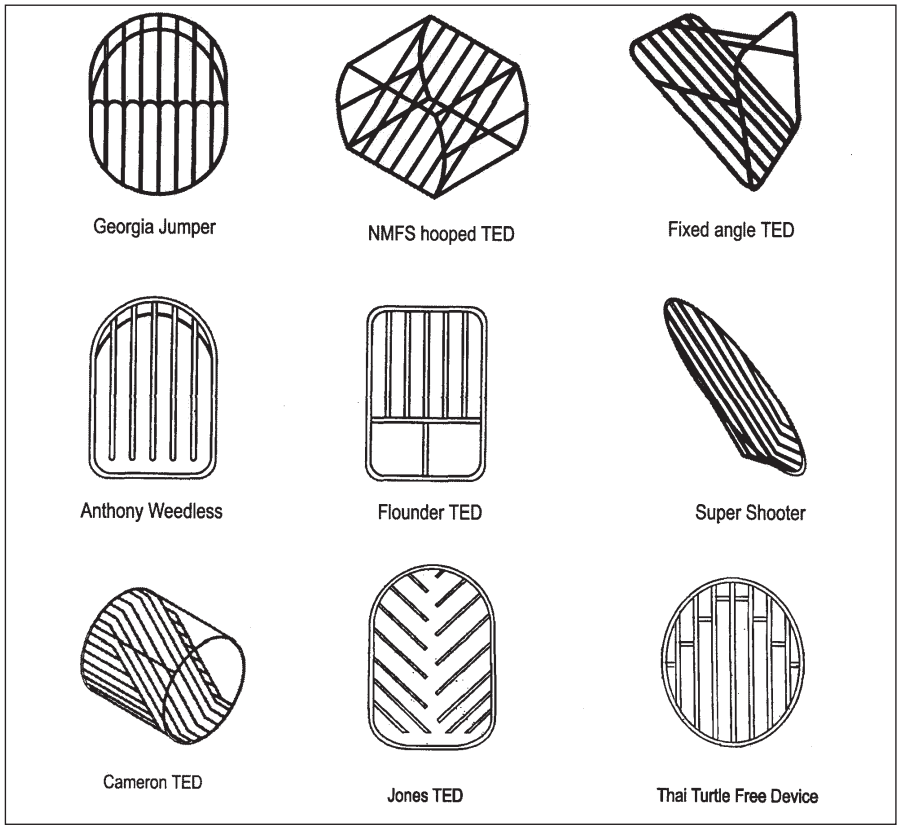

Figure 2. Variation in single-grid hard TED designs.

Appropriate modifications of the basic TED design have been carried out by different nations to suit their fisheries. These include the Thai turtle-free device (TTFD), developed by Kasetsart University, and the SEAFDEC/TD, both in Thailand (Chokesanguan et al 1996, Chokesanguan 2000). The AusTED (Australian trawling efficiency device) was developed in Australia (Mounsey et al 1995, Robins-Troeger and Dredge 1995, Brewer et al 1998, Robins-Troeger and McGilvray 1999, McGilvray et al 1999), and the CIFT-TED in India (Dawson 2001, Dawson and Boopendranath 2001, 2002a,b, 2003).

Hard TEDs are generally constructed of solid steel rods with a minimum outer diameter of either 6.4 mm fiberglass, or an aluminium rod with a minimum outer diameter of 12.7 mm, or steel or aluminium tubing with a minimum outer diameter of 12.7 mm and wall thickness of 3.2 mm. The height and width of the escape opening for turtles in the single-grid hard TED is an important parameter, and is related to the size of turtles in the fishing area. According to US regulations in the Atlantic coast, the requirement is 889-mm width and 305-mm height; in the Gulf of Mexico, the measurements are 813-mm width and 254-mm height. The angle of TED deflector bars must be between 30–55 degrees. The gap between deflector bars, and between deflector and frame, must not exceed 102 mm (Mitchell et al 1995, Anon. 2002a, Epperly and Teas 2002).

The TED for Indian Fisheries

CIFT was closely associated with the evaluation of TED designs of US origin (Super Shooter), as envisaged under the mandate of the Expert Scientific Panel, along with the Central Institute of Fisheries Nautical Engineering and Training (CIFNET) in Kochi, with the support of the Marine Products Export Development Authority (MPEDA), Kochi and the Fisheries Survey of India (FSI) Mumbai. CIFT concurrently executed a research programme to address the issue of bycatch in trawl fisheries which focussed on the development of bycatch reduction devices (BRDs) and TEDs (CIFT 1999). Two training workshops on TED technology were conducted in India by gear technologists of the National Marine Fisheries Service (NMFS, US Department of Commerce) (Oravetz 1999), at Paradeep (11–15 November 1996) and Kochi. Several workshop-cum-demonstrations on the indigenously built TED have taken place in India (Dawson 2001, Dawson and Boopendranath 2002a, Anon 2002b) (see Appendix).

EXPERIMENTS WITH THE IMPORTED SUPER SHOOTER TED

From 16–25 August 1995, CIFT conducted experiments to evaluate the Super Shooter TED (1,030 × 850 mm size and deflector bar gap of 90 mm) imported from the USA by the MPEDA, onboard the *Matsya Shikari* (39.8 m L_{OA}, 1,740 bhp stern trawler), a vessel of the Fisheries Survey of India, Visakhapatanam. The TED was attached in front of the codend of a 44-m headline shrimp trawl, rigged with polyvalent oval otter boards of 1,400 kg each.

Six operations, of 90 minutes duration each, were conducted; four operations were with TEDs. Fishing operations were conducted off Andhra Pradesh, north of Kalingapatnam, at a depth of 45–55 m. Catch retained in the codend during the TED-installed trawl operations included catfish, perch, pomfret, seer and carangids. Maximum sizes of fish caught in the TED-installed trawl were—460 mm TL (weight: 1.8 kg) for catfish, 51 mm (1.6 kg) for perch, 250 mm (0.8 kg) for pomfret, 480 mm (1.1 kg) for seer fish and 600 mm (2.4 g) for carangids. Maximum girth of the largest fish retained was limited by the gap between deflector bars (90 mm). No turtle was retained in the codend of the trawl net during the experiment (Ramarao 1995a).

Experiments with the imported Super Shooter TED were continued between Bhimli and Chilika, using the same trawl gear and rigging on the *Matsya Shikari*, from 20–30 September 1995 (Ramarao 1995b). An exit-hole codend was additionally provided in order to retain the catch excluded due to the installation of the TED in the trawl net (Figure 3).

During five operations conducted in the 45–140 m depth range (18°01'–18°31' N, 83°53'–85°10' E), a total of 676 kg of fish was landed, of which 469 kg was retained in the main codend. Overall CPUE for TED-installed operations was 53.3 $kg.h^{-1}$, while CPUE for trawls without TED (catch retained in the main codend + losses) was 76.9 $kg.h^{-1}$. Results indicated an overall escape of 30.8 per cent (14.9–50.0 per cent) of finfish. Catch retained in the main codend included *Priacanthus* spp. (42.9 per cent), carangids (15.2 per cent), lizard fish (*Saurida* spp.) (13.1 per cent), black pomfret (*Parastromateus niger*) (7.3 per cent), silver bellies (*Leiognathus* spp.) (6.4 per cent), catfish (*Arius* spp.) (4.1 per cent),

Upeneus spp. (3.2 per cent), sciaenids (2.6 per cent), perch (2.2 per cent), wolf herring (*Chirocentrus dorab*) (1.3 per cent), cuttlefish (*Sepia* spp., *Sepiella* sp.) (0.4 per cent), squids (*Loligo* spp.) (0.2 per cent) and miscellaneous fishes (1.1 per cent). The excluded catch included *Priacanthus* spp. (48.3 per cent), silver bellies (12.1 per cent), black pomfret (10.1 per cent), rays (5.8 per cent), catfish (4.8 per cent), sciaenids (3.9 per cent), *Upeneus* spp. (2.4 per cent), carangids (1.9 per cent), lizard fish (1.9 per cent), perch (1.5 per cent), and miscellaneous fishes (7.3 per cent) (Figure 4). Marine turtles were not retained in either the main codend or the exit hole covered codend during the experiment. Olive ridleys do not migrate to the Orissa waters till October and the experiments were conducted early primarily to study exclusion rates using TEDs.

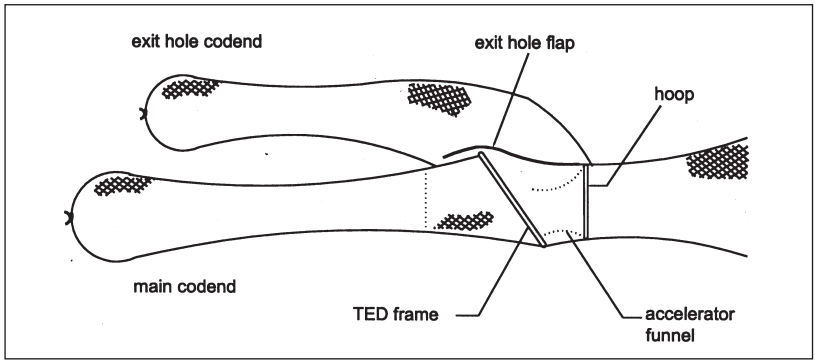

Figure 3. Details of rigging of exit hole codend for experimental operations.

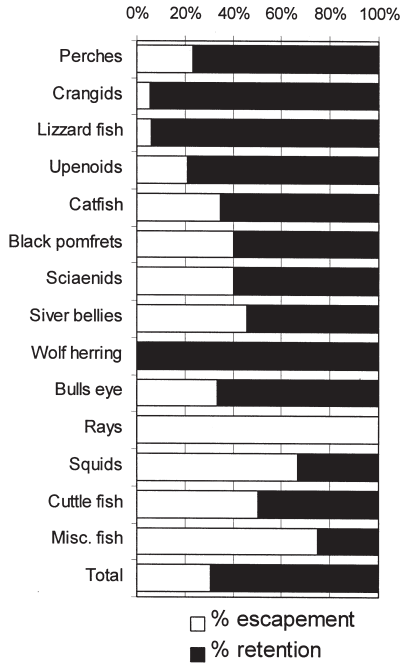

Figure 4. Relative exclusion rates of different species groups after the installation of an imported Super Shooter TED, during experimental trawling off Visakhapatnam.

Catch obtained in the TED-installed trawl (catch in the main codend) was significantly less than the estimated catch of the trawl without TED (catch + losses) (paired t test on log transformed data, $t=4.5$, df: 4, $p<0.05$).

Preliminary observations were carried out using a Super Shooter-type TED fitted to a 31.8-m shrimp trawl from the *MV Skipper* (28.19 m L_{OA}; 600 bhp) by CIFNET (Kochi), in the four months between October 1999–January 2000, off Andhra Pradesh, in the area 17°37–55' N and 83°22–48' E, in the depth range of 36–50 m (Kirubakaran et al 2002). The TED was of 1,040 × 840 mm size and constructed of 16-mm aluminium rods with 89-mm deflector bar gaps. Two turtles were excluded during the operations in November 1999.

TED operations with the exit hole at the top of the net resulted in total catch loss of 43.4 per cent, while operations with the exit hole at the bottom resulted in catch loss of 13.7 per cent. During operations with the exit hole at the top, the relative percentage of catch loss for different components was—shrimp (35.3 per cent), cephalopods (52.5 per cent), pelagic fish (50.6 per cent), demersal fish (40.7 per cent) and low-value fish (83.6 per cent). Relative catch loss during operations with the exit hole at the bottom was—shrimp (0.5 per cent), cephalopods (8.4 per cent), pelagic fish (43.3 per cent), demersal fish (23.9 per cent) and low-value fish (11.3 per cent) (Kirubakaran et al 2002).

Unlike fishers in the USA, Australia and other advanced maritime nations (who fish exclusively for shrimp), fishers on the Indian coast target both shrimp and non-shrimp resources. If the target is shrimp alone, fishers benefit from the installation of TED in the trawl net due to: (i) higher catch values due to reduction of large bycatch species which could damage the shrimp, (ii) shorter sorting times, (iii) lower fuel costs due to reduced net drag as the codend would fill more slowly, and (v) higher catches of shrimp (Brewer et al 1998). Hence, TEDs are sometimes designated as trawling efficiency devices (Watson et al 1986, Mounsey et al 1995). Experiments with TED designs which have a deflector gap of less than 90 mm in Indian waters, though successful in excluding turtles, showed poor performance in the retention of targeted non-shrimp catch components. Hence, these TEDS were not considered suitable for Indian conditions, nor were they acceptable to Indian trawler-owners and operators (Mishra and Behera 2001).

DEVELOPING AN INDIGENOUS TED FOR INDIAN FISHERIES

An indigenous design of TED was developed at CIFT with a focus on reducing catch loss, which is a particular cause of concern for trawl fishers. The device, christened CIFT-TED, is a simple single-grid hard TED with a top-opening. It consists of an oval frame measuring 1,000 × 800 mm and is constructed with 10 mm Ø stainless steel rod. Five vertical grid bars made of 8 mm Ø stainless steel rod are welded to the inside of the oval frame. The spacing between the deflector bars is 142 mm and the maximum spacing between the frame and the adjacent deflector bar is 90 mm. The frame is fixed in the TED extension at a 45° angle. Construction, installation and operation of the CIFT-TED are described in detail by Dawson and Boopendranath (2001, 2002b, 2003). The device can be fabricated and installed with minimum training using locally available infrastructure and net-making skills, at a cost of Rs 2,500 or less.

Experiments with indigenous TED designs

Experiments were conducted off Kochi with prototypes of indigenous TED designs, from the research vessel *MFB Matsyakumari* (17.5 m L_{OA} steel trawler; 278 bhp @ 1,000 rpm), during 2001–02, to evaluate overall performance of these TEDs with respect to catch loss. TED designs with dimensions of 1,000 × 800 mm, 900 × 800 mm and deflector bar spacing of 144 mm, constructed of 10-mm and 6-mm Ø stainless steel rods for TED frame and deflector bars respectively, were used for the experiments.

A total of 710.9 kg of fish was landed during 38 operations, using 32-m headline demersal trawls rigged with V-form otter boards (1,500 x 890 mm; 125 kg each), an overall total catch rate of 19.2 kg.haul^{-1}. An exit hole codend was provided to retain the catch excluded due to the installation of the TED in the trawl net (Figure 3). Results have shown an overall escapement of 2.4 per cent of the fishes which entered the trawl, through the exit hole of the TED. The catch retained (693.6 kg) in the main codend included squids (15.9 per cent), shrimp (15.4 per cent), jellyfish (9.4 per cent), silver bellies (6.1 per cent), sciaenids (5.6 per cent), cephalopods (0.5 per cent), sole (0.5 per cent), crabs (0.3 per cent), perches (0.3 per cent), wolf herring (0.1 per cent) and miscellaneous catch (48.9 per cent). Catch excluded (17.3 kg) comprised of jellyfish (9.4 per cent), silver bellies (10.2 per cent), shrimp (6.1 per cent), sciaenids (0.3 per cent) and miscellaneous fish (71.9 per cent).

With regard to the relative percentage of excluded catch for different species groups, wolf herring, perches, cephalopods, sole, crabs and squilla were retained in the codend entirely. Among other species groups, sciaenids were excluded at the rate of 4 per cent, followed by miscellaneous fish (3.5 per cent), jellyfish (3 per cent), prawns (1 per cent) and sciaenids (0.3 per cent) (Figure 5).

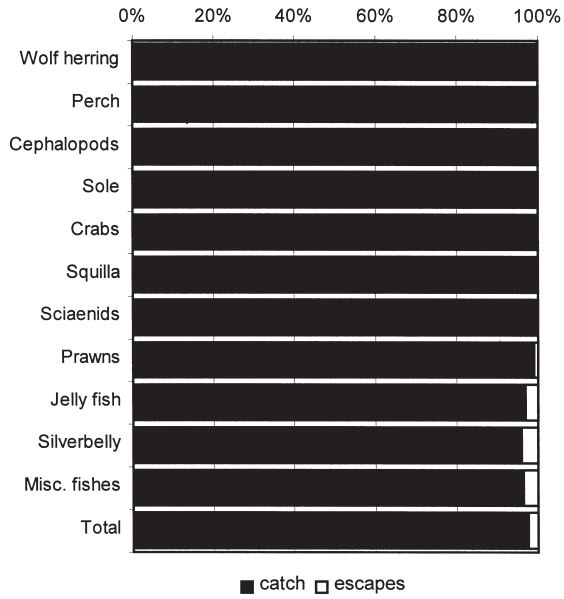

Figure 5. Relative exclusion rates of different species groups due to installation of CIFT-TED, during experimental trawling off Kochi.

A comparison of the catch obtained in the TED-installed trawl (catch in the main codend) and the estimated catch of the trawl without TED (catch + losses) shows a significant difference in the catch of non-shrimp components ($t=2.9$, df: 36, $p<0.05$). The percentage loss of non-shrimp components were 2.3 per cent due to TED installation. However, the difference in shrimp catch due to the installation of the TED was not significant ($t=1.0$, df: 23, $p>0.05$).

Field trials and demonstration of the CIFT-TED off the east coast of India

Initial field trials on the east coast using CIFT-TED were conducted off Agarnasi (north of Paradeep) on 24 February 2001, from a boat belonging to the Orissa fisheries department; and on 14 September 2001, off Visakhapatnam, from a commercial trawler. Additional field trials were conducted off Orissa and Andhra Pradesh, during demonstration-cum-workshops conducted in association with SIFT, state fisheries and forest departments and the MPEDA, for the benefit of trawl fishers and other stakeholders (see Annexure 1).

The results of 19 field trials conducted on the east coast yielded a total catch of 544.3 kg (Table 1). The mean catch rate in operations without TEDs was estimated to be 27.3 $kg.haul^{-1}$ (SE = 4.52), while the mean catch rate in operations with a CIFT-TED installed in the trawl was determined to be 26.4 $kg.haul^{-1}$ (SE = 4.3). Catch loss of fish due to the installation of TED was estimated to be 3.3 per cent. Out of total of 26.8 kg of shrimp landed, which is economically the most important component in trawl catches, only 0.5 per cent (~ 0.1 kg) was observed to have been excluded after the installation of the CIFT-TED. All four marine turtles which entered the trawls were excluded. The results of 51 hauls between November 2001–March 2002, off Gahirmatha, Paradeep and Devi river mouth (Orissa) between 11–24 m depth showed 100 per cent escape rates; 21 marine turtles that entered the trawls managed to escape, catch loss ranged from 2.3 to 10.3 per cent (Gopi et al 2002).

Table 1. Details of TED-installed trawl operations along the east coast during 2001–02.

Area	Date	No. of hauls	Catch retained (kg)	Catch loss (kg)	Catch loss (%)
Paradeep (Orissa)	24.2.2002 11.2.2002	6	290.2	14.24	4.68
Visakhapatnam (AP)	14.9.2001 25.2.2002	3	44	0.13	0.28
Kakinada (AP)	24.1.2002	6	133	1.8	1.34
Nizampatnam (AP)	13.2.2002	2	35	0.25	0.71
Krishnapatnam and Vadreva (AP)	14.3.2002 15.3.2002	2	25	0.7	2.72
Total		**19**	**527.2**	**17.12**	**3.14**

The catch rate of turtles during experimental trawls on the east coast (February 2001 to March 2002) was determined at 0.16 turtles per trawling hour and nil during TED-installed operations. This is higher than the rate of 0.0022 turtles per trawling hour

reported from the Gulf of Mexico and Atlantic coast (Renauld et al 1991). A comparison of the catch obtained in the TED-installed trawl (catch in the main codend) and the estimated catch of the trawl without TED (catch + losses) shows a significant difference in the catch of non-shrimp components ($t=2.9$, $df=18$, $p<0.05$); however, the difference in shrimp catch was not significant ($t=1.4$, $df=8$, $p>0.05$).

Construction and Installation of the CIFT-TED

Construction of the Frame

An oval frame measuring 1,000 × 800 mm is constructed from a 10-mm diameter stainless steel rod. Five vertical grid bars, of 8-mm diameter stainless steel rods, are welded to the inside of the frame. The spacing between deflector bars is 142 mm and the maximum spacing between the frame and the adjacent deflector bar is 86 mm (Figure 6a).

Construction of the TED extension

The TED extension is constructed of a single piece of polyethylene netting of 40-mm stretched mesh size and 1.5-mm diameter twine of size 150 × 60 meshes. The 60 mesh sides of the netting piece are sewn together to construct a cylinder (Figure 6b).

Construction of the hoop

A single hoop, with a diameter of 900 mm, is constructed using 8-mm stainless rods, to be attached to the leading edge of the TED extension.

Fixing the grid at the correct angle

The hoop is laced to the TED extension, 5 meshes from the leading edge. For ease of installation, another hoop can be attached to the other end of the extension. The TED frame is slid into the extension. Using the hoops, the extension tube should be stretched so that it is taut. The TED extension should be so positioned that the extension seam is at the bottom. Starting from the rear edge of the extension, 36 meshes forward along the seam should be counted, followed by 75 meshes perpendicular to the seam, to arrive at the top centre attachment point. This TED frame is attached to the extension netting. The sides of the secured TED frame may then be sewn to the extension netting. The grid angle should be between 40–55 degrees from the horizontal for proper operation (Figure 6c).

Cutting the exit hole

The mesh cut should be initiated in front of the top centre of the TED frame and continued along the frame, maintaining mesh distance from the frame on either side, until the first and fifth grid bars are reached. The distance between the first and fifth grid bars is 620 mm; 19 meshes can be cut forward on either side. The mesh can be cut perpendicular to one of these to obtain a rectangular opening of 40 × 19 meshes in the extension.

Construction and attachment of the exit hole cover (flap)

The exit hole cover is made of a single piece of depth-stretched and heat-set polyethylene netting of 90 × 50 meshes, 25-mm stretched mesh size and 1-mm diameter twine size. The centre mesh of the 96-mesh edge of the flap should be attached to the centre mesh

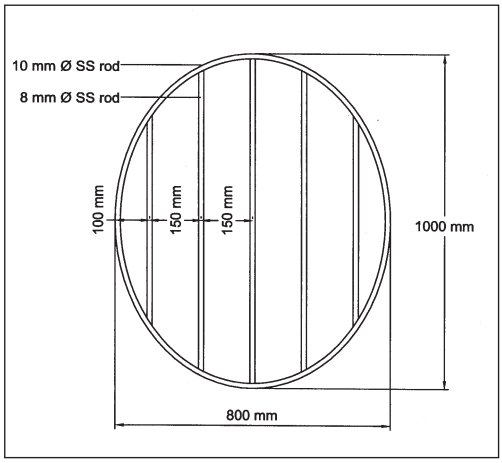

Figure 6a. 1,000 × 800 mm CIFT-TED design.

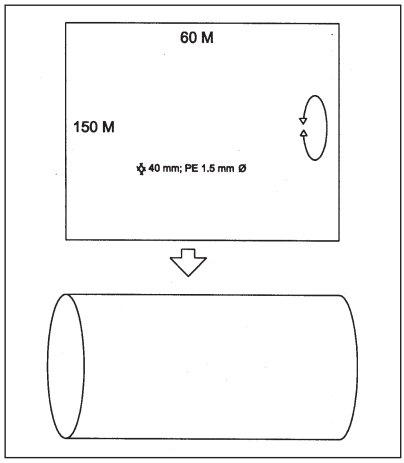

Figure 6b. Construction of CIFT-TED extension.

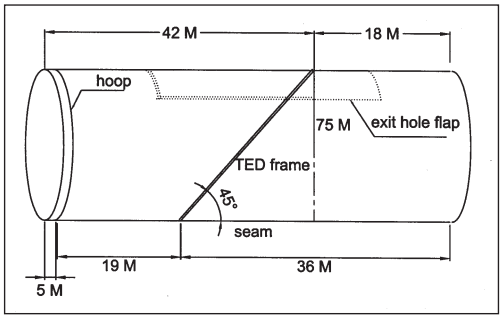

Figure 6c. Fixing the grid at the correct angle.

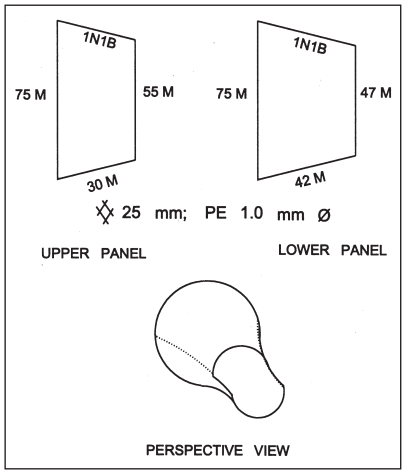

Figure 6d. Construction of the accelerator funnel.

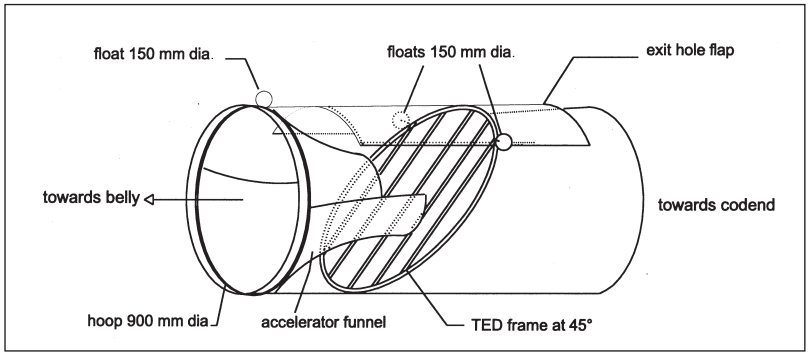

Figure 6e. Perspective view of TED extension.

of the forward edge of the exit hole opening, and this should be continued to 45 meshes of the flap to 20 meshes of the opening on either side of the attachment point.

The remaining meshes of the flap should be sewn to the extension meshes to provide strength and shape to the flap. Along the sides, 30 meshes of the flap should be attached to 19 meshes of the extension ahead of the TED frame, 6 meshes of the flap are attached to 4 meshes of the extension ahead of the TED frame. The remaining 14 meshes of the flap are left unattached.

Construction and installation of the accelerator funnel

Two trapezoidal pieces of depth-stretched and heat-set polyethylene netting (25 mm stretched mesh size and 1-mm diameter twine size) with 75 meshes each in the leading edge should be cut; and 30 and 42 meshes each in depth with a cutting rate of 1NIB resulting in 55 and 47 meshes, respectively, in the rear edge. The two pieces are sewn together along the tapered edges, beginning from the leading edges, to form the funnel. The funnel is installed inside the extension, ahead of the TED frame with the longer half of the funnel positioned opposite to the exit hole.

The funnel is sewn to the TED extension, immediately after the hoop, which is attached to the leading edge. 150 meshes of the funnel may be attached, mesh to mesh, to 150 meshes of the extension. The longer half of the funnel may be secured at appropriate intervals to the grid bars, a few centimetres from the bottom (Figure 6d).

Attachment of floats

Two 150 mm hard plastic floats are to be attached to the outside of the TED on the upper side, to the frame at the junction of outer grid bars. Another float is to be attached to the top of the hoop for weight compensation and stability during operation.

Installation of TED in trawl

The complete TED (Figure 6e) is installed between the codend and hind belly extension of the trawl, with the exit hole facing upwards, by joining the edge meshes.

Operation and Maintenance of CIFT-TED

Before shooting the gear, the net should be inspected to ensure that the netting ahead of the TED is not twisted. The speed of the vessel should be increased before deploying the otter boards, so that the TED extension will ride high in water. Twists, if any, can be easily detected; if twists are present, they should be removed before deployment of the gear. While hauling the gear, it is better to keep the vessel against the current or maintain a low speed, in order to prevent the catch from being washed forward to the exit hole. Once the otter boards are hauled up, the vessel should maintain speed and direction for a few minutes so that all catch washes past the TED and into the codend.

After each haul, the accumulated trash and debris that clogs the grid should be removed. Also, any gilled fish in the netting around the TED should be removed in order to permit good filtration. It is important to check the grid angle on a regular basis, and make sure that it is between 40–55 degrees from the horizontal.

Conclusion

Field trials with the CIFT-TED have shown a statistically non-significant catch loss in the range of 0.52–0.97 per cent for shrimp. Though the catch loss of 2.4–3.3 per cent for non-shrimp resources is statistically significant, it is still considerably less than the loss incurred during experiments with imported TED designs. The loss of finfish catch is expected to vary from zone to zone and from season to season, depending on the percentage representation of large finfish and elasmobranchs in the trawl catch. As turtle exclusion by the TED is dependent on a physical separation process based primarily on size difference, there is no way of retaining finfish larger than can be let in through the deflector bar spacing. Additional increase in the deflector bar spacing may not be feasible, as it could lead to wedging and inefficiency in the exclusion of turtles. It is to be noted, however, that large species that are excluded due to the installation of TEDs are not lost to the fishery as a whole, as they can be caught by other fishing techniques in use in the fishing area. Further, the representation of such large fishes in trawl catch is generally on the decline, due to varying degrees of overfishing.

The Government of India, along with the concerned state governments, is in the process of implementing the recommendations of the Expert Scientific Panel through the amendment of the Marine Fishing Regulation Act. As of now, four states, namely Kerala, Andhra Pradesh, Orissa and West Bengal have introduced TED regulations for their mechanised trawler fleets. The MPEDA, CIFT, Wildlife Institute of India, state forest and fisheries departments, trawler-owners and fisher folk, non government organisations interested in marine turtle conservation, and the fisheries trade in India are involved in popularisation and promotion of the TED among trawl fishers. During 2000–01 and 2001–02, the MPEDA has so far fabricated 1,217 units of CIFT-TED and distributed 887 units among trawl fishers in Orissa (617 units), Andhra Pradesh (220 units), West Bengal (50 units), free of cost through the state fisheries departments. However, the effective implementation of TED regulations would depend critically on the extension of TED technology to trawl fishers and monitoring and enforcement of TED regulations on the part of the government.

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Appendix. Demonstration and training imparted by CIFT on fabrication, installation and operation of the CIFT-TED.

Location and date	Training content	Organisers	Participants
Paradeep (Orissa) 21–22 Feb. 2001	Public talk and discussion; demonstration of fabrication and installation; demonstration of operation at sea.	Directorate of Fisheries (Orissa); MPEDA (Kochi); CIFT (Kochi)	Mechanised boat owners and operators; net makers; representatives of the fisheries and forest departments, fisher cooperatives, net material manufacturing industries and NGOs
Dhamra (Orissa) 25 Feb. 2001	Public talk and discussion; demonstration of fabrication and installation	Directorate of Fisheries (Orissa); MPEDA (Kochi); CIFT (Kochi)	”
Sankarpur (West Bengal) 5–6 Sept. 2001	Public talk and discussion; demonstration of fabrication and installation	Directorate of Forests, Dept. of Fisheries (West Bengal); MPEDA (Kochi); CIFT (Kochi)	”
Frazergunge (West Bengal) 8 Sept. 2001	Public talk and discussion; demonstration of fabrication and installation	Directorate of Forests, Dept. of Fisheries (West Bengal); MPEDA (Kochi); CIFT (Kochi)	”
Visakhapatnam (Andhra Pradesh) 12–14 Sept. 2001	Public talk and discussion; demonstration of fabrication and installation; demonstration of operation at sea.	Dept. of Fisheries (Andhra Pradesh); MPEDA (Kochi); CIFT (Kochi)	”

Location and date	Training content	Organisers	Participants
Kochi (Kerala) 15–20 Oct. 2001	*Short-term Training Course on Turtle Excluder Devices* Training in fabrication and installation and operation of CIFT-TED.	CIFT (Kochi)	State fisheries officials of Andhra Pradesh and Tamil Nadu
Paradeep (Orissa) 9–12 Feb. 2002	*Workshop-cum-Demonstration on Turtle Excluder Devices for Trawl Operators of Orissa Coast*; Demonstration of fabrication and installation of CIFT-TED; demonstration at sea.	Directorate of Fisheries (Orissa); Project Swarajya (Orissa) under GOI–UNDP Sea Turtle Project	Mechanised boat owners and operators; representatives of fisheries and forest departments, fisher cooperatives, and NGOs
Kakinada (Andhra Pradesh) 24–25 Jan. 2002	*Workshop on Operation of Turtle Excluder Devices:* Demonstration of fabrication and installation of CIFT-TED; demonstration at sea.	Dept. of Fisheries (Andhra Pradesh); Wildlife Institute of India (Dehradun) (GOI–UNDP Project)	”
Kochi (Kerala) 19–21 June 2002	*Capacity Building Training Workshop on Sea Turtle Conservation and Management:* Presentations and discussion on fabrication and installation of CIFT-TED; familiarisation of of CIFT-TED at CIFT Gear Lab.	CMFRI (Kochi); Wildlife Institute of India (Dehradun) (under GOI–UNDP Sea Turtle Project)	Frontline staff of wildlife, fisheries and research organisations on the west coast of India and Lakshadweep