STUDY ON TURTLE EXCLUDER AND BY-CATCH REDUCTION DEVICES IN THE PHILIPPINES

by

Jonathan O. Dickson
Bureau of Fisheries and Aquatic Resources
Philippines

Abstract

Experimental test-fishing of different TED types, namely : modified Thai Turtle Free Device (TTFD), Super Shooter (SS) and Hooped TED were conducted for eight (8) fishing days in March and April 1997 in Manila Bay. Assessment of the TED performance, i.e. its separating efficiency (escapement) and effect to catch (retained) was observed. Likewise, a single cod-end trawl (without TED) was also tested to serve as control. A total catch of 538.3 kgs. were obtained from thirty-two (32) sets of tow or eight (8) tows for each type. Of these, retained catch was 459.62 kgs. (85.38% relative abundance) while escaped accounts a total of 78.7 kgs. or 14.62% of the over-all catch. Lowest escapement was recorded in the modified TTFD with a total of 13.64 kgs or a mean escapement rate of 1.71 kgs. per hour of dragging (11.55% of the over-all catch). The modified TTFD, likewise, has the highest total of shrimps retained with 8.83 kgs or 1.10 kgs/hr (8.45% of the mean total retain) which is slightly higher than the control. Relative escapement rate for shrimps was recorded least in the SS with 0.05 kgs/hr followed closely by modified TTFD with 0.07 kgs/hr/drag. Initial results indicated that the modified TTFD has a better output if the TED performance factor to be considered were least escapement rate and higher shrimp catching efficiency. It is imperative that more test trials be conducted to validate each of the TEDs efficiency. Proof of the actual turtle release is also very crucial to support the use of trawl-fitted with TEDs. Some by-catch reduction devices were also tried. Sorting efficiency of shrimp selective devise with upper and lower panels was tested in shrimp trawl. Shrimps were expected to concentrate at the upper portion because of its behaviour. Preliminary results indicated that greater catching efficiency of the lower bag was observed. Catch difference between shrimps and by-catch at the upper and lower portion of separator grid was significant and sorting efficiency of shrimps from by-catch was low. Studies on square-meshed codends for trawl and Danish seine, and purse seine mesh selectivity are also presented.

I. TURTLE EXCLUDER DEVICES

1. INTRODUCTION

Marine turtles are among the Earth oldest creature. They have plied the seas for nearly 90 million years, and their ancestral lineage dates back to about twice that age. Of the eight (8) species of marine turtles in the whole world, five (5) can be found in the Philippines. These are the leatherback (*Dermochelys coriacea*), the loggerhead (*Caretta caretta*), the olive ridley (*Lepidochelys olivacea*), the hawksbill (*Eretmochelys imbricata*), and the green sea turtle (*Chelonia mydas*). The Protected Areas and Wildlife Bureau of the Department of Environment and Natural Resources have an on-going marine turtle conservation and protection program. By virtue of Executive Order No. 542 signed on June 1979, the Task Force Pawikan now referred as the Pawikan Conservation Project, became the government's urgent response to conserve the endangered marine turtle population in the country. The project has included the following major activities : (1) the Turtle Islands Heritage Protection Area where a bilateral agreement is forged between Malaysia and Philippines; (2) the declaration of Taytay Bay and Green Island Bay in Palawan as the first dugong sanctuaries; (3) the establishment of the 1st marine mammal sanctuary in Pamilacan Is.; (4) establishment/declaration of nine (9) marine turtle sanctuaries; (5) habitat surveys in 136 sites from 19 provinces; and, (6) researches on marine turtles excluding the turtle excluder devices.

In 1996, the United States Embassy in Manila informed the Philippine government that the United States will embargo shrimps trawled in open water in the countries without sea turtle protection program beginning 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 sea turtle excluder devices on all commercial shrimp trawl vessels and effective enforcement of this requirement. In order for the Philippines to export wild-caught shrimps to the US beyond May 1, 1996, the Department of State must certify to Congress by that date that the Philippines has adjusted a sea turtle conservation program comparable to the US program, that the program requires commercial shrimp vessels to use TEDs.

This study is intended to determine the catching efficiency of shrimp and fish trawls using TEDs, to study the turtle releasing efficiency of TEDs, to determine the escaping rate of fishes and to compare the catch composition between a trawl net without TED and with TED.

2. MATERIALS AND METHODS

Three (3) kinds of turtle excluder devices were used in the study, namely : the modified Thai Turtle Free Device (TTFD), the Super Shooter (SS), and the Hooped TED (Fig 1 to 3). Another trawl net without TED was used as control.

One (1) medium-sized trawler was leased for five (5) days a month to try the TEDs. TEDs will be installed in the trawl net before the cod-end extension. The cod-

end will be provided with a cover net to determine the rate of escape of fish/shrimp caught as well as the rate of capture of any sea turtles. Fishing operations will be tried during daytime and nighttime, at one (1) hour drag each.

The catch composition for both the bag and cover net will be weighed by species type. The catching efficiencies of the three (3) TEDs and the trawl net without TED will be statistically analyzed.

3. PRELIMINARY RESULTS

3.1 Total Catch and Species Composition

Thirty-two (32) tows or 8 tows for each type were completed for two months observation. The observed total catch was 538.3 kgs. Of these, retained catch was 459.62 kgs. (85.38% relative abundance) while escaped accounts a total of 78.7 kgs. or 14.62% of the over-all catch (Table 1).

For the retained catch, percentage grouping was dominated by fish with 215.38 kgs. (46.86%). This was followed by invertebrates with 213.49 kgs. or 46.45% of the total retained; and, lastly, shrimps with 30.75 kgs. or 6.69% of the catch (Table 2).

Also presented is the escaped catch percentage in descending order : invertebrates (54.7 kgs or 69.5% relative abundance); fish with 22.37 kgs. (28.42%); and, shrimps with 1.64 kgs. escapement or 2.08% escaped occurrence (Table 3).

3.2 Without TED

Recorded catch of an ordinary trawl type was 132.76 kgs. The mean catch rate was 16.6 kgs/hr. Total shrimps caught weighed 8.5 kgs. (6.4% of the total retained) and a mean rate of 1.06 kgs/hr/drag. Fish caught totaled 61.85 kgs. (46.59%) or a mean catch rate of 7.73 kgs/hr. Other invertebrates has contributed around 62.41 kgs. (47.01%) which is almost in proportion with fishes. Its mean catch rate was 7.8 kgs/hr.

Dominant species caught were crabs with 28.07 kgs. or 21.14% retainment; cardinal fish with 21.49 kgs. (16.19%); and, sea mantis (*Squilla spp.*) with 15.96 kgs. or 12.02% relative abundance.

3.3 Modified Thai Turtle Free Devise (TTFD)

The modified TTFD has a pooled catch of 118.09 kgs. Retained catch recorded was 104.35 kgs. or a mean catch rate of 13.06 kgs/hr. Escaped catch has a total of 13.64 kgs. or a mean escapement rate of 1.7 kgs/hr of dragging. Mean percentage distribution of retained and escaped were 88.45% and 11.55%, respectively (Table 1).

Shrimps caught registered a total of 9.39 kgs. Retained shrimps has a volume of 8.83 kgs. (8.45% of the total retained catch). Mean catch rate of shrimp was 1.1

kg./hr. Escaped shrimps recorded was 0.56 kgs. (4.11% of the total escaped) or a mean shrimp loss of 0.07 kgs/hr/drag. The relative retain and escapement percentage for shrimps were 94.09% and 5.91%. Shrimps caught by this TED type was slightly higher than the control (without TED) and escapement was lowest among the other TED types (Table 4).

Fish accounts a total of 54.37 kgs. Its retained has a volume of 48.43 kgs. (46.37% of total retain) and has a mean catch rate of 6.05 kgs/hr. Moreover, escaped fish has a total of 5.95 kgs (43.62% of total escapement) and a mean escapement rate of 0.74 kgs/hr. Retain and escapement percentage for fish were 89.06% and 10.94%. Accounted escaped catch was lowest among other TED type (Table 5).

The remaining portion of the catch which are comprised by invertebrates totaled 54.32 kgs. Of these, retained weight was 47.19 kgs. (45.18% of the total retain) or a mean catch rate of 5.9 kgs/hr. Recorded escaped weight was 7.13 kgs.(52.27%). Its mean escapement rate was 0.89 kgs/hr. Retain and escapement distribution was 86.88% and 13.12% (Tables 2, 3 and 6).

Commercially-viable escaped catch totaled 7.63 kgs. (55.98% of total escapement) for 8 hours dragging or a mean escapement of 0.95 kgs/hr while non-commercial catch was 6.0 kgs. (44.02 %) or a mean of 0.75 kgs/hr. Data shows that the distinction of catch was almost equal in proportion. Escaped species were dominated by crabs with 3.38 kgs. or 24.83% of individual catch, followed by cardinal fish with 3.14 kgs. or 23.03%,; and, sea mantis with 3.03 kgs. escapement which is 22.25% of the total escapement.

For retained catch, relative percentage distribution was 52.78% for commercial and 49.32% non-commercial. As such, almost half of the catch were composed of trash fish.

3.4 Super Shooter (SS)

Trawl fitted with this TED type had a total catch of 158.49 kgs. Retained catch was 110.9 kgs. or a mean catch rate of 13.86 kgs/hr. Recorded escaped catch was 47.59 kgs. or a mean escapement rate of 5.95 kgs/hr. The average retained viz. escapement percentage was 69.97% and 30.03% (see Table 1).

Shrimps caught in the codend comprised around 5.93 kgs. (5.35% of the total retained) and 0.4 kgs. escaped total (0.84% of the total escaped). Average shrimp catch rate was 0.74 kgs/hr. while escapement rate values 0.05 kgs/hr (tables 2 and 3). Lowest escapement rate for shrimp was noted for this TED type. Fish retained totaled 47.39 kgs. (84.34% of the pooled fish catch) and 8.8 kgs loss (15.66%). Its catch and escapement rate was 5.92 and 1.1 kgs/hr, respectively. The invertebrate group has a total retain of 57.58 kgs. (60.0%) while escaped species has a total of 38.4 kgs (40.0%) (Tables 2, 3, 4,5 and 6).

Data on commercial and non-commercial species distribution (escaped) was 11.1 kgs (23.33%) and 36.49 kgs. (76.67%). Large-sized jellyfishes escaped through this TED type with cummulative weight of 32.0 kgs. (28.65% of the total escaped). Other major species that escaped were the cardinalfish (2.93 kgs.; 6.15%) and sea mantis (2.85 kgs; 5.99%).

As TTFD, percentage sharing of commercial and non-commercial retained catch was 47.74% and 52.26%.

It could be noted that among other TED types, SS had the relatively highest escapement.

3.5 Hooped TED

The total catch of this TED was 128.96 kgs. distributed into retained catch of 111.49 kgs. or a mean of 13.94 kgs/hr.; and, escaped total of 17.5 kgs. or a mean escapement rate of 2.18 kgs/hr. The average escapement viz. retained catch percentage was 86.46% and 13.54%, respectively (Table 1). The Hooped TED was next to TTFD with least escapement percentage.

Shrimps has a total catch of 8.17 kgs. Retained shrimps caught was 7.49 kgs. or a mean catch rate of 0.94 kgs/hr. Escaped weight of shrimps was 0.68 kgs. or mean escapement rate of 0.09 kgs/hr.; retained fishes comprised a total of 57.69 kgs. (mean of 7.21 kgs/hr) and escaped weight of 7.61 kgs.(mean escapement of 0.95 kgs/hr); and, retained invertebrates has a total of 46.31 kgs. and escaped catch of 9.2 kgs. (Table 2,3,4 and 5).

Commercial and non-commercial escaped species has recorded a total of 7.93 kgs. (45.41%) and 9.54 kgs. (54.59%). Again, jellyfish has the topmost volume among the escaped catch with 5.0 kgs. (28.65%). But contrary to SS, half of the escaped catch were of commercial value such as crabs (2.04 kgs; 11.69%) and cardinalfish (1.84 kgs; 10.54%). While its retained catch, consisted with other TEDs, has an almost equal distribution (commercial, 51.73% by 48.27% non-commercial).

II. SELECTIVITY AND BY-CATCH REDUCTION DEVICES

1. SELECTIVE SHRIMP TRAWLING

One of the most prominent gear type for harvesting shrimp in the Philippines is the shrimp trawl. These gears are widely used in shrimping grounds of Manila Bay, Calbayog Bay, Carigara Bay, Pilar Bay and Maqueda Bay and carried out by all sizes of vessels with engine ranging from 10-500 horse power. Existing shrimp trawls being used in the country may not be as selective as its name suggests since shrimps form only a minor part of the catch.

Of the total shrimp production in 1994, 85% (92,647 mt) came from aquaculture and only 15% (16,702) came from capture fisheries. Of the production from the capture fisheries, 95% (15,867 mt) came from municipal or small scale fisheries using vessels of 3 gross tons or less; only 5% (835 mt) were caught by commercial fishing vessels as bycatch from finfish fishing operations.

Only in recent years, the importance of shrimp trawl efficiency devices has become a major factor in the fishery management aspect and sustainable resource use of penaied shrimps.

The study, thus, aims to test the sorting efficiency of separator devices through shrimp trawling to catch shrimps and eventually permitting unwanted species to escape.

The objectives are to determine the efficiency of separator panel/device to dissociate shrimps from other bycatch species in shrimp trawl fishing; to determine and compare the shrimp-fish ratio in the catches of the traditional shrimp trawl and the shrimp trawl with separator; to determine and compare the catch-per-unit-effort of the same gears; and, to recommend appropriate policies on shrimp trawling.

Two trawl nets similar in size were constructed. The net with separator (experimental net) has a double cod-end partition (i.e., the upper and lower section), while the other has a single cod-end which is traditionally being used (Figures 4 & 5). Both nets were also provided with a single-lined tickler device (i.e., rope provided with sinker). The design concept was based from the Devismes System of Ets Le Drezen in France but some modifications were included to suit local fishing conditions.

An outriggered shrimp trawl with 90 hp was used in test-fishing operations. Fishing areas were conducted in the traditional shrimping grounds of Manila Bay from 5 to 29 m deep and over a substrate ranging from soft mud, sandy-muddy and sandy.

The two (2) net types were operated alternately in a standard dragging time of one (1) hour per set. Drags of less than one hour due to various reasons were not counted as valid hauls.

The catch of each haul was sorted, identified and weighed (grams) according to group or species, whenever possible. Shrimps and bycatch from the upper and lower bunt of the net with separator viz. catch with and without separator were treated separately.

A total of ninety-four (94) complete tows or 47 pair sets for each net were used to evaluate the catching efficiency of both nets yielded a total catch of 994.86 kgs. or an average catch rate of 10.05 kgs. per hour. Shrimps obtained a volume of 97.26 kgs. or a relative abundance (RA) of 10.29% of the total catch; by-catch species includes fishes and other invertebrates with 438.79 kgs. (46.44% RA) and 408.82 kgs. (43.27% RA), respectively.

The net with separator caught a total of 460.33 kgs. or a mean catch of 9.79 kgs./hour . The net without separator yielded a total of 484.53 kgs. or a mean catch of 10.31 kgs./hour.

Catch comparison of shrimps between nets was almost similar. The net with separator devise contributed around 47.19 kgs. or an average catch rate of 1.0 kgs./hr. while the net without separator recorded a volume of 50.07 kgs. or an average catch rate of 1.07 kgs./hr. (Fig.6).

By-catch species (fishes and other invertebrates) caught with separator device totaled around 413.14 kgs. or an average catch rate of 8.79 kgs./hour of dragging. On the other hand, the net without separator obtained a total of 434.45 kgs. or a average catch rate of 9.24 kgs./hr.

Of the total shrimp catch of 47.19 kgs., the upper and lower bag obtained a share of 14.49 kgs. (30.7% RA) and 32.7 kgs. (69.3% RA), respectively (Fig.7).

For bycatch, upper bag produced 131.75 kgs. (31.89% share). Lower bag harvested a total of 281.39 kgs. or 68.11% share of the total by-catch.

Based from the two-way test (t-Test) analysis, no significant difference was observed on the mean catch rate of shrimps between nets. The catch rate are almost similar. Comparing the shrimp catch of the upper and lower bag, observations were contrary to expected results since the lower bag harvested more shrimps than the upper bag. Test comparisons also supported the greater catching efficiency of the lower bag. Thus, sorting efficiency of the separator panel was low. Details are discussed in a separate paper.

2. SQUARE-MESHED CODEND IN SMALL TRAWL

Bottom trawl is the most important fishing gear in exploiting demersal species especially in soft-bottom areas in bays, gulfs, straits and other nearshore areas. With the decrease in production of most of the trawlable areas in the country, the bottom trawl was pinpointed as a major cause of overfishing. It is so efficient that it catches almost everything along the path of the gear, including small and juvenile fishes. It is also argued that the bottom trawl destroys breeding and rearing grounds of fish.

A selective mesh size and shape is one of the methods in the management of the trawl fisheries. Therefore, there is indication that square meshed cod-ends could significantly contribute to improving the trawl fisheries. It can improve the efficiency of the trawl operation since the amount of trash fish are discarded easily and sorting time is reduced.

This study was made to determine differences between the square mesh and the traditional diamond shaped mesh in the rate of retention and escapement of catches. The study was conducted in Manila Bay with depths from 3 to 9 fathoms. The pumpboat used was a 27-footer, outriggered banca with a 16 HP gasoline inboard

engine. A two-seamed trawl net with two (2) different shapes of mesh at the cod end were constructed and utilized in the experiment. The net headrope is 6.5 meters long while the netting was made of polyethylene and nylon materials. The square-meshed and the diamond shaped mesh of 3.81 cm. stretched were temporarily attached to the body of the trawl net and detached after each fishing operation.

Experimental trawl fishing was conducted for three to five days per month. The duration of one drag was one hour. All catches in the cod-end and cover net were measured and recorded.

A total of 39.3 kgs. of various demersal and pelagic fishes were caught in 33 drags of one hour duration. Using the 3.81 cm cod-end, the 22 drags caught a total of 29.1 kgs. of various species while the 5.08 cm. cod-end, the 11 drags caught 10.12 kgs. Using the cod-ends with the same mesh size but different shapes, the catch by volume of square shaped cod-end shows a lower mean percentage of retainment with 4.6% compared with the diamond mesh of 15.8% retainment. The escapement ratio for the square and diamond mesh is 85.4% : 18.8%, respectively. Using the catch of square shaped cod-ends with 3.81 cm. and 5.08 cm. mesh size, the percentage retained for both mesh size is 57.02% and 40.76% respectively while the escape percentage is 33.89% and 59.24% respectively indicating that a larger square mesh has a higher percentage of escapement. A detailed technical paper is being prepared.

3. SQUARE-MESHED CODEND IN DANISH SEINE

The use of square mesh netting instead of diamond mesh in danish seines have been gaining ground in various countries such as Canada, Japan, Australia and Taiwan because of its high selection rate for larger fish and a promotion of juvenile escapement. The high-selectivity of square mesh nets have been attributed primarily to characteristic of the meshes to stay open allowing escapement of smaller fish especially juveniles of commercially important species (Sterling, 1991; Huang and Chow, 1992: Maclennon, 1992) which ultimately results in increased juvenile recruitment in the area and assures sustainable fisheries.

In this study, two fishing boats of the same size will be used; one using the square-mesh cod-end and the other will be using the diamond mesh cod-end. The two fishing boats will be simultaneously operating in one area. Fishing will be confined in the Visayan sea. Fishing ground will be stratified according to the distance from the shore (0-15 km. and more than 15 km.)

The project will be conducted for a period of five (5) days per month for 5 months . Four (4) drags for each boat will be targeted. The duration of one drag is one hour. The total weight and species composition of the catch from the cod-end (retained) and the cover net (escaped) will be determined.

The net will be designed and constructed for a typical commercial danish seine vessel. Three mesh sizes of polyethylene materials will be used. The cod-end will be fitted with a fine meshed cover net in order to catch the fish that escaped through the

cod-end.

The traditional modified danish seine is provided with a diamond mesh cod-end. A cover net will be provided while the other net is provided with a square-meshed codend. This project is on-going.

4. PURSE SEINE MESH-SELECTIVITY FOR SMALL PELAGICS

The study was conceptualized in connection with the issuance of Fisheries Administrative Order No. 155 regulating the use of fine meshed nets in fishing pursuant to Sections 4, 7 and 34 of the Presidential Decree No. 704 (Fisheries Decree) Fine mesh nets means all nets/webbing's whether made of natural fibers, synthetic or any other material with a mesh less than three (3) centimeters between two (2) opposite knots of a full mesh when stretched. Its prohibition states that it shall be unlawful for any person, corporation, partnership or cooperative to fish in Philippine waters using fine mesh nets except for fish species that are small but matured already.

In view of the experiences of fishing companies that the use of three (3) cm. mesh size caused major problem in the fishing operation due to gilling of small pelagic at the body and wing parts of the net, there is a need to verify and validate the observations whether the existing regulation will be revised or amended.

The study was conducted on board M/V Maya-Maya, a 185 gross ton-steel training and research vessel rigged with purse seine and longline gears. It was done for one-year period in Zambales coast. Monthly fishing operation was undertaken. A productive purse seine gear measuring 800 meters long by 137 meters deep exclusively designed with compartmentalized parts of net using various mesh sizes ranging from 2.54; 3.04; 3.81 cms. was constructed. The three (3) mesh sizes were replicated in the bunt, body and wing portion of the net. All sectoral portions are provided by cover nets with mesh sizes smaller than the strip mesh sizes. It shall serve as impounding nets to determine the different sizes and types of species that will escape in this various mesh sizes. It is through the escapement from the cover nets and those gilled that we can detect the composition and percentage of juveniles and matured species caught. The escaped fishes per mesh size are collected with their lengths, bodies and girths measured. Likewise, the total catch will be sorted by species and their volume recorded. Monthly distribution and fluctuation of catch are also analyzed.

Based on preliminary results there were 5082 individuals of fish (186 kgs) gilled in the three experimental mesh sizes and gilling percentage were as folllows : 3.048 cm, 53%; 3.81, 36%; and, 2.54 cm, 11%. Commonly gilled fishes were roundscads, sardines and herrings Fig.8).

Gilling was highest at the central portion of the net, most likely due to the effect of the position of dimboat during hauling. It was also interesting to note that the difference in gilling between the sectoral parts was due to gilled sardines and herrings which gravitated towards the center. For the other species including the roundscads, gilling was observed to increase slightly towards the bunt portion

A total of 17,014 pcs of fish weighing 163 kgs were able to escape from the experimental mesh sizes. Only three species/groups were of significant quantity namely : red sea harder (*Emmelycthys nitidus*), roundscads (*Decapterus spp.*) and anchovies (*Stolephorus spp.*). Observed escaped species were juveniles except some of the anchovies which are characteristically small but already matured species.

Escapement of fish through a mesh is directly proportional to the mesh size and this was evident in this study. Among the experimental mesh sizes, percentage escapement was highest at the largest mesh and correspondingly decreased with decreased mesh size. Of the total number, 65.6% escaped through 3.81 cm., followed by 3.048 cm. with 28.5% , and, 5.9% through 2.54 cm. mesh size. By weight, comparative difference was more apparent since 76% were recorded at 3.81 cm., 21.5% at 3.048 cm. and, lastly, 2.5% at 2.54 cm.(Fig. 9). This also suggests that the average weight of individual fish escaping through the mesh also increases with the mesh size. Likewise, escapement for all of the species proportionally increased with increasing mesh size. Data collected are presently analyzed and the paper will be the basis to increase mesh sizes in sardine purse seine and ringnet.

III. RECOMMENDATIONS

The status of major fishing grounds in the Philippines particularly at municipal waters were proven at or beyond its critical condition. Fishery resources are finite, thus, fishery management options are necessary in order to ensure its sustainability. Only in recent years that wise use and conservation measures were hereby stressed. As a solution to such problems, selectivity devices were introduced.

Understudied is the shrimp trawl-fitted with "Turtle Excluder Devices (TEDs)". The main purpose of rigging the TEDs is to allow the escape of sea turtles and other endangered species. With the absence of sea turtle catch experiment in Manila Bay, operation of TEDs in other shrimp trawlable grounds and where sea turtles exists will be conducted. Future activities will include a release of live sea turtle inside the net and its behaviour will be observed through underwater video documentation.

Trawl and modified danish seines have been pinpointed as major contributors to overfishing. These gears make use of diamond mesh netting. Realizing the potential of the use of square-meshed codends as another management tool, current studies on the escapement and retention of catches, especially of juveniles using this type of net and the diamond mesh codend are being implemented. Although preliminary results show that the square mesh had lower percentage retention by volume regardless of operation, a thorough study on mesh size is still needed.

The small-mesh sizes employed in surrounding nets especially in purse seine and ringnet allows the possibility of growth overfishing which is detrimental to the fishery resources and unsustainable fishing. Although, there exists a regulation on minimum mesh size, continuous research on the optimum mesh size for multi-species stocks is encouraged. The research results will validate whether the existing regulation

will be strictly enforced or amended.

Continued scientific researches are required to complement with the long-range strategies for sustaining fishery resources and to intensify responsible fishing practices.

IV. REFERENCES

Bacallan, J.J. The Future of Marine Turtles. People and Nature.

Huang, T.S. and Y.S. Chow. 1992. The Effect of Trawl Cod-end design on selection characteristics. J. Fish. Soc. of Taiwan. 19(2) : 103-114.

Maclennon, D. N. 1992. Fishing Gear Selectivity : An Overview. Fish. Res. 13 (3) : 201-204.

Mitchell, J. F. et. al. 1995. The Turtle Excluder Device (TED) : A Guide to Batter Performance. NOAA Tech. Memorandum. NMFS-SEFSC-366.

National Marine Fisheries Development Center. 1995. A Study on Purse Seine Mesh Selectivity for Small Pelagic. Travel Reports. Unpublished.

Ramiscal, R. et. al. 1997. Travel Accomplishment Reports on the Study of Turtle Excluder Devices. March-April 1997. BFAR.

_____. 1996. Selective Shrimp Trawling in Manila Bay. Reports unpublished.

Sanchez, J. and J. Dickson. 1995. Mesh Size Selectivity of Small Trawl Net with Square-Meshed Cod-end. Report Unpublished.

Sanchez, J. et. al. 1997. Reports on the Study of the Selectivity of Modified Danish Seine Using Square-Meshed Cod-end. March-April 1997.

Sterling, D. 1991. AMC Investigates Square Mesh Netting. Australian Fisheries. Jan. 1991:31-32.

Table 1. Retained and escaped catch of different TED types

TED TYPE	Retained (kgs)	%	Escaped (kgs)	%	Total (kgs)	%
(1) TTFD						
catch (kgs)	104.45	88.45	13.64	11.55	118.09	100.00
mean catch rate (kgs/hr)	13.06		1.71		14.76	
(2) SS						
catch (kgs)	110.91	69.97	47.59	30.03	158.49	100.00
mean catch rate (kgs/hr)	13.86		5.95		19.81	
(3) Hooped						
catch (kgs)	111.50	86.46	17.47	13.55	128.96	100.00
mean catch rate (kgs/hr)	13.94		2.18		16.12	0.00
(4) Without						
catch (kgs)	132.76	100.00	0.00	0.00	132.76	100.00
mean catch rate (kgs/hr)	16.60		0.00		16.61	0.00
GRAND TOTAL (kgs)	459.62	85.38	78.70	14.62	538.30	100.00
Mean Total (kgs/hr)	14.36	85.38	2.46	14.62	16.82	100.00

Table 2. Retained catch composition by group and percentage contribution

TED TYPE	Shrimp	%	Fish	%	Invert	%	RETAINED TOTAL	%
(1) TTFD								
catch (kgs)	8.83	8.45	48.43	46.37	47.19	45.18	104.45	100.00
mean catch rate (kgs/hr)	1.10		6.05		5.90		13.06	
(2) SS								
catch (kgs)	5.93	5.35	47.40	42.74	57.58	51.92	110.91	100.00
mean catch rate (kgs/hr)	0.74		5.93		7.20		13.86	
(3) Hooped								
catch (kgs)	7.49	6.72	57.70	51.75	46.31	41.53	111.50	100.00
mean catch rate (kgs/hr)	0.94		7.21		5.79		13.94	
(4) Without								
catch (kgs)	8.50	6.40	61.85	46.59	62.41	47.01	132.76	100.00
mean catch rate (kgs/hr)	1.06		7.73		7.80		16.60	
GRAND TOTAL (kgs)	30.75	6.69	215.38	46.86	213.49	46.45	459.62	100.00
Mean Total (kgs/hr)	0.96	6.69	6.73	46.86	6.67	46.45	14.36	100.00

Table 3. Escaped catch composition by group and percentage contribution

TED TYPE	Shrimp	%	Fish	%	Invert	%	ESCAPED TOTAL	%
(1) TTFD								
catch (kgs)	0.56	4.11	5.95	43.62	7.13	52.27	13.64	100.00
mean catch rate (kgs/hr)	0.07		0.74		0.89		1.71	
(2) SS								
catch (kgs)	0.40	0.84	8.80	18.49	38.39	80.67	47.59	100.00
mean catch rate (kgs/hr)	0.05		1.10		4.80		5.95	
(3) Hooped								
catch (kgs)	0.68	3.89	7.62	43.59	9.18	52.52	17.48	100.00
mean catch rate (kgs/hr)	0.09		0.95		1.15		2.19	
GRAND TOTAL (kgs)	1.64	2.08	22.37	28.42	54.70	69.50	78.71	100.00
Mean Total (kgs/hr)	0.21	2.08	2.80	28.42	6.84	69.50	9.84	100.00

Table 4. SHRIMP retained and escaped catch of different TED types

TED TYPE	Retained(kgs)	%	Escaped (kgs)	%	Total
(1) TTFD					
catch (kgs)	8.83	94.04	0.56	5.96	9.39
mean catch rate (kgs/hr)	1.10		0.07		1.17
(2) SS					
catch (kgs)	5.93	93.68	0.4	6.33	6.32
mean catch rate (kgs/hr)	0.74		0.05		0.79
(3) Hooped					
catch (kgs)	7.49	91.68	0.68	8.32	8.17
mean catch rate (kgs/hr)	0.94		0.09		1.02
(4) Without					
catch (kgs)	8.50	100.00	0.00	0.00	8.50
mean catch rate (kgs/hr)	1.06		0.00		1.06
SHRIMP TOTAL (kgs)	30.75	94.97	1.64	5.06	32.38
Mean catch rate (kgs/hr)	0.96		0.05		1.01

Table 5. Fish retained and escaped catch of different TED types

TED TYPE	Retained	%	Escaped	%	Total	%
(1) TTFD						
catch (kgs)	48.42	89.06	5.95	10.94	54.37	100.00
mean catch rate (kgs/hr)	6.05		0.74		6.80	
(2) SS						
catch (kgs)	47.39	84.34	8.80	15.66	56.19	100.00
mean catch rate (kgs/hr)	5.92		1.10		7.02	
(3) Hooped						
catch (kgs)	57.69	88.35	7.61	11.65	65.30	100.00
mean catch rate (kgs/hr)	7.21		0.95		8.16	
(4) Without						
catch (kgs)	61.84	100.00	0.00	0.00	61.84	100.00
mean catch rate (kgs/hr)	7.73	100.00	0.00	0.00	7.73	100.00
FISH TOTAL	215.34	90.59	22.36	9.41	237.70	100.00
Mean Total	6.73	90.59	0.70	9.41	7.43	100.00

Table 6. Other invertebrates retained and escaped catch of different TED types

TED TYPE	Retained	%	Escaped	%	Total	%
(1) TTFD						
catch (kgs)	47.19	86.87	7.13	13.13	54.32	100.00
mean catch rate (kgs/hr)	5.90		0.89		6.79	
(2) SS						
catch (kgs)	57.58	60.00	38.39	40.00	95.97	100.00
mean catch rate (kgs/hr)	7.20		4.80		12.00	
(3) Hooped						
catch (kgs)	46.31	83.46	9.18	16.54	55.49	100.00
mean catch rate (kgs/hr)	5.79		1.15		6.94	
(4) Without						
catch (kgs)	62.41	100.00	0.00	0.00	62.41	100.00
mean catch rate (kgs/hr)	7.80		0.00		7.80	
INVERTEBRATES TOTAL	213.49	79.60	54.70	20.40	268.19	100.00
Mean Total	6.67	79.60	1.71	20.40	8.38	100.00

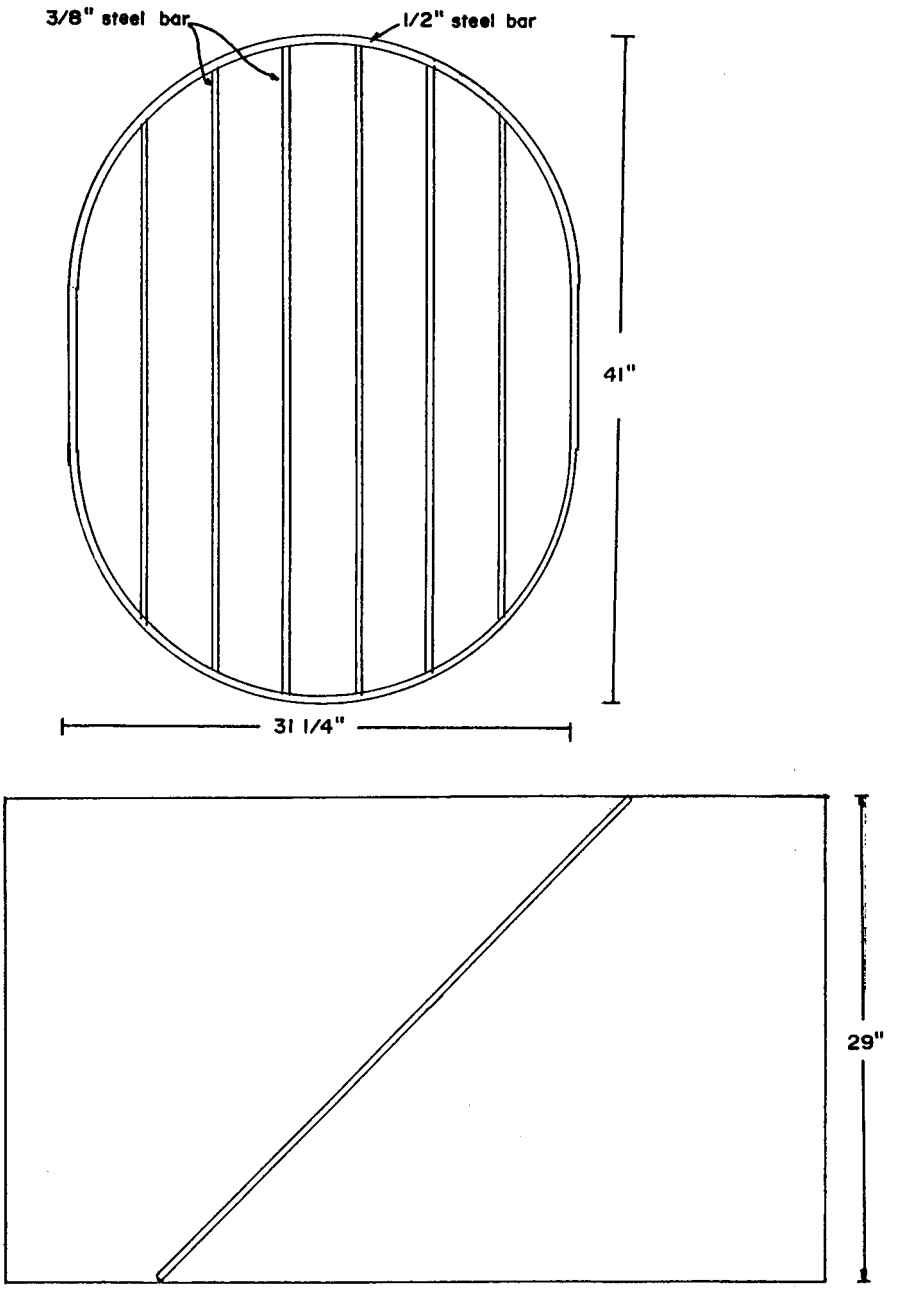

Fig. 1. FLAT OVAL GRID TYPE MODIFIED TTFD

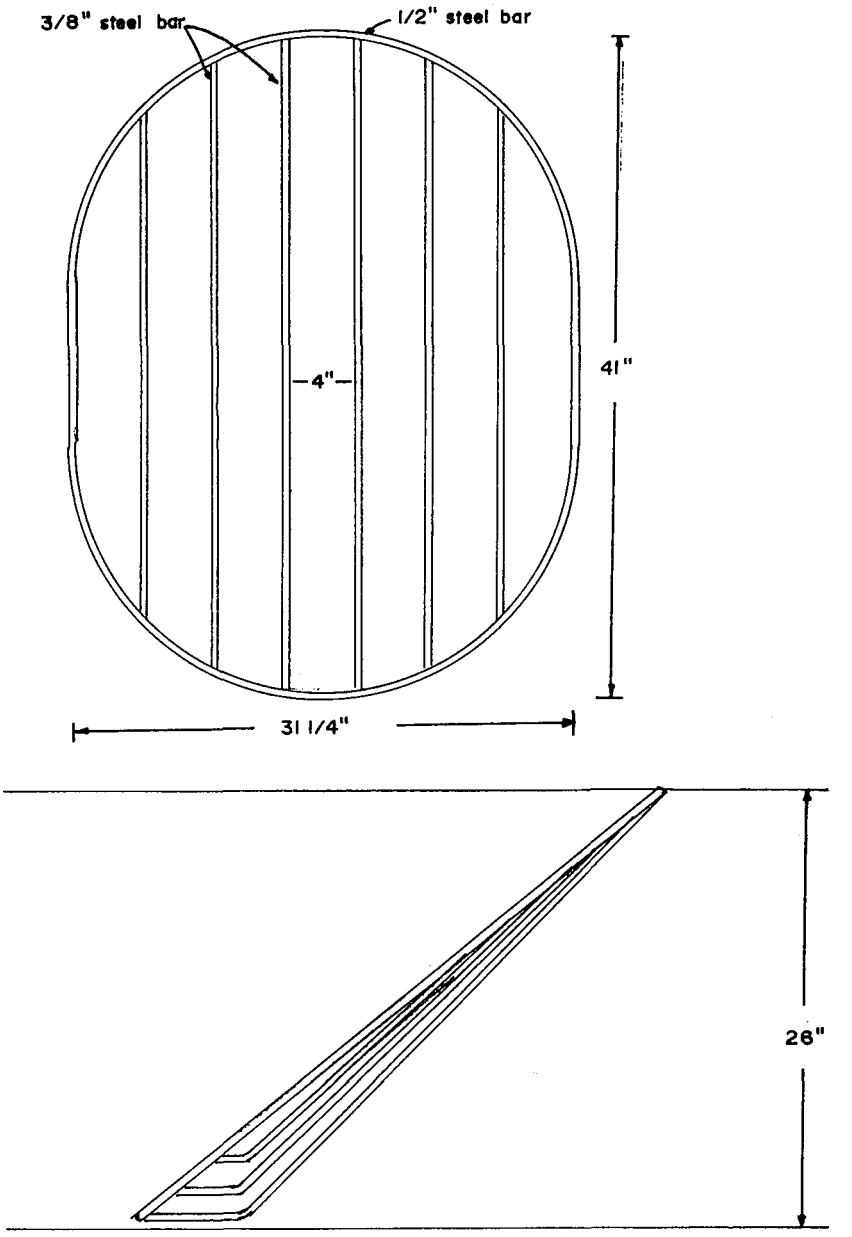

Fig. 2. SUPER SHOOTER TYPE

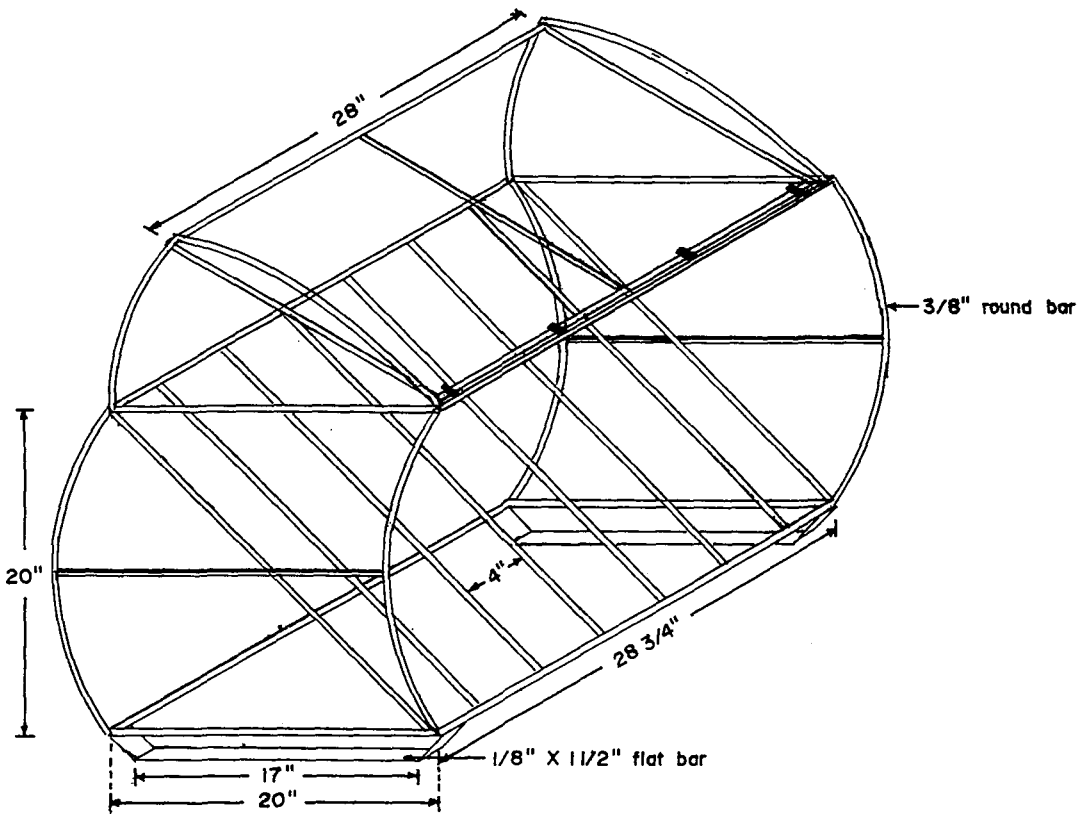

Fig. 3. HOOPED TED TYPE

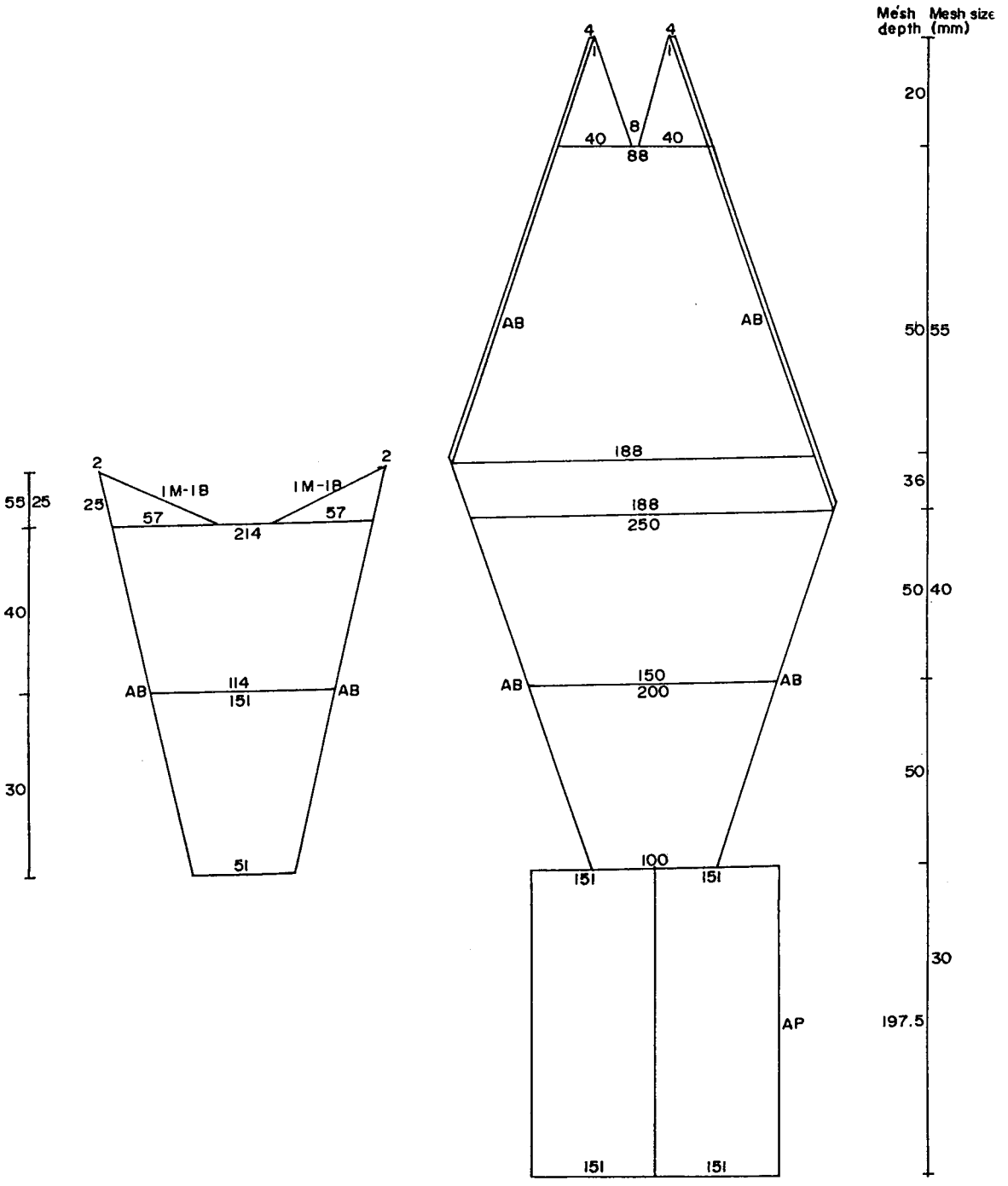

Fig. 4. ACTUAL DESIGN OF CONSTRUCTED SHRIMP TRAWL WITH SEPARATOR

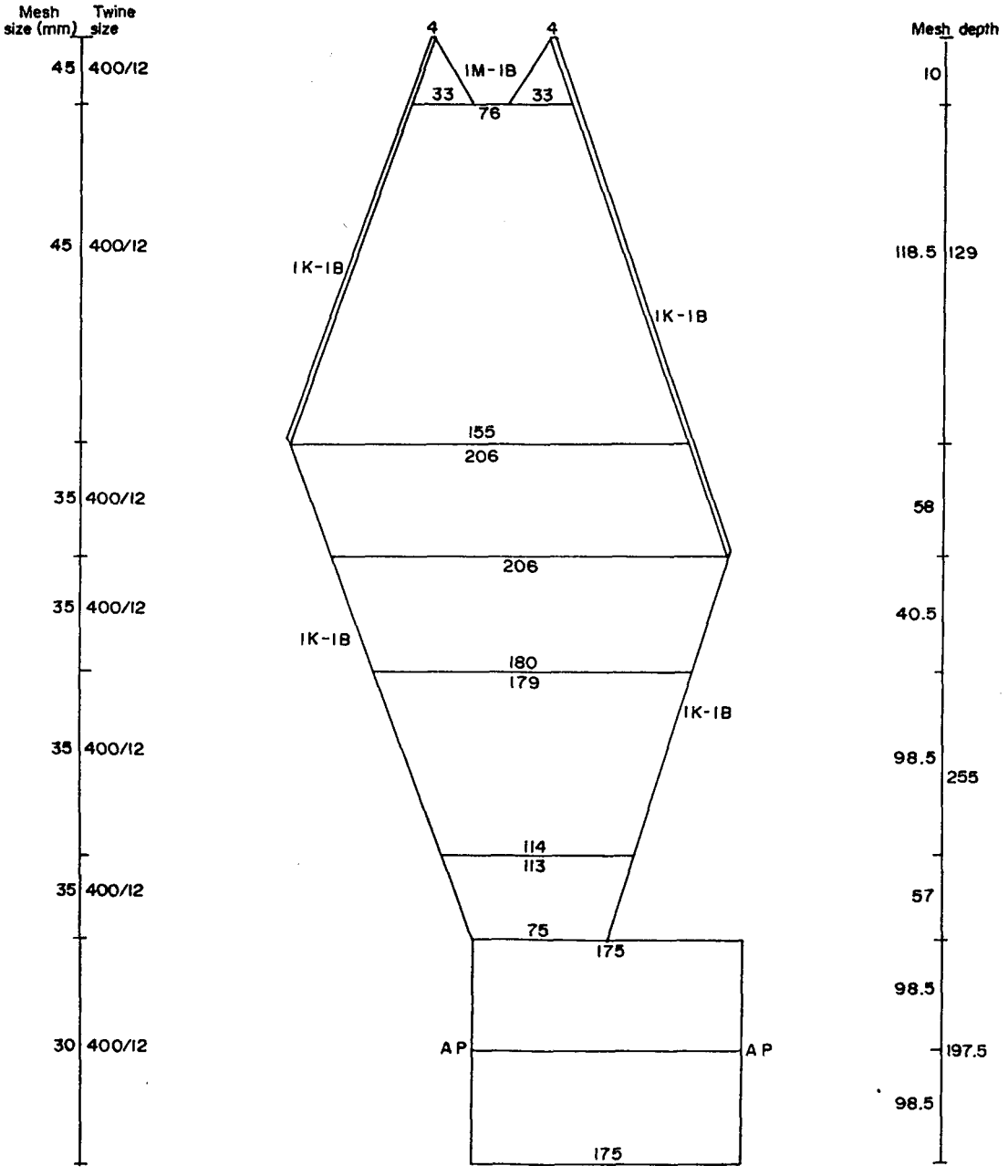

Fig. 5. ACTUAL DESIGN OF TRADITIONAL SHRIMP TRAWL

Fig. 6. Shrimp caught between nets (Total = 97.26 kgs)

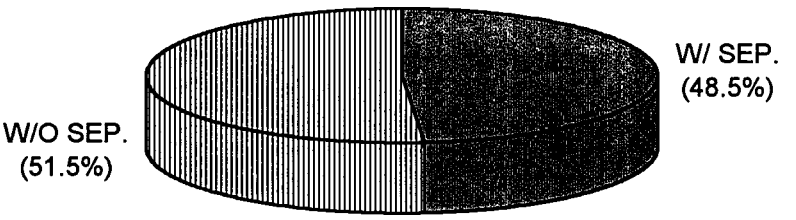

Fig. 7. Shrimp distribution between bags (Total = 47.19 kgs)

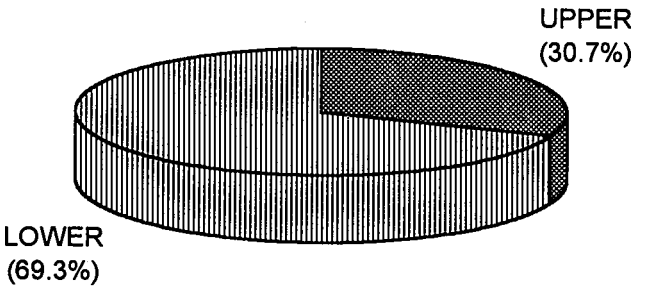

Fig. 8. Gilling by mesh size

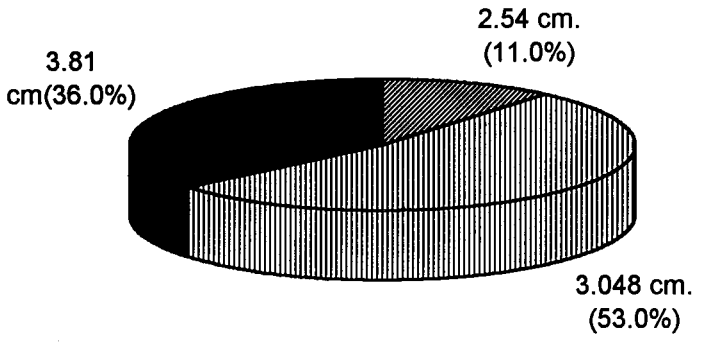

Fig. 9. Escapement by mesh size