STUDY ON

JTEDs

JUVENILE AND TRASH EXCLUDER DEVICES IN INDONESIA

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
TRAINING DEPARTMENT

TD/RES/83

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Abstract

The experiment was conducted during August 2002 in the Bintuni Bay, Arafura Sea of East Indonesia using the commercial double-rigged trawler in order to examine the releasing ability of Juvenile and Trash Excluder Devices (JTEDs) in bottom trawl. This experiment was in the serial study of using the JTEDs under the program of selective fishing gear and practice for responsible fishing, sponsored mainly by FAO/GEF project. Three types of JTEDs (Rectangular, Semi-curve and Rigid sorting grid JTEDs) with 40 mm bar spacing were used in this experiment as 40mm bar spacing has been shown the best results for releasing the non-target catch and could maintain the maximum catch resulted from the previous experiments.

The results indicated that the rigid sorting grid JTED could give the escapement levels of about 79% of the total catch when it was about 25% for semi-curve and rectangular type JTED. However, it was observed that semi-curve JTED performed the highest ability in shrimp retention ratio as compared with another two type of JTED used in this experiment. It could be suggested that the effectiveness of the modifications for JTEDs used in the region could be further fine-tuned to improve the performance.

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Introduction

SEAFDEC Training Department, in cooperation with SEAFDEC member countries conducted JTEDs experiments, as a part of a study on Juvenile and Trash Excluder Device in Southeast Asia. This collaborative project is a related Turtle Excluder Device (TED) project which successfully carried out experimented in the region in 1997.

Since 1998, Training Department has continued to promote on responsible fishing operation through selective fishing gear namely JTEDs (Juvenile and Trash Excluder Devices) in Thailand, Brunei Darussalam, Vietnam, Malaysia and Indonesia.

The SEAFDEC/TD has carried out a series of experiments to release the juvenile, small fish and trash fish by conducted the experiments using the Juvenile and Trash Excluder Devices (JTEDs) installed in the bottom trawl net in the Southeast Asian Region. In 1998, the first experiment were started. SEAFDEC/TD carried out the experiments using rectangular shape window and semi-curve JTEDs in the water off coast of Prachuab Kirikhan and Chumporn province, Gulf of Thailand under cooperation with the Department of Fisheries, Thailand. It was suggested that improvements of JTEDs for bottom trawl nets are needed for more selective performance. In September 2000, second experiments were conducted in the water off the coast of MauraTown, Brunei Darussalam. In these experiments, the design of the JTEDs devices had been developed to be a rigid sorting grid JTEDs. The results indicated that the rigid sorting grid has higher separating performance than others. The width of the bar spacing of the sorting grid should effect to the release performance. With this reason, the third experiment was designed to be carried out to study on the release performance of the rigid sorting grid in difference widths of the bar space. Then, the third experiments and demonstrations were carried out in Cat Ba Island in Hai Phong Province, Vietnam in May 2001 under the collaboration with RIMP of Vietnam. The results from these experiments showed that the rigid sorting grid has a better separating performance than rectangular and semi-curve JTEDs for releasing juvenile and trash fish. To cover all Southeast Asian countries and the suitable width of bar spacing of the rigid sorting grid, the fourth experiment was conducted in the waters off the coast of Alor Setar, Kedah State of Malaysia in September 2001 under the cooperation with the Department of Fisheries, Malaysia. The results from these experiment found that the 12 mm bar spacing rigid sorting grid JTED seem to be suitable to release juvenile, small fish, trash fish and kept target species/size in these fishing area. In May 2002, SEAFDEC/TD organized the Regional Practical Workshop on Selective Fishing Devices associated with the FAO/GEF project to promote the selective fishing devices under the responsible fishing technology and practices program through training and demonstrations to the participants from member countries. To continue these activities Indonesia was selected as a country where the implementation of such devices can be beneficial. As the Department of Fisheries, Indonesia also has a project on Demonstration and Training on By-Catch Reduction Devices (BRDs) /Turtle Excluder Devices (TEDs) in Sorong in August 2002. The experiments were carried out in the coastal waters off Bintuni Bay, Arafura Sea, Papua, Indonesia.

Material and Methods

An experiment was conducted in August 2002 using double rig trawls on a commercial trawler in the Arafura Sea (Eastern Indonesia) (Fig.1). Eight operations were done in shrimp trawl fishing ground. The modified JTEDs were designed to release juvenile, small fish and trash fish and maintain shrimps catches in the codend. In this experiment, three modified JTEDs were constructed which developed by SEAFDEC/TD, namely, Rectangular shape, Semi-curve and Rigid sorting grid JTEDs. Rectangular shape JTEDs was 80x100 cm^2 iron frame, with diameter 10 mm and the escape opening using vertical grid (iron rod with diameter 6 mm). For semi-curve type was the same size of the opening (80x100 cm^2) but the escape opening using vertical soft grid (polyethylene rope Z twist with diameter 6 mm.)(Fig.2). Both types have 20 escape opening with 40 mm bar spacing. For the rigid sorting grid JTEDs was modified from the NOFITRAOMSA/S Sort-X system, this system was developed in Norway, and it consist of a metal grid fitted into the top side of the trawl ahead of the codend. The rigid sorting grid was made of rigid rod steel and consisted of three sections join together Two separate grid with fixed bar space 40 mm. were connected to polyethylene net covered steel frame, the main function of which was guide escaping fish away from the trawl net and to keep the system balanced during operation. This weighed about 15 kg. and neutral buoyancy was achieved with plastic floats. During fishing operation, the sorting grid opened and kept in a steady position by using chains. The angle of attachment was 45 degree in the first part of the sorting grid. The JTEDs frame consist of 65x80 cm^2 two pieces which the top of frame is a semi-curve shape were modified to suitable for the net shape and the 50x80 cm^2 was the middle piece with 40 mm bar spacing (Fig.3.). In this experiment, the cover net was designed to cover all the opening escape and codend that attached supporting hoops with a diameter of 1.30 m (Fig.4.).

Experiment and Data collection

Experiment was carried out between 31 August – 1 September 2002 on board the KOKAS 18, Loa 23 m, 350 hp., 98 tongross commercial shrimps trawler (Mexican shrimp trawl) based in Bintuni bay, Papua, Indonesia. Trawling was carried out during daytime from 0900-1700 hrs. in depths between 29-43 m. The net was a trawl used commercially by the KOKAS 18 (Fig.5.) which the JTEDs and cover net were attached at ahead of the codend. Towing speed was approximately 2.5 to 4.0 knots. Eight operations were done, each of one hour duration, the rectangular shape and semi-curve JTEDs were tested for 2 replications each except for rigid sorting grid JTEDs was tested for 4 replications.

The entire catch in the codend and the cover net were divided into species components and weighed. Escape fish from the trawl net by using JTEDs devices were calculate as:

$$\text{Escape } (\%) = W_{\text{cover net}} \times 100/(W_{\text{codend}}+W_{\text{cover net}}) \quad (1)$$

Where

$W_{\text{cover net}}$ is the catch weight (kg) in the cover net

W_{codend} is the catch weight (kg) in the codend

Length frequency of economically important species, and trash fish obtain from both cover net and codend were analyzed in relation to the percentage escapement. The parameter of total length of *Thryssa mystax* and *Johnius* sp. were collected during the study in the experimental area.

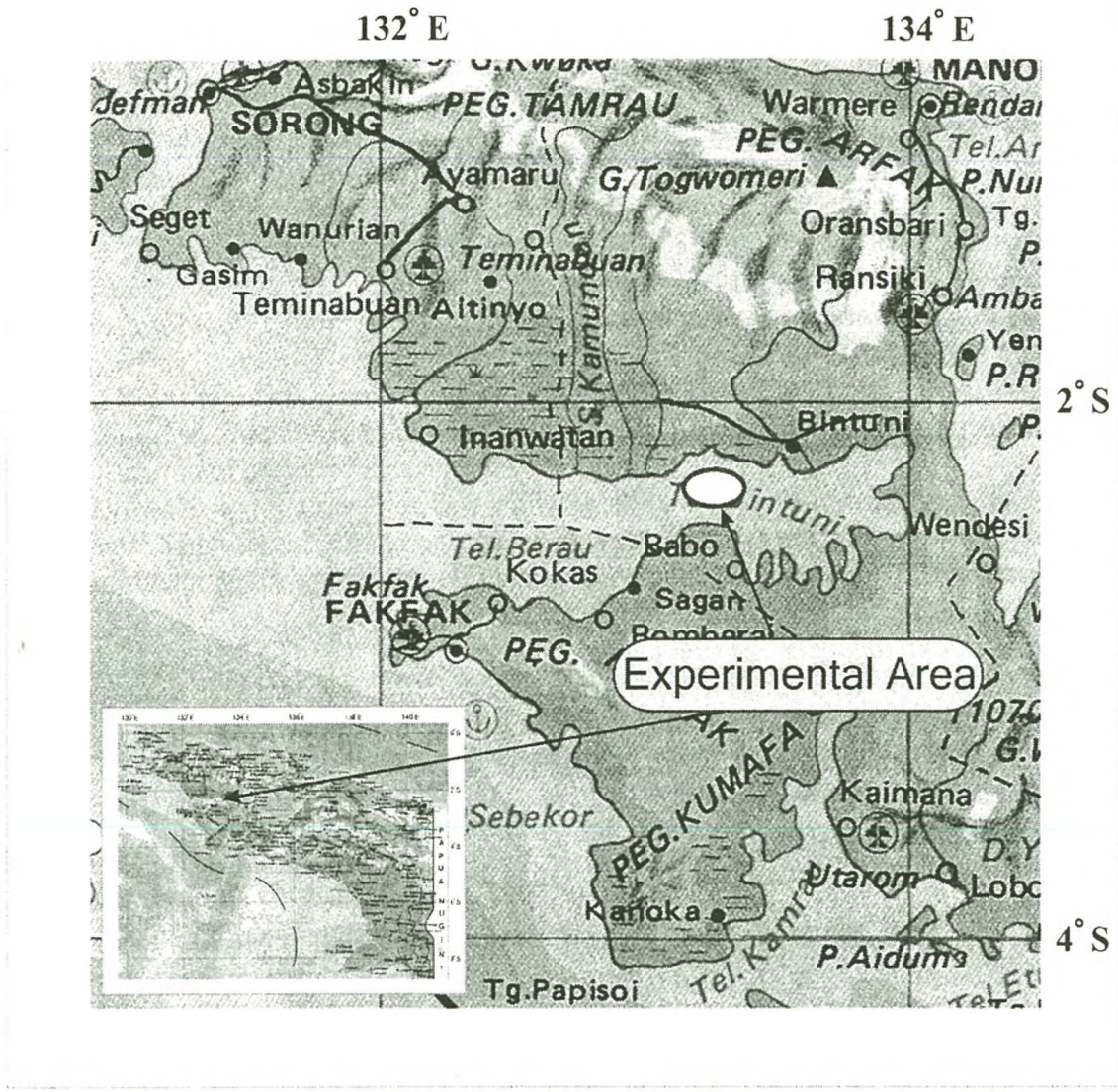


Fig. 1. Map for the Arafura Sea showing the general area (hatched ellipses) where experimental trawling was performed

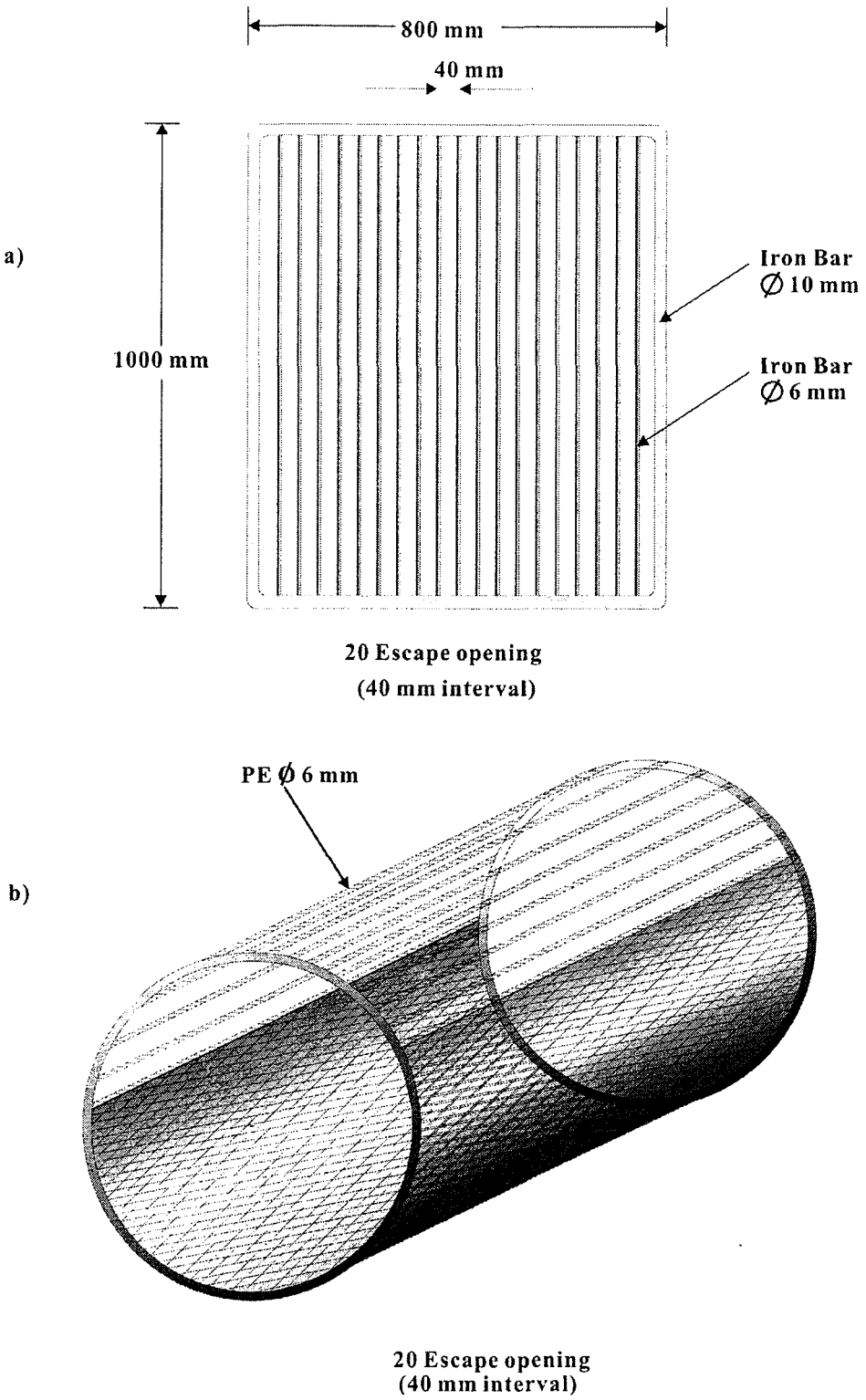


Fig. 2. Diagram of construction of JTEDs
a) Rectangular shape JTEDs

b) Semi-curve JTEDs

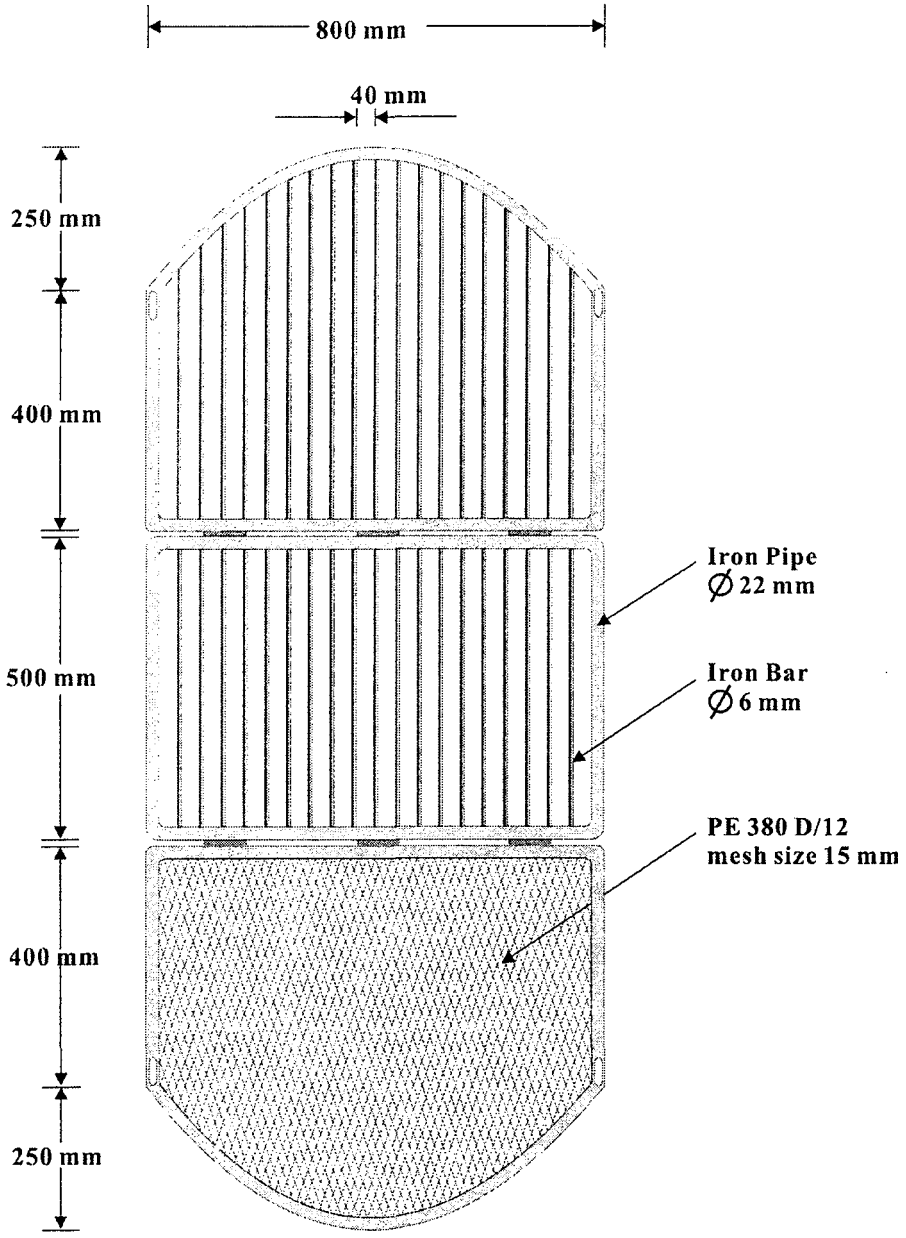
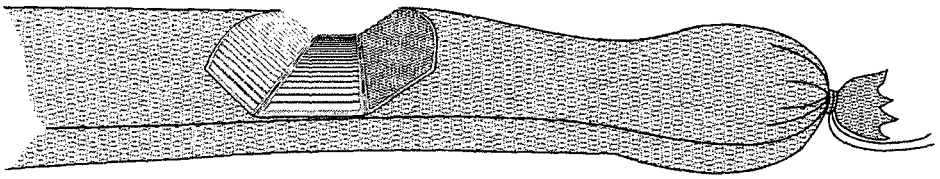


Fig. 3. Diagram of construction of Rigid sorting grid JTEDs

a)



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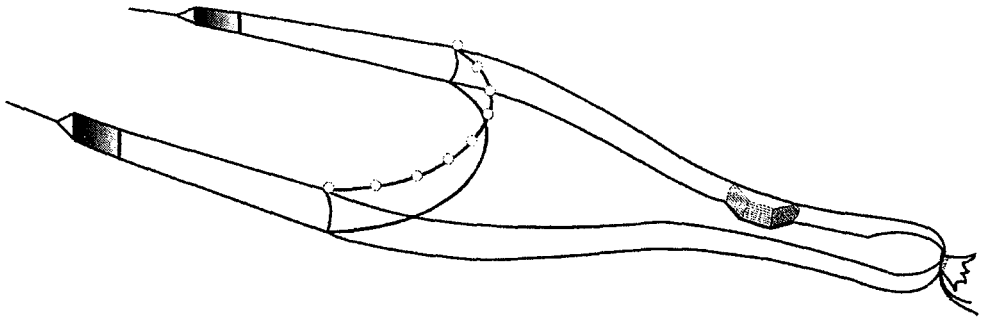

c)

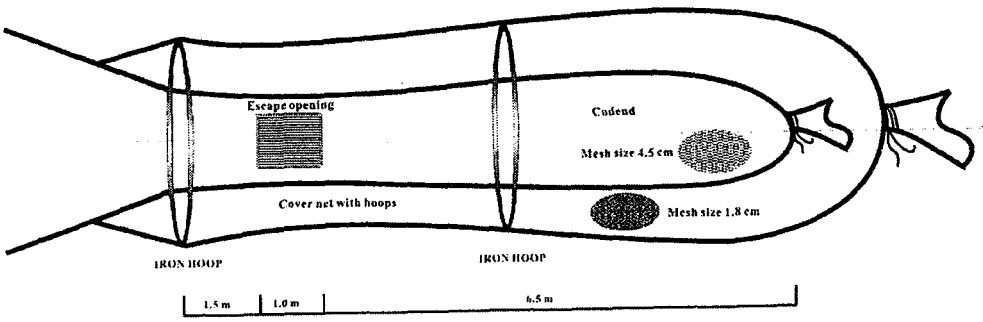

Fig. 4. A diagrammatic representation of JTEDs
a) and b) showing an installation of JTEDs in to the codend part
c) showing the cover net for experiments

Trawl net Plan of KOKAS 18

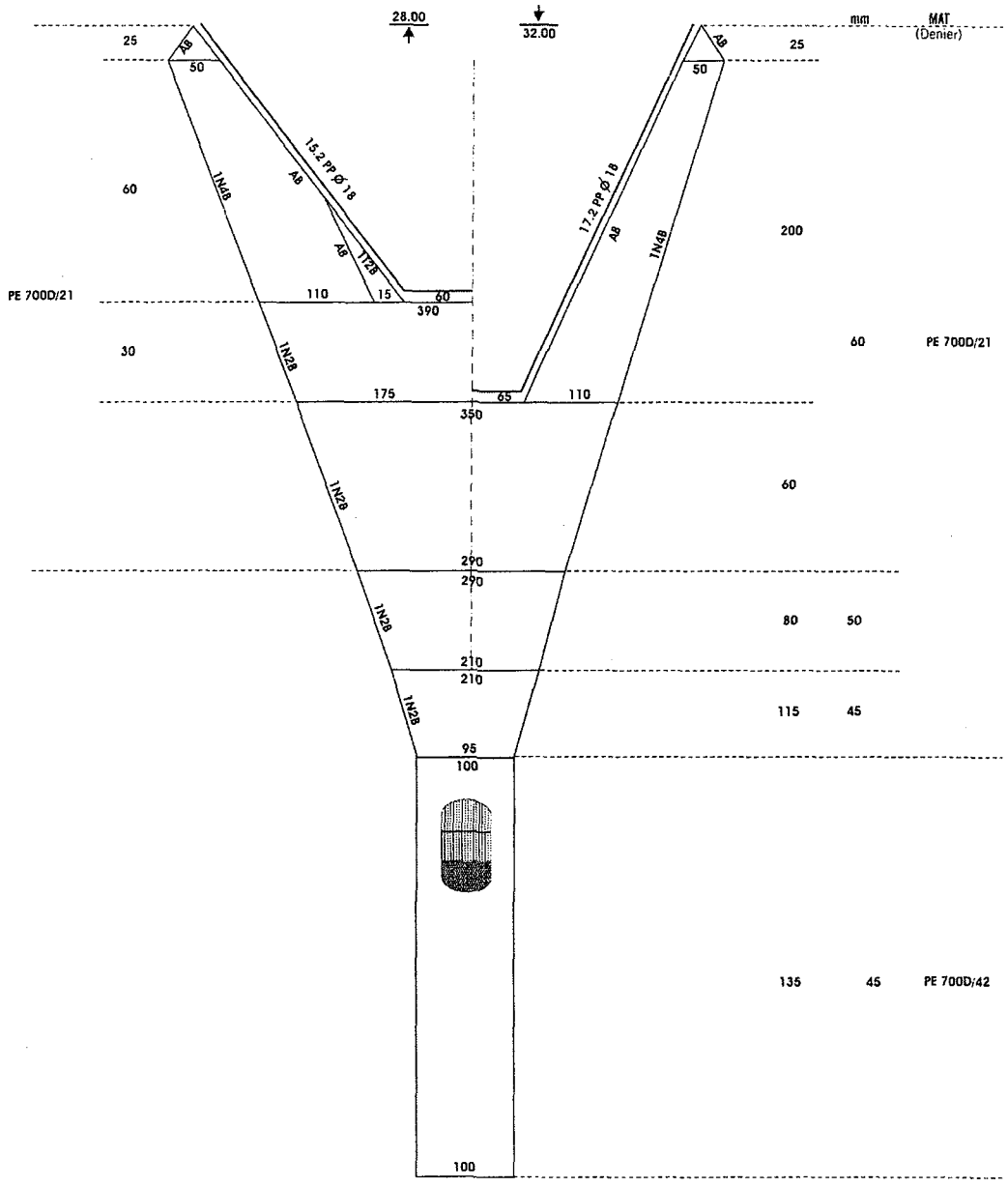

Fig. 5. Diagram of fish trawl net used in the experiment

Estimate of trawl net selectivity

Per Sparre, et.al. (1989) delivered the mathematical expression for the cumulative normal distribution to describe the selection ogive. (As done by Jones, 1963 and 1976). However, from a calculation point of view it is easier to work with the so-called "logistic curve":

$$S_L = \frac{1}{(1 + e^{(S_1 - S_2 * L)})} \qquad (2)$$

where L is the length and S_1 and S_2 are constants (Paloheimo and Cadima, 1964, Kimura, 1977 and Hoydal, Rorvik and Sparre, 1982). By applying a few algebraic manipulations it follows that there is a one to one correspondence between Length at which 50% of the fish entering the gear are retained ($L_{50\%}$) and S_1, S_2:

$$L_{50\%} = S_1 / S_2 \qquad (3)$$

$$L_{75\%} = (\ln 3 + S_1)/ S_2 \qquad (4)$$

A direct method is to set up a gear selectivity experiment. The most commonly used experiment is the "covered codend method" (described by among others Pope *et. al.* 1975 and Jones 1976). The relatively large meshed codend of the trawl is covered with a small mesh net, which retains (almost) all fish. By comparing the length compositions of the fish remaining in the codend and in the cover net, the probability of escapement through the large mesh net can estimated. The model to estimate the selective ogive is defined by Equation (3) rearranged into

$$\ln (1/S_L - 1) = S_1 - S_2 * L \qquad (5)$$

where L is the length interval midpoint
S_L is the fraction of length group L fish retained in the codend

$$S_L = \frac{\text{number of fish in the codend}}{\text{number of fish in the codend and in the cover}} \qquad (6)$$

It is seen that if S = 0 or S = 1 the expression in Equation (5) is not defined. The regression analysis by Equation (5) gives the results:

Intercept (a) = S_1 and
Slope (-b) = S_2

Result and Discussion

Table 1. Shows the general information from the experiment. Eight fishing operations for three different types of JTEDs were carried out.

CPUE and Catch composition

Table 1. Shows the catch per unit effort (CPUE) in the experimental area were varied from 37-162.5 kg/hr/haul

Fig.6. Shows the catch composition by group (by percentage of total weight) in the experiment. Percentage of pelagic fish, demersal fish, shrimp and trash fish were 25%, 8%, 18% and 44% combination respectively.

Appendix 1. Shows the total catch composition by group (by percentage of total weight) of each operations.

Commercial species mostly found in this experiment are *Penaeus merguensis*, *Penaeus scuptilis*, *Metapenaeus ensis*, *Johnius* sp. and *Thryssa mystax.*

Table 1. General information of the experimental study on the JTEDs attached to the shrimp trawl net during 31 August to 1 September 2002 in the waters off Bintuni Bay, Arafura Sea, Papua, Indonesia.

No.	date	time		Position		towing		depth	wind	warp	JTED			non JTED	Type of
		set	haul	set	haul	speed	dir.	m		m	Codend	Cover	total	kg.	JTEDs
1	31/08/02	1115	1215	2°,23'.322 S 133°,23'.901 E	2°,23'.806 S 133°,25'.281 E	2.4 kt.	085°	29.7	E	160	17.0	54.0	71.0	51.0	rigid sorting grid
2	31/08/02	1250	1350	2°,23'.188 S 133°,24'.256 E	2°,22'.858 S 133°,24'.723 E	2.6 kt.	225°	29	E	160	18	36.0	54	32.8	rigid sorting grid
3	31/08/02	1425	1525	2°,23'.153 S 133°,23'.662 E	2°,22'.535 S 133°,24'.463 E	2.2 kt.	105°	43-36	N/E	160	4.0	34	38	33.5	rigid sorting grid
4	31/08/02	1545	1645	2°,23'.075 S 133°,24'.933 E	2°,22'.811 S 133°,22'.940 E	2.7 kt.	220°	37-43	N/E	160	5.0	42.0	47.0	28.0	rigid sorting grid
5	01/09/02	0945	1045	2°,22'.811 S 133°,24'.410 E	2°,22'.225 S 133°,26'.051 E	2.8 kt.	030°	41.0-34.6	N/E	160	62.0	6.0	68.0	38.0	semi-curve window
6	01/09/02	1205	1305	2°,22'.190 S 133°,25'.290 E	2°,22'.200 S 133°,25'.265 E	2.2 kt.	339°	33.9	N/E	160	111.0	51.1	162.5	98.0	semi-curve window
7	01/09/02	1301	1401	2°,21'.557 S 133°,26'.067 E	2°,22'.125 S 133°,25'.505 E	4.0 kt.	205°	28.4-36.9	N/E	150	45.0	17.0	62.0	48.0	rectangular window
8	01/09/02	1425	1525	2°,21'.867 S 133°,25'.855 E	2°,22'.527 S 133°,25'.495 E	3.1 kt.	204°	31.8-38.6	N/E	150	28.0	9.0	37	29.0	rectangular window

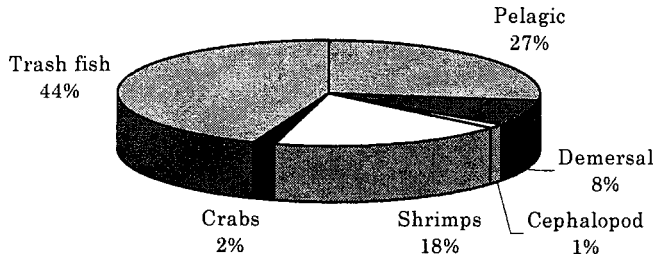

Fig. 6. Total Catch composition by group (by percentage of the total weight)

Escapement Level

Appendix 2, 3 and 4. Show the total catch composition in the cover net, codend from each operations and the total catch from the rigid sorting grid, semi-curve and rectangular JTEDs respectively.

The escapement levels of catch from different type of JTEDs are shown in Fig.7. The results indicated that the escapement levels were in wide range from 0-100% using JTEDs devices. About 79% of total catch were released by rigid sorting grid JTEDs type with the 40 mm of bar spacing, and about 25% escapement levels of total catch were released by semi-curve and rectangular shape JTEDs. The escapement levels for pelagic species was in range from 49-97 %. On average, 97%, 53% and 49% of the pelagic fish are released by rigid sorting grid, semi-curve and rectangular shape JTEDs, respectively. The escapement levels for trash fish were 68%, 4% and 17% for rigid sorting grid, semi-curve and rectangular shape JTEDs, respectively. It is clearly seen from these results that pelagic fish and trash fish could be easily released from the trawl nets by using the rigid sorting grid JTEDs.

About 1-2% of total catch are cephalopods and crabs.

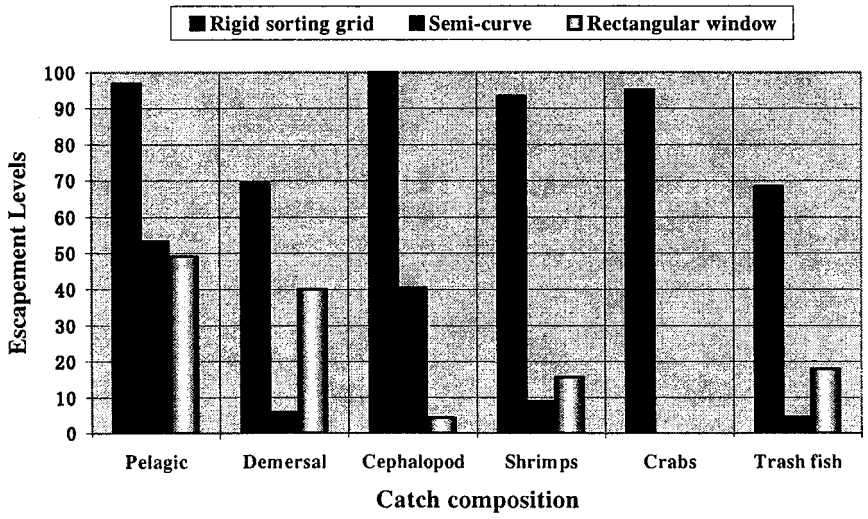

Fig.7. Escapement level of different type of JTEDs

The catch size composition of the anchovy (*Thryssa mystax*) and croakers (*Johnius* sp.) using semi-curve and rigid sorting grid JTEDs with 40 mm bar spacing as well as numbers of fish retained in the cover net are presented in Table 2 and 3. The minimum size of *Thryssa mystax* caught is 1.0 cm and maximum size is 17.9 cm. *Thryssa mystax* size classed at 10.1-11.0 cm is the mode of the majority of the catch. Croakers (*Johnius* sp.) minimum sizes caught were 1.35 cm and maximum was 15.4 cm. The mode of catch is fish classed at 4.1–5.0 cm.

Trawl net selectivity

The number of anchovy (*Thryssa mystax*) in each length class caught by rigid sorting grid JTEDs codend and number of fish in the cover net are presented in Table 2, calculated for fraction retained by Equation (6) are plotted against total length as shown in Figure 8, a). The estimated logistic curve calculated by Equation (3) are also simultaneously presented in the Figure 8. The length at which 50% of the fish entering the gear are retained ($L_{50\%}$) as calculated by Equation (4)

Table 2. Number of *Thryssa mystax* caught in codend and cover net from the experiment

Length interval	Class	sRigid sorting grid JTED		curve JTEDs-Semi	
2L - 1L		Number in Codend	Number in Cover net	Number in Codend	Number in Cover net
1.0-0.1	1	0	0	0	0
2.0-1.1	2	0	0	0	0
3.0-2.1	3	0	0	0	0
4.0-3.1	4	0	0	0	0
5.0-4.1	5	1	0	0	0
6.0-5.1	6	0	0	0	0
7.0-6.1	7	0	4	0	0
8.0-7.1	8	2	13	0	1
9.0-8.1	9	11	65	2	16
10.0-9.1	10	27	28	9	25
11.0-10.1	11	7	14	19	72
12.0-11.1	12	3	7	9	90
13.0-12.1	13	2	5	5	40
14.0-13.1	14	0	1	0	8
15.0-14.1	15	1	0	0	1
16.0-15.1	16	0	1	0	1
17.0-16.1	17	0	0	0	0
18.0-17.1	18	0	1	0	0
19.0-18.1	19	0	0	0	0
20.0-19.1	20	0	0	0	0
Total		**54**	**139**	**44**	**254**
		193		**298**	

Table 3. Number of *Johnius sp.* caught in codend and cover net from the experiment

Length interval 2L - 1L	Class	Rigid sorting grid JTEDs		curve JTEDs-Semi	
		Number in Codend	Number in Cover net	Number in Codend	r inNumbe Cover net
1.0-0.1	1	0	0	0	0
2.0-1.1	2	0	1	0	0
3.0-2.1	3	0	2	0	0
4.0-3.1	4	0	22	2	0
5.0-4.1	5	0	58	9	0
6.0-5.1	6	0	30	2	0
7.0-6.1	7	3	25	1	2
8.0-7.1	8	5	25	3	0
9.0-8.1	9	5	30	5	1
10.0-9.1	10	3	19	4	4
11.0-10.1	11	2	17	2	4
12.0-11.1	12	1	4	0	0
13.0-12.1	13	0	1	0	2
14.0-13.1	14	0	0	0	0
15.0-14.1	15	0	0	0	0
16.0-15.1	16	0	0	0	1
17.0-16.1	17	0	0	0	0
18.0-17.1	18	0	0	0	0
19.0-18.1	19	0	0	0	0
20.0-19.1	20	0	0	0	0
		19	**234**	**28**	**14**
Total		**253**		**42**	

Calculation of fraction retained of *Thryssa mystax* caught by rigid sorting grid JTEDs codend plotted against total length associated with the estimate logistic curve are shown in Fig.8, a). The length at which 50% of the fish entering the gear are retained ($L_{50\%}$) for rigid sorting grid JTEDs codend is 9.9 cm

Calculation of fraction retained of *Thryssa mystax* caught by semi-curve JTEDs codend plotted against total length associated with the estimate logistic curve are shown in Fig.8, b). The length at which 50% of the fish entering the gear are retained ($L_{50\%}$) for semi-curve JTEDs codend is 13.8 cm.

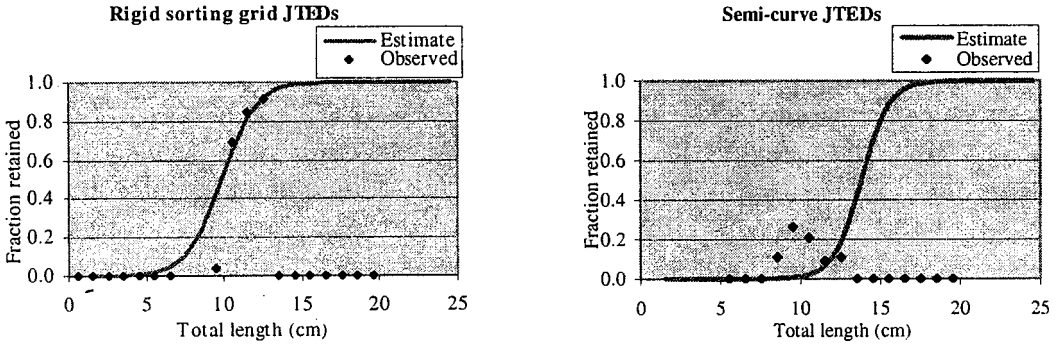

Fig. 8. Gear selection ogive for *Thryssa mystax* caught by a 40 mm bar spacing from Rigid sorting grid and Semi-curve JTEDs

Calculation of fraction retained of croakers (*Johnius* sp.) caught by rigid sorting grid JTEDs codend plotted against total length associated with estimate logistic curve are shown in Fig.9, a). The length at which 50% of the fish entering the gear are retained ($L_{50\%}$) for rigid sorting grid JTEDs codend is 12.6 cm.

Calculation of fraction retained of croakers (*Johnius* sp.) caught by semi-curve JTEDs codend plotted against total length associated with estimate logistic curve are shown in Fig.9, b). The length at which 50% of the fish entering the gear are retained ($L_{50\%}$) for semi-curve JTEDs codend is 7.3 cm.

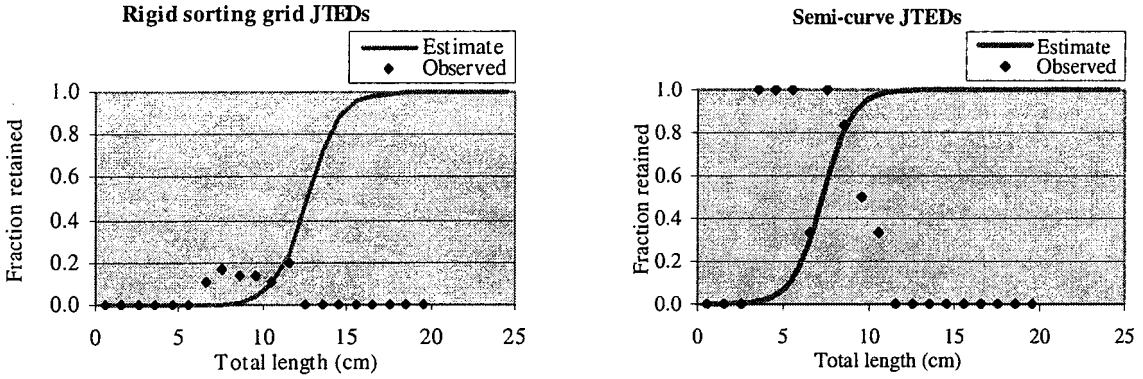

Fig. 9. Gear selection ogive for *Johnius* sp. caught by a 40 mm bar spacing from Rigid sorting grid and Semi-curve JTEDs

In this experiment the size selectivity of *Thryssa mystax* and *Johnius* sp. using trawl net with 40 mm bar spacing rigid sorting grid and semi-curve JTEDs with codend mesh size 45 mm were compared. The result indicate that $L_{50\%}$ of *Thryssa mystax* caught by trawl net with rigid sorting grid and semi-curve JTEDs is 9.9 cm and 13.8 cm respectively (Fig.8, a) and b)). When comparing fish size at $L_{50\%}$ between semi-curve and rigid sorting grid JTEDs, it found that, the value of $L_{50\%}$ of the semi-curve are larger than the rigid sorting grid JTEDs. This mean that the semi-curve JTEDs performed with more flexible than rigid sorting grid JTEDs for the opening because of the opening of the semi-curve are made from polyethylene rope.

The logistic curve of *Johnius* sp. shows reversed phenomenon. The $L_{50\%}$ of *Johnius* sp. caught by trawl net with 40 mm bar spacing rigid sorting grid and semi-curve JTEDs with codend mesh size 45 mm also were compared. The result indicate that $L_{50\%}$ of *Johnius* sp. caught by trawl net with rigid sorting grid and semi-curve JTEDs is 12.6 cm and 7.3 cm respectively (Fig.9, a) and b)). It found that, the value of $L_{50\%}$ of the rigid sorting grid is larger than the semi-curve JTEDs. This means that the selectivity of the rigid sorting grid JTEDs performed with higher for *Johnius* sp. than semi-curve JTEDs. It seems to be caused by missing data on the ratio of fish in the codend and cover net at small fish size.

Conclusion

This study has shown that the JTEDs devices with 40 mm bar spacing not benefit to shrimps trawl fisheries in this fishing area, especially the rigid sorting grid JTEDs which have the highest escapement levels of shrimps which are the main target species, while the semi-curve JTEDs seem to be more suitable for this fishing ground than others JTEDs. With this reason, the rigid sorting grid JTEDs must be modifications could greatly improve its performance for suitable for shrimp trawl fishing ground. The weight and buoyancy balance of the grid is the first priority for more consider in the next experiment. From the observed during the experiment found that the rigid sorting grid seem to be good buoyancy balance only in the first operation in the shallow water (which is already cut off from the experiment because of it is not the same fishing ground). After that the buoyancy become reducing because of the float were effected by the water pressure after more using in the deeper area cause to the rigid sorting grid JTEDs sink effect to the fish and shrimps can be easily escape through the opening escape from rigid sorting grid JTEDs more than semi-curve and rectangular shape JTEDs which are lower weight, so the buoyancy balance need to be calculate and check. Second is the grid design must be improve as develop especially grid interval for the best performance to release juvenile, small fish and trash fish and also must be remain the large shrimps which are the main target species. The bar spacing need more consider same as the good result from the previous experiment in the study on juvenile and trash excluder devices in Malaysia, May 2001, which shows that the 12 mm bar spacing rigid sorting grid seem to be suitable for shrimp trawl fisheries because of it can be maintain all large shrimps in the codend 100 %. Reducing of the bar spacing or grid interval it mean additional more grid rods cause to the weight will be increase then the buoyancy balance must be adjust again. Third, cover net design and mesh size of the net in codend part should be improved. The result from this experiment when compare between total catch weight by using 40 mm bar spacing JTEDs (cover net mesh size 18 mm and codend mesh size 45 mm) and control codend (with out JTEDs and cover net) found that the total catch weight by using JTEDs with cover net is higher than total catch weight by control codend (with out JTEDs and cover net) in all operations (Appendix .1). It mean that some small fish and shrimps may freely pass through the mesh of the codend net to the cover net cause to effect on the total catch data because of the cover net can catch both from codend mesh and JTEDs escape opening. With this reason, in case of the large mesh size of codend which is similar to bar spacing of JTEDs, the pocket net is more appropriate than cover net method. And the last thing that should be consider is the good planning and management. The experiment should be cover in the nighttime operations to compare between the efficiency of catching especially for shrimp trawl fishing operations. The numbers of replications need to be additional more for good data. Resource persons who understanding in sorting and collecting data are also needed. For a good result to be release juvenile, small fish and trash fish and can be shorted the time for sorting the small fish from shrimps. This device must be maintain the target catch (shrimps) in the codend for the acceptable from fishermen in the future.

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