

THE IMPLEMENTATION ON THE USE OF TEDs AND CURRENT RESEARCH IN SOUTHEAST ASIA

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INTRODUCTION

The United States import shrimp embargo against shrimp caught with gear not equipped with means of preventing Sea Turtle catch, was unilaterally imposed upon the Southeast Asian countries on the 1st of May, 1996. Ostensibly to improve the catch composition of shrimp trawls and specifically to exclude the potential catch of Sea Turtles that are an endangered species.

The embargo posed a serious threat to the livelihood of the fishermen of the Southeast Asian nations. National governments in the region viewed the threat very seriously and through the agency of the SEAFDEC governing body, the Council of Directors, approval was given for the urgent consideration of practical designs of additional shrimp trawling gear, thus deflecting the U.S. import ban by effecting the release and potential conservation of Sea Turtle.

The Training Department (TD) and the Marine Fisheries Resources Development and Management Department (MFRDMD) were assigned to study this problem by cooperating with the Departments of Fisheries of SEAFDEC member countries. A series of experiments commenced in Thailand and as progress was made, more trial were carried out in Malaysia, the Philippines and Brunei Darussalam and the results disseminated to the fishermen. Since large numbers of fishermen in the region live by catching shrimp, various activities have been conducted to safeguard them and to minimize the impact that could be anticipated by the enactment of the import embargo.

This report outlines the implementation situation of the use of TEDs in Southeast Asia countries and the research on TEDs carried out in each country in the light of the cooperation of fishing gear expert of the region. It further includes how the results of the research have been evaluated. Disseminated to the fishermen for their use to avoid the shrimp embargo has been achieved through workshops and seminars, which also serve to promote the conservation of the Sea Turtle by the use of TEDs.

THAILAND

Implementation Situation

Thai people have a traditional belief that sea turtles are long-lived animals and that it is sinful to kill them. In practice, the Royal Thai Government has enacted legislation to protect and conserve the sea turtle from any fishing implement. Nevertheless, the U.S. shrimp import embargo that went into effect on 1st May, 1996, stipulates a condition that methods such as trawling used in shrimp capture by harvesting countries should inflict no harm on the sea turtle.

In Thailand the trawl fishing technique was introduced more than 30 year ago, but the development of trawl gear has been toward ways to increase catch efficiency. The knowledge of By-catch reduction devices and TEDs was very limited. To comply with the conditions set by the U.S. shrimp import

embargo, SEAFDEC/TD in cooperation with the Department of Fisheries (DOF), Thailand have conducted many series of experiments to develop a suitable device, now called the Turtle Excluder Device (TED) for use with shrimp trawls in Thailand. Since solving the problem of the imposed shrimp embargo was very urgent, the most effective method was to observe what had been done in the USA where the original TEDs were designed. Previously, Mexico was one of the countries subject to the shrimp embargo. A method of overcoming the embargo problem was devised that first there should be a study on TED design and construction, with the experiments following. A study tour to U.S.A. and Mexico was undertaken by the TD and DOF researchers in July of 1996 to gain knowledge of the TEDs regulations and the type of TED used in the USA and Mexico.

To carry out the experiments, five types of TEDs were imported for testing: Three from the USA, namely, the Anthony Weedless, the Super Shooter and the Bent Pipe. These three types were recommended by NMFS NOAA and two from Mexico, namely, the Georgia Jumper and the Mexican these two are presently being used in Mexico.

When the five type of TEDs were received the sea trials began. Because the import price was very high, the author and the team decided to modify the TEDs to make them more suitable for use in the region. The SEAFDEC/TD in cooperation with the Department of Fisheries of Thailand studied the design and construction of various types of TEDs and then modified the super shooter and Georgia Jumper into what has become known as the Thai Turtle Free Device (TTFD).

In conjunction with this work the faculty of Engineering at Kasetsart University then modified the Super Shooter and Hooped TED into the Thai-KU. This design was more complex and not acceptable because of the hydrodynamics and high water resistance.

The results from the experiments suggested that the Super Shooter and TTFD had quite reasonable results in terms of escape rate and convenience of operation. For use by fishermen, however, the TTFD seemed to be the most suitable TED based on the lowest escape rate of fish, low fuel consumption and for ease of construction and installation because all materials used are available locally.

The experiments in the use of TEDs in Thailand had the aim of solving the problem of the U.S. shrimp embargo. The experiments had to be carried out within a time limit and the results had to be distributed to the fishermen to encourage them to use the TED. Another aim was to promote selective fishing gear and responsible fishing that is vitally important both now and in the future.

The Department of Fisheries in cooperation with the Export Department and with the technical assistance of NOAA, SEAFDEC/TD and Kasetsart University organized a workshop on the use of TEDs for shrimp trawls between 7-10 October, 1996. The participants were representatives of the fishermen from 22 coastal provinces in Thailand (4 fishermen from each province) and 2 extension fishery officers from each province. The fishermen had a positive reaction to the use of TEDs. They readily accepted the reasons for their introduction and the results of the fishing trials gave them confidence in the low escape rate levels and cleaner shrimp caught. The first 100 TTFDs were contributed for voluntary use.

For the further use of TEDs, several trials and demonstrations both to concerned authorities and fishermen were undertaken. Some 2,900 have been manufactured and distributed to fishermen, there being a complement of 3,000 shrimp trawlers registered in Thai shrimp fisheries. In November, 1996, the American shrimp embargo was lifted with respect to Thailand. The U.S. team still comes to check annually on the implementation and use of TEDs in Thailand.

To gain the fishermen's acceptance, emphasis has been placed on how they may benefit from their use so the low escape rates and the cleaner catch have been emphasized rather than the release of the turtles, which nonetheless must be achieved. In Thailand, a law is already enacted such that nets for shrimp trawling must be equipped with TEDs.

RESEARCH ON TEDs

The Preliminary Study on the Efficiency of Shrimp Trawl Nets with TEDs

The Preliminary study on the efficiency of shrimp trawl nets with TEDs was carried out in June 1996 (Podapol, L., Aosomboon, P. and Chokesanguan, B.). This preliminary study was made to observe the efficiency of shrimp trawl nets with two types of TED, namely, the Hooped TED and the Super Shooter. The main focus being to investigate whether the TED is the most appropriate and/or practical device to use to conserve the sea turtles in Thai waters. The results of the experiment are as follows:

The pattern of catch from shrimp trawl net with Hooped TED and Super shooter TED was similar. Trash fish and economic fish were the major part in the catch. The catch rate for shrimp was quite low in each type of TED used.

The length of cod-end should not be less than 10m. If the cod-end is too short, the water turbulence in will significantly affect to the rate of escape.

In considering the shrimp catch it was found that the rate of escape of shrimp for Hooped TED was 9.63% for 10m cod-end and 16.18% for Super Shooter TED for the same length of cod-end. Vendeville, 1990 concluded that the rate of reduction of by-catch of shrimp trawl net should not exceed 10% at night. McGilvray, 1995 from the U.S. National Marine fisheries Service (NMFS) compiled figures showing that the reduction rate of Hooped TED was 51% in fish and 2% in shrimp. For the Super Shooter, the reduction rate was 4% in fish and 1% in shrimp. Therefore, when compared with the criteria by Vendeville and McGilvray, the rate of escapement from both of Hooped TED and Super Shooter TED in this experiment must be considered relatively high. The suitability and practicability of TED use in Thailand is thus, still questionable!

Although the experimental time is reduced by using two types of TED: the Hooped and the Super Shooter which are considered as the best and least efficient for excluding sea turtles, the results clearly indicate that there are significant rates of escapement in using both types of TED. Therefore, it can be concluded that to use TEDs in shrimp trawls in Thailand, there must be more studies done in order to design the most suitable and/or practical type of TED for shrimp resources.

The First Experiment on Turtle Excluder Devices (TEDs) for Shrimp Trawl in Thailand

These experiments were carried out by TD, MFRDMD of SEAFDEC in cooperation with the Thai DOF in the waters off Chum Phon province during 5 – 18 September 1996 (Chokesanguan, B., Theparoorat, Y., Ananpongsuk, S., Siriraksophon, S., Podapol, L., Aosomboon, P. and Ali, A.). Six types of TEDs were used, namely the Anthony Weedless, the Super Shooter, the Bent pipe, the Georgia jumper, the Mexican and the Thai-KU (Kasetsart University). This study investigated the efficiency of TEDs suitable for use with shrimp trawl nets in order to encourage shrimp trawler fishing communities to use TEDs for the conservation sea turtles. Finally, it is to the benefit of Thailand if it can be excluded from the shrimp import embargo by the US government. The results of experiments were:

- The three types of TEDs (the Super Shooter, the Georgia jumper and the Thai-KU) showed quite good result for a low rate of escape (8.36%, 5.94%, 8.02% during day time and 5.34%, 11%, 2.75% at night).
- The Anthony Weedless TED showed that the rate of escape is 49 % in day time and 35.94% at night.
- The Thai-KU showed the lowest rate of escape, however, because of structure, operation and installation, it was found that there were some operational weight problems.
- The experiments showed that no marine sea turtles were caught in the cod-end or the cover net of the shrimp trawl.

The Second Experiments on Turtle Excluder Devices (TEDs) for Shrimp Trawls in Thailand

These experiments were continued from the first experiments and were carried out in the waters off Song Khla province during 11–24 October 1996. Six types of TEDs were used for these experiments. Five TEDs were the same as in the first experiments and the TTFD (Thai Turtle Free Device, which was developed by SEAFDEC and replaced the Anthony Weedless). The results of experiments were:

- The three types of TED (the Super shooter, the Georgia jumper and the TTFD) showed quite good results for low rate of escape (2.67 %, 6.15%, 1.8% during day time and 1.91%, 0.85%, 1.04% at night).
- The Thai-KU TED did not show the lowest rate of escape this time, it was 8.76% in day time and 11.12% at night.
- During the experiment no sea turtles were caught in the cod-end or the cover net of shrimp trawl net.

The results from the first and second experiments can be concluded that the Super shooter and the TTFD had a quite reasonable result in terms of low rate of escape and convenience of operation. In practical use by fishermen the TTFD seemed to be the most suitable which showed the lowest rate of escape and also ease of installation and construction because all materials used are available locally.

A Comparison of Catchability between Shrimp Otter Board Trawling operated with and without Turtle Excluder Devices (TEDs).

This experiment was carried out by EMDEC (Eastern Marine Fisheries Development Center) in the waters off Trat province (Trat Bight) from June to August 1998 (Roonggratri, M., Songjidswat, A., and Yoosookswat, S.). These experiments used a TTFD-equipped trawler. The results of experiments were:

- The TTFD-equipped trawl showed a significant difference in catch of marine fauna via the TTFD opening, compared with the non-TTFD-equipped trawl. This means that a loss of value of about 47.03 baht/kg/hr or 470.30 baht in one night (10 hour per one night of operation).
- In comparison to Non-TTFD-equipped trawl, the TTFD fishermen would lose 578.50 baht per night.
- With regarding to marine shrimps, the TTFD fishermen would lose 436 baht per night.
- Although the escape of 0.226 kg/hr or 2.32 % of marine shrimp could not confirmed by statistics, the price is, however, very much different because shrimp prices are considerably higher.
- An advantage was that the TTFD could sort out garbage from the net. It was found that about 22.93 % of garbage passed through the TTFD-opening and about 24.46 % remained in the cod-end. Whereas the whole garbage portion of about 63.78 % of the catch were kept in the Non-TTFD-equipped cod-end. In sorting out garbage, the net should offer less resistance and this probably saves fuel.

An Experimental Study of TEDs installed in the Shrimp Trawl Nets of Fishermen in Hua Hin District, Prachuab Kirikan province.

This experiment was carried out by BMDEC (Bangkok Marine Fisheries Development Center) in the waters off Hua Hin District to the Pran Buri river mouth, between 12– 14 June, 18 – 22 July, 18 – 21 August 1998 (Boonkerd, S.). These 3 experiments used the TTFD. The results of experiments were:

- The total escape of marine fauna was 341.92 kg during the 3 trip survey (14.96% of the total catch of which economic fishes species were 7.03%, trash fish were 7.93%). This can be considered as losing an income value of 425.88 baht per day (or 16.15%). For this reason, the fishermen are not convinced to equip their shrimp trawl nets with the TTFD.
- From this survey data, the rate of escape varies directly with the quantity of catch, if there is more catch there will be a high rate of escape.

- The experiment also indicated that no sea turtles were caught in the cod-end or cover net of the shrimp trawl.

Experimental study of Shrimp trawl nets equipped with TEDs of local fishermen in Songkhla province

This experiment was carried out by SMDEC (Southern Marine Fisheries Development Center) in the waters off Songkhla province during June, July and August 1998 (Khaunthanam, N., Nichalanont, N., and Juntakwan, N.).

The experiment was conducted by two baby shrimp trawl fishing boats which have the same length of boat, horse power of engine, size of fishing gear and fishing ground. The comparison of Non TTFD and TTFD were showed about total catch, catch per unit of effort (CPUE) catch and species composition, rate of escape and income. The period of experiments were conducted in 4 months from June to September 1998, about 60 hauls/boat in Songkhla province. The results are as follows:

The data on total catch, catch per unit of effort and income was analyzed to compare the efficiency of Non TTFD and TTFD. And it was showed that it have non significant in statistic. The small shrimp were the most catch composition about 45.74 and 45.76% for Baby-Shrimp Trawl Non TTFD and with TTFD respectively. The catch per unit of effort (CPUE) of Baby-Shrimp Trawl Non TTFD and with TTFD was 21.57 and 20.74 Kg./hr. respectively. The rate of escape is 3.38 %.The small shrimps were the most in escapement composition about 33.92%. The Baby-Shrimp Trawl with TTFD Fishermen showed lose their income about 11.38 baht/hr.

MALAYSIA

Implementation Situation

Various type of fishing gear are used to harvest shrimp in Malaysia. The most popular is the shrimp trawl net that has been used in Peninsular Malaysia since 1966. The use of this gear has spread to all part of the country because it is efficient in catching shrimp.

To comply with the conditions set by the U.S. Shrimp import embargo, the Marine Fisheries Resource Development and Management Department (MFRDMD) and the Training Department (TD) of SEAFDEC in cooperation with the Department of Fisheries, Malaysia, have conducted many experiments to develop TEDs and implement their use by the fishermen in Malaysia.

The first trial was carried out in Thailand and MFRDMD sent staff to join the experiment in September of 1996. After the trail, the actual experiments were conducted in Pantai Segari, Perak State between 17-25 February 1997.

The experiment results indicated that the shrimp catch rate was unaffected by the TED. MFRDMD and TD carried out the 1st demonstrations and a workshop in March 1997 at Pantai Perrius, Perak State in cooperation with Department of Fisheries, Malaysia. There was also an exhibition as an introduction to TEDs on shore. Secondly, the demonstration of the use of TEDs onboard shrimp trawlers was carried at sea. During July 13-14, 1997, training on the use of TEDs was conducted at MFRDMD for DOF staff from various states. Follow up training was again conducted for the Sabah Fisheries officers on 16-17 December 1997.

A questionnaire on the use of TEDs was also given to the fishermen at the start of the implementation process.

The 2nd Demonstration on the use of TEDs was conducted in Sandakan, Sabah during 20-21 May 1998. 20 TEDs were distributed to local fishermen.

The most recent activity was a Lecture on TEDs and a demonstration was given by MFRDMD and TD staff during the Regional Training Course on Sea turtle conservation at MFRDMD on 30 August 1998.

RESEARCH ON TED

MFRDMD (Marine Fisheries Resources Development Management Department), in cooperation with TD (Training Department) and the Malaysian Department of Fisheries (DOF) carried out more experiments. The study was conducted in Pulau Pangkor waters, Perak, Malaysia from 17 to 25 February 1997 (Ali, A. and Ananongsuk, S.). There were 2 sizes of TTFD in these experiments (small size being 80 x 80 cm. and medium size at 80 x 100 cm). The objectives of this study was firstly to compare the escape rate of catches of shrimp trawl nets with 2 sizes of TTFD having different construction angles both during the day and at night time. Secondly, to compare the catch composition with and without the TTFD installation. Thirdly, to study the turtle release efficiency of TTFD. The results of experiments were:

- TTFD prevented marine turtles from being trapped in the net but did not affect the catch of fish and shrimp.
- The average total escape rates by weight of the small and medium sized TTFD in the research vessel were 2.3 and 5.25% for day time operation, 0.01 and 4.67% during night time operation respectively.
- The escape rates of the small and medium sized TTFD in the fisherman's boat were 6.53 and 4.05% for daytime operation, 3.34 and 7.70% during the night operations respectively.
- The use of two sizes of TTFD did not reduce the catch of shrimp.
- The small and medium sized TTFDs were found to be suitable for the use by Malaysian fishermen.

THE PHILIPPINES

Implementation Situation

In 1996, The United States Embassy in Manila informed the Philippines Government that the USA would embargo shrimps trawled in open waters in the countries without sea turtle protection devices beginning on May 1, 1996. With the presence of marine sea turtles in the country, the Philippines is one of the countries where export is embargoed. The US program includes mandatory use of TEDs on all commercial shrimp trawl vessels and has effective enforcement of this requirement.

In order for the Philippines to export wild-caught shrimp to the US beyond May 1, 1996, the Department of State must certify to congress by that date that the Philippines has implemented a sea turtle conservation program comparable to the US program. Thus compelling commercial shrimp vessels to use TEDs.

Sea trials and demonstrations on the use of TEDs in the Philippines waters were conducted by SEAFDEC/TD in cooperation with the Bureau of Fisheries and Aquatic Resources (BFAR) of the Philippines in April of 1997.

Research on TEDs

Experiment of Turtle Excluder Devices (TEDs) in Manila Bay, The Philippines

This experiment was carried out by the researchers of Bureau of Fisheries and Aquatic Resources (BFAR), J.O. Dickson, R.V. Ramiscal, R.D. Mango, N. Lamarca, M. Chiuo and A. Santiago.

There were two-phase study to assess the potentiality of shrimp trawl net fitted with TEDs in Manila Bay.

1. The first phase study is selection of suitable TEDs (TTFD Thai Turtle Free Device, SS Super Shooter and Hooped HP). A five month period (from March to July 1998) of sea trial, to collect

the catch and escapement data of fish, shrimp and others species in order to make comparison. There are 88 hauls (52 hauls in day time and 36 hauls in night time). Towing time was set for one hour duration. A total catch of shrimps, fish and others (invertebrates) is 1,170.00 kg. An overall mean catch is 13.29 kg/hr (CPUE). The catch composition by group shored shrimp is 5.4%, fish is 41.8% other 52.8%. The catch of TTFD is 272.00 kg., a CPUE of TTFD is 12.34 kg/hr. The catch of shrimps was highest in TTFD with CPUE of 0.73 kg/hr.

In term of escapement, a total weight of 110 kg. Was able to escape through the opening of three types of TED (9.4% of the total catch). Among the TED types, pooled average escapement rate was significantly lowest in the TTFD with 6.9% compared to SS is 10.5% and HP is 11.6%. The average escapement by weight was also significantly lowest in TTFD.

The experiment of TEDs to determine which type was most suitable under local condition that indicated the Thai Turtle Free Device can be adopted in local shrimp trawlers. Because of, it is the most simple, easier to construct and light to handle during operation.

2. The follow up study (second phase) or variation testing was made to evaluate the effect of funnel in directing the catch towards the bag and placement of escape opening to minimize further the escapement rate of shrimp in TTFD. This experiment used four-variations were tested (WT-with funnel top opening, WB-with funnel bottom opening, WOT-without funnel top opening and WOB-without funnel bottom opening respectively). This experiment was conducted in five periods from August to December 1998. Data collection in 80 hauls (44 hauls in day time and 36 hauls in night time operation). Towing time also was set for one hour duration. A total catch of shrimps, fish and others (invertebrates) is 876.07 kg. An overall mean catch is 10.95 kg/hr (CPUE). The catch composition by group showed shrimp is 37.63 kg. (4.3%), fish is 518.88 kg. (59.2%) and others is 319.57 kg. (36.5%). The highest catch (CPUE) was observed in WT is 13.17 kg/hr. and the lowest catch was obtained in WB is 9.23 kg/hr. In addition, commercial or marketable species has 473.03 kg. (54% of the entire catch). The other proportion was non-commercial species about 403.04 kg. (46% of the total).

For the escapement, a total weight of 55.69 kg. (about 6.36% of the total catch) was able to escape through the opening of the 4 types. The percentage escapement of different species grouping by types used are: WT type (shrimp 1.17%, fish 6.12% invertebrate 5.22%), WB type (shrimp 5.29%, fish 3.86%, invertebrate 9.49%), WOT type (shrimp 2.49%, fish 6.42%, invertebrate 6.33%), WOB type (shrimp 3.71%, fish 5.20%, invertebrate 9.55%) respectively.

The experiment to determine which position of the escape openings (top or bottom portion). It was determine that shrimp escapement is significantly correlated with position of the escape openings. It is recommended that the escape openings be placed at the top portions of the net. In addition, to determine the effect of funnel. The test of four variation types (WT, WB, WOT, WOB) indicated that funnel has no significant effect in reducing escapement.

INDONESIA

Implementation Situation

Indonesia government has banned trawl fishing gear throughout the country since 1980. Due to some reasons, however, industrial shrimp trawling has been licenced only in the Arafura Sea and its adjacent waters since 1 January 1983 with another name as BED-equipped shrimp net. BED is Indonesian term for TED (Turtle Excluder Device) which was introduced by National Marine Fisheries Service (NMFS) NOAA, USA.

When US Shrimp Import Embargo went in effect on May 1996, Indonesia was not included, because Indonesia has changed that Hooped TED has been used in Indonesia since 1983.

Then NMFS introduced Super Shooter TED to Indonesia in October 1996 to replace the Hooped TED. In 1997 November, SEAFDEC/TD has also introduced TTFD to Indonesia based on experience in Southeast Asia Countries.

Indonesia shrimps have been exported over the world, particularly to Japan and in small quantity to USA. In global free trade, shrimp import embargo to Indonesian shrimp should be anticipated as it can happen any time by any country. The solution is Indonesia still develop the selective shrimp trawling by utilizing the NMFS TEDs and also the TTFD based on experience in the Region.

A new type, Super Shooter TEDs, was introduced to Indonesia by NMFS when a term of NMFS's expert visited Indonesia and conducted a short training program at Tegal, Central Java, on 14-19 October 1996. In response to the new type of TED, by the official letter No. IK.320/D3.702/97K on 28 January 1997 DGF ordered the provincial Fisheries Services in Amber and Jayapura to conduct the TED-training on 17-22 February 1997 in particular for the fishing masters of the shrimp fishing companies.

Research on BED

Research on selective devices in industrial shrimp fishing BED has rarely been carried out, at least by Research Institute for Marine Fisheries (RIMF). Before introducing BED or the first type TED to shrimp fishing companies, a collaborative scientific trial on BED was conducted by Agency for Assessment and Application of Technology (AAAT), Bogor University of Agriculture (BUA), DGF and RIMF in the Arafura Sea in September/October 1982 (AAAT, 1982). Two trawl nets of the same size-one equipped with BED (BED-net) and another without BED (non BED net)-were continuously towed within one hour (trial towing hour) in the waters of 40-50 m deep by a double rigger, tonnage 180.50 GT and powered 425 HP. The trial resulted in a statistically significant reduction of by-catch in the BED-net by 80.11 kgs or 42.51% per towing and a statistically insignificant loss of shrimp in the BED-net by 4.27 kgs or 27.48% per towing. However statistically insignificant, the loss of shrimp in BED-net appears to be rather high, 27.48-31.41%. Considering in the actual fishing if two net towed within two hours (commercial towing hours), the shrimp loss will be 17.08 kgs/towing. This result could not prove the potential benefit of BED to be promoted in industrial shrimp fishing in the Arafura Sea and since then, no more scientific trials to be conducted. Therefore, it could be understood if the shrimp fishing companies rejected the BED, as many of American shrimpers also complained that it was too cumbersome and dangerous to use, especially in the rough sea and were reluctant to use it (Oravets and Grant, 1986) in addition to heavier, larger and hard to handle (Prodo, 1993).

In relation to FAO Cooperative Research Network in Asia and Indian Ocean Region on Selective Tropical Shrimp Trawling, a preliminary fishing trial on the use of the new type TED, Super Shooter TED in industrial shrimp fishing in the Arafura Sea was carried out RIMF in cooperation with a shrimp fishing company in Ambon on 1-10 April 1997 (Nasution, 1997b). Two of four-seam trawl nets of the same size-TED-net and non TED-net- were continuously towed within two hours (commercial towing hours) in the Aru and Dolak waters of 15-25m deep by a double rigger, tonnage 180.70 GT and powered 600 HP. The trials in the Aru water (15 hauls) resulted in a statistically significant loss of tiger shrimp in the TED-net by 3.427 kgs or 34.07% per towing, a statistically insignificant loss of banana shrimp in the TED-net by 2.591 kgs or 33.59% per towing and a statistically significant reduction of by-catch in the TED-net by 128.419 kgs or 41.15% per towing. The trial in the Dolak waters (20 hauls) resulted in a statistically insignificant loss of banana shrimp in the TED-net by 9.226 kgs or 33.09% per towing (tiger shrimp were not caught in this waters) and a statistically significant reduction of by-catch in the TED-net by 196.590 kgs or 45.65% per towing.

However the Super Shooter TED can really reduce by-catch, the shrimp loss appeared to be rather high, while significant loss of tiger shrimp happened in the Aru waters. These results still could not prove the potential benefit of the TED to be promoted into industrial shrimp fishing in the Arafura Sea. The reasons of high loss of shrimp might be due to the position of the exit hole, where the trialed TED

equipped with bottom exit hole, while top exit hole appeared to be better than bottom exit hole (Michell, *et. al.*, 1995), the material and weight of TED and its size in relation to the circumference of codend, as well as the flotation. There should be a modification of TED design and construction before introducing to industrial shrimping, otherwise they will reject it again. Unlike the BED, which has been rejected by most American shrimpers, the Super Shooter TED should not be complained as it showed a statistically insignificant loss of shrimp when triaging in USA (Renaud, *et. al.*, 1992) as well as in Australia (Robins and Campbell, 1997).

While trialing in the Aru waters, the endangered sea turtles were not caught, but in the Dolak waters two sea turtles were caught in different hauls, one in the TED-net trapped in the TED then could escape alive by itself and another in the non-TED-net which then released alive into the water. It meant that endangered sea turtles might frequently be caught in the Arafura Sea.

BRUNEI DARUSSALUM

The SEAFDEC/TD assist Brunei fisheries officer to conduct sea trials and demonstrations of TTFD from 2 to 9 September 1997. The trials and demonstrations were divided into two parts, the first being conducted on the Fisheries Research Vessel, K.P. Tenggiri, the second being conducted aboard the commercial trawlers, Sri Mega Berangkat and Seri Maa Moor.

Eleven TTFD equipped hauls were conducted, seven with bottom opening and four with a top opening TTFD. The escape rate at 15% was rather high because there were a lot of big fish in the area which could not pass through the TTFD. Also, there were a lot of big logs and garbage which were retain on the TTFD. However, the sea trials were successful from the point of view of excluding sting rays and garbage.

Six hauls were made on board the Sri Mega Berangkat, three using a bottom and three using a top opening TTFD. The escape rate in this series was 10%. Four hauls were carried out on board the Seri Maa Moor, two hauls with bottom opening and two with a top opening TTFD. The escape rate for this series was 5% with one sea turtle being caught in the cover net over the opening (second codend).

The overview of the result is that the trials and demonstrations were successful, but the escape rate was rather high due to the fishing conditions in Brunei Darussalam waters, big fish, logs of wood and garbage.

CONCLUSIONS

As was shown in the foregoing efforts conducted by many of the Southeast Asian member countries. In general, the development of TFDs have been successfully and effectively conducted in a short period of time. However, the policy makers in the region have to think whether the above exercise was the most appropriate approach. Since all action was politically and unilaterally initiated by the condition and threats by the shrimp importers such that the shrimp export will be stopped from the countries which do not implement the TED obligation to their fishermen. By this unilateral intervention, all possible research work for conserving marine turtle was regarded as a second priority and the development of appropriate TEDs received the highest priority. After four years extensive efforts by regional researchers as well as the management staff, the harshest impacts of the shrimp embargo were avoided. Now, is the time for the regional countries to consider how we can achieve sustainable fisheries including avoiding the catch of endangered species.

Firstly, The TEDs were in general, successfully developed to 1) exclude the catch of sea turtle, 2) minimize the reduction of catch as seen above. However, it was also found that the fishermen were very reluctant to use the TEDs for the following reasons. A) In some parts of the region such as the Gulf of Thailand, the population of sea turtles were already reduced and a catch of turtle cannot be

anticipated. B) Heavy devices are sometimes dangerous to handle on board and in the water. C) Due to the large amount of debris on the sea bottom, TEDs work as garbage collectors and choke the TEDs opening preventing further catch to go into the cod end. In this connection, each Government will have to invest more money and staff time to enforce the obligation of the fitting of TEDs to the trawl nets not only on shore, but also at the time of operation. Therefore, there is a question of sustainability of the application of TEDs.

If the issue is to protect the sea turtle, another approach can be taken. Awareness building exercises to avoid the consumption and marketing of sea turtle in all countries can be another avenue. Since the TED application has to anticipate a large investment for its enforcement, investment to change the culture not to consume turtles have a similar or even more effective outcome. If such a cultural change does not occur, consumption and marketing of the turtles will be continued through illegal operation. Penalties for the consumption and marketing of sea turtle is another approach in line with the foregoing.

The most important initiative, at this moment, is to initiate a comprehensive regional research program on turtle conservation with effective dissemination mechanisms of the knowledge and advice derived from the research work to the policy makers and general public especially on the status of the turtle population and the proposals to conserve such resources.

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