REDUCTION OF ENVIRONMENTAL IMPACT FROM TROPICAL SHRIMP TRAWLING, THROUGH THE INTRODUCTION OF BY-CATCH REDUCTION TECHNOLOGIES AND CHANGE OF MANAGEMENT

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National Executing Agency:
INVEMAR

National Coordinator:
Dr. Mario Rueda

Instituto de Investigaciones Marinas y Costeras José Benito Vives de Andréis
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By:

MARIO RUEDA
National Coordinator

Research group: Mario Rueda[1], Luis Majarrés[2], Farit Rico[1], Harley Zúñiga[2], Augusto Angulo[1], Luis Duarte[2], Nayibe Madrid[1], Jairo Altamar[2], Alexander Girón[1], Felix Cuello[2], Fabián Escobar[2], Paul Gómez[2].

ABSTRACT

Quantification of the tropical shrimp trawling impact and mechanics to reduce it on both Caribbean and Pacific Colombian coasts were evaluated. The methodological approach included census of the fishing technology, monitoring, workshops, trials and experiments. The census revealed that vessels and net designs are 30 years old. Fishing monitoring showed the following catch composition: shrimp 8%, incidental catch 27% and discards 65% for the Caribbean; while for the Pacific shrimp is 5%, incidental catch is 43% and discards are 52%. In this sense, new trawl nets were designed introducing new netting materials and BRDs (fish-eye and TED). 12 Trawl nets prototype were manufactured during 2 workshops, where 60 fishers were trained in fishing trials. These trawl nets were used in fishing experiments comparing catches of an experimental vessel (using prototype nets) with those of a control vessel (using traditional nets) to test reduction of by-catch and fuel consumption if possible. For the Caribbean 88 paired hauls showed that the fish by-catch reduction ranged from 20 - 54%; while 240 hauls in the Pacific showed reductions ranging from 23 - 57%. The fuel saved on the Caribbean was 17%, whereas on the Pacific the save was 25%. Current decrease of the shrimps stocks and high fuel prices, are part of the issues that the fishery management agency in Colombia faces to change of management.

Key words: Shrimp trawling; net design; BRD’s; TED; tropical fisheries; Colombia.

[1]INVEMAR. Cerro de Punta Betin; Santa Marta, Colombia. E-mail address: mrueda@invemar.org.co
[2]Universidad del Magdalena

INTRODUCTION

The shrimp fisheries in Colombia are conducted since 60's by the small-scale and industrial fleets. The shrimp trawl industrial fishing have been an important source of foreign incomes, however their importance involve food and employment for many people also. Fishing operations are conducted on both Caribbean and Pacific Colombian coasts in shallow waters (< 40 fathoms), although shrimp deep sea fishery is in operation 10 years ago. This report involves only the work carried out in shallow waters. The vessels are 13 through 25 m long, using 2 nets on the Caribbean and 4 nets on the Pacific coast. Trawl nets have "Japanese" (56%) and the "Corean" (43.4%) models with 42´ and 37´ of headrope respectively in the Caribbean. In the Pacific trawl nets use "flat" models with headrope ranging from 60´to 80´. Shrimp species landed include *Farfantepenaeus notiales*, *F. brasiliensis*, *F. subtiles* and *Litopenaeus schmitii* on the Caribbean, whereas for the Pacific the main species are *Litopenaeus occidentalis* and *Xiphopenaeus rivety*.

As occur in others tropical fisheries, the shrimp fishing in Colombia face problems related with loss of fishing efficiency, high operation costs (fuel), decreasing of catches and high by-catch, all these affecting its performance. Shrimp catches have decreased from around 1000 t/year in '90s to 200 t/year after the year 2000 in the Caribbean. For the same period catches decreased on the Pacific from 3000 t/year to 800 t/year. Consistent with this trend the size fleet has declined more than 50% on both Colombian coasts; however the catch of concurrent fish, mollusks and crustaceans increase annually with consequences of overfishing and loss of biodiversity.

In this report briefly are highlighted the results of the REBYC project in Colombia, which was aimed to quantify the by-catch composition in the shrimp trawl fishery and to test changes in fishing technology to reduce it and fuel consumption is possible. Additional aims included transference of new fishing technologies to the industry and generation of information for changing management. For more details, two annexes are included with independent analysis for both Colombian coasts Caribbean and Pacific (Spanish versions).

METHODS

<u>Study areas</u>: activities of the project were conducted on both Caribbean (Manjarrés, et al., 2006) and Pacific (Rueda, et al., 2006) Colombian coasts (Figure 1). Fishing grounds on the Caribbean are distributed along 5700 km^2 of coasts, which are separated by a zone with estuarine influence (south-west) and other of marine and wind influence (north-east). Fishing operations on the Pacific coast cover 1392 km of coasts from the limit with Panama to the limit with Ecuador. The fishing grounds include a zone of short shell and typical marine influence (north), and other of wide shell influenced by rives and estuaries (south).

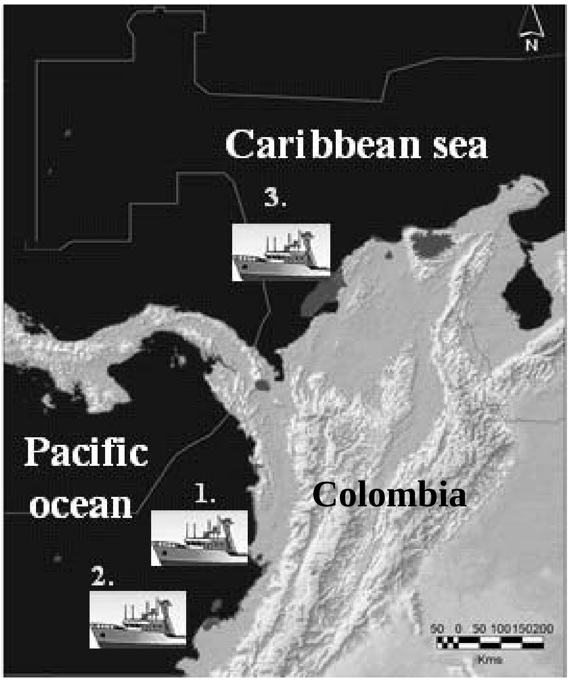

Figure 1. Caribbean and Pacific coasts from Colombia. Vessels indicate fishing ports on Bueventura (1), Tumaco (2) and Cartagena (3).

Field sampling: in order to quantify shrimp by-catch of the trawl fleets, on board fishery monitories were carried out during one year by coast. Taxonomic identification, quantity and weigh of species caught, enabled estimate components of total catch: target catch (shrimp), incidental catch (commercial fishes) and discards (unwanted individuals). Review of the current fishing technology, indicated that changes in the net design (including new netting materials) and introduction of By-chatch Reduction Devices (BRD's), could improve the trawl net performance. New materials to be used included knotless nets type spectra, and metallic trawl doors. The BRD´s to be tested were the Turtle Exclusion Device (TED) of mandatory use, and the fish-eye, which should let the escapement of fishes as part of the incidental catch and discards. The hole of the fish-eye used was 32 and 22 cm of major and minor exe, respectively. One workshop for each coast was conducted to transference of fishing technology to the industrial sector (design, built and operation of trawl nets). Resulted of theses workshops 12 trawl nets or prototypes were manufactured by local fishers. Finally, fishing experiments were conducted to test the new technologies by comparison of traditional trawl nets vs. prototypes nets, using two vessels per coast with equal fishing power. 88 and 240 Paired hauls were conducted for the Caribbean and Pacific, respectively. For each paired haul the following combination was made: one net with the fish-eye, other net with the TED, other net with both devices, and other net without any device (control). Paired hauls of each vessel were carried out on the same fishing ground to let comparisons. Abundance relative (CPUE) of target catch, incidental catch and discards, were calculated per haul. Fuel consumption per haul also was measured using a special device.

Data analysis: to test differences in abundance per catch category between BRD´s, blocks and one-way ANOVAs were carried out, previous verification of homocedasticity and normality assumptions. Differences in fuel consumption between traditional and prototype nets were tested by paired t-test. The percentage of reduction of by-catch (% BR) was computed as follows:

$$\%BR = \frac{CPUE_E}{(CPUE_E + CPUE_C)} \times 100$$

Where $CPUE_E$ is the abundance in the net with BRD, and $CPUE_C$ is the abundance in the control net.

RESULTS AND DISCUSSION

Catch composition by coast: Discards are bigger in the Caribbean (65%) than the Pacific coast (52%), however incidental catch, mainly of fishes, is bigger in the Pacific (Figure 2). Both coasts showed the same percentage of target catch (shrimp), indicating relations shrimp:by-catch around 1:20, which is consistent with proportions found in tropical waters. Since the by-catch in the Pacific is dominated by fishes, a significant part of it has commercial value (incidental catch) with species of different sizes.

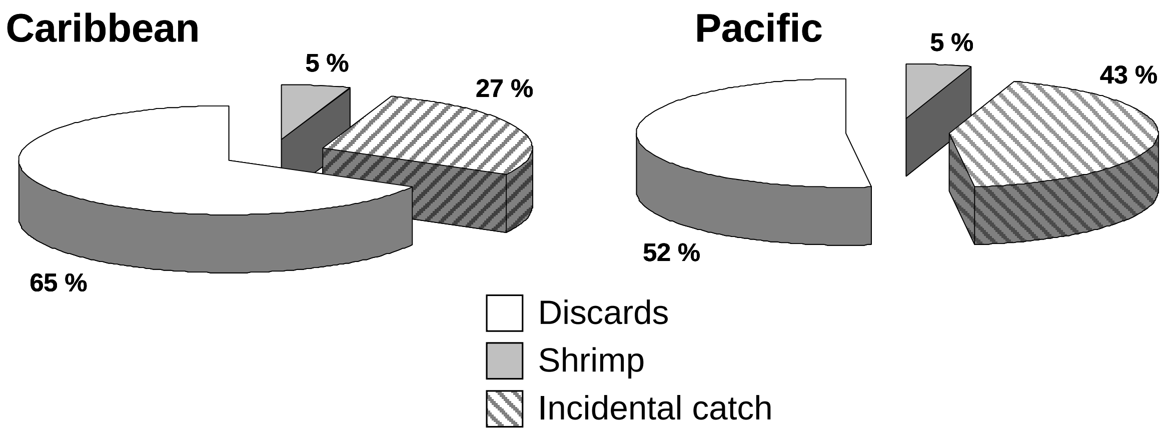

Figure 2. Catch composition (shrimp, incidental catch and discards) by Colombian coast after fishing monitoring of the shrimp trawl fishery.

Effects of the by-catch reduction devices (BRD´s) tested in fishing experiments: For the Caribbean Sea the abundance relative (kg/h) of each category of catch differed between BRD´s ($P<0.01$; Figure 3). This indicates that the devices tested in this experiment did reduce significantly the discards and the incidental catch, however was demonstrated that the use of TED and its combination with the fish-eye, reduced abundance of shrimp. The last effect was not expected, but revealed inadequate position of the TED in the trawl net. In any case, part of this study was assessing the mandatory use of the TED, which never was tested before. The effect of the fish-eye on the incidental catch was bigger than the TED effect, reducing commercial fishes generally. More clear effect of the BRD´s did occur on the discards, because each device and its combination did reduce the discards composed by fishes, mollusks and other crustaceans.

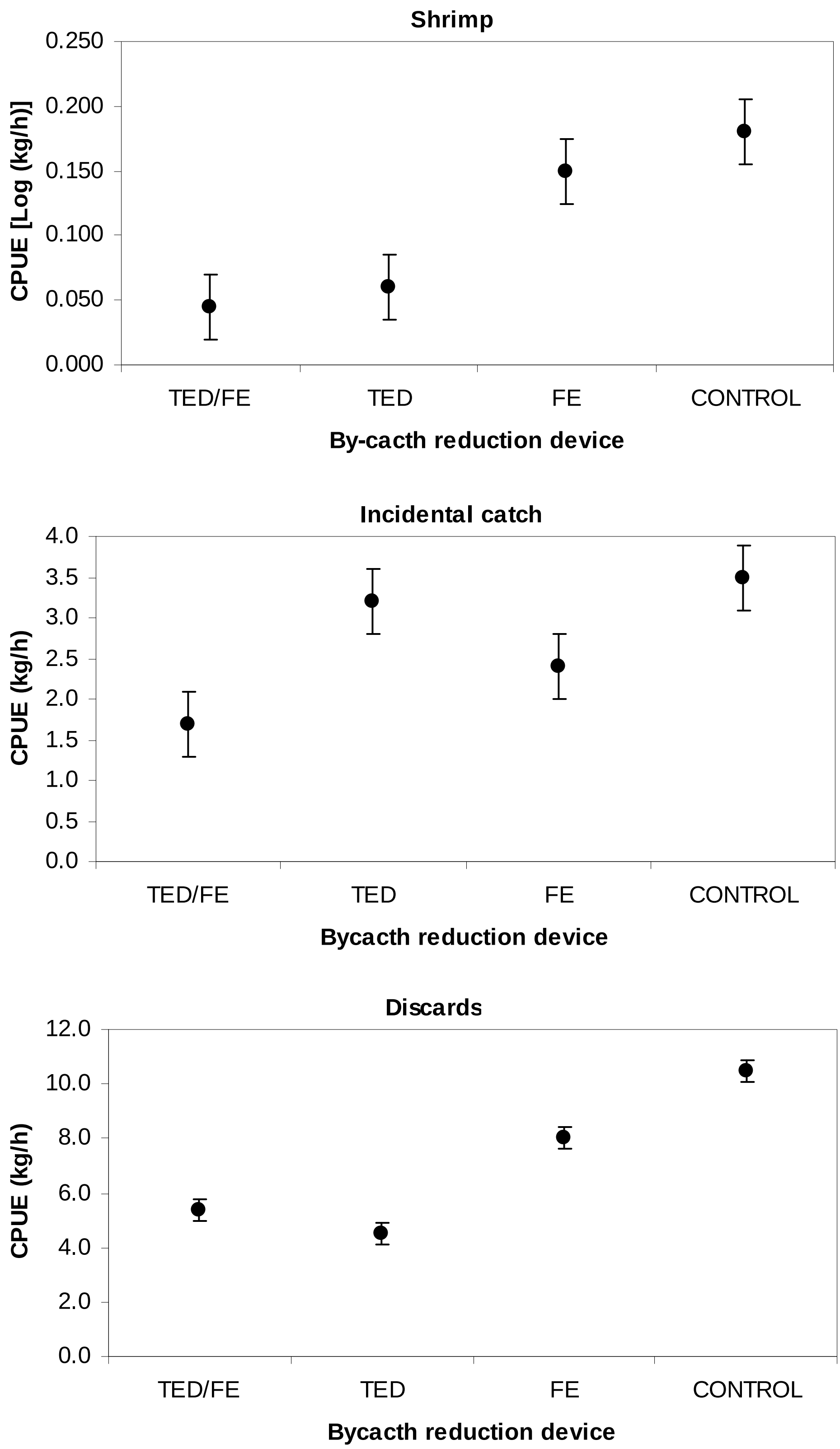

Figure 3. Abundance relative of the catch categories discriminated by BRD after fishing experiments on the Caribbean Sea in Colombia. Bars indicate confidence intervals of 95%. FE = fish-eye.

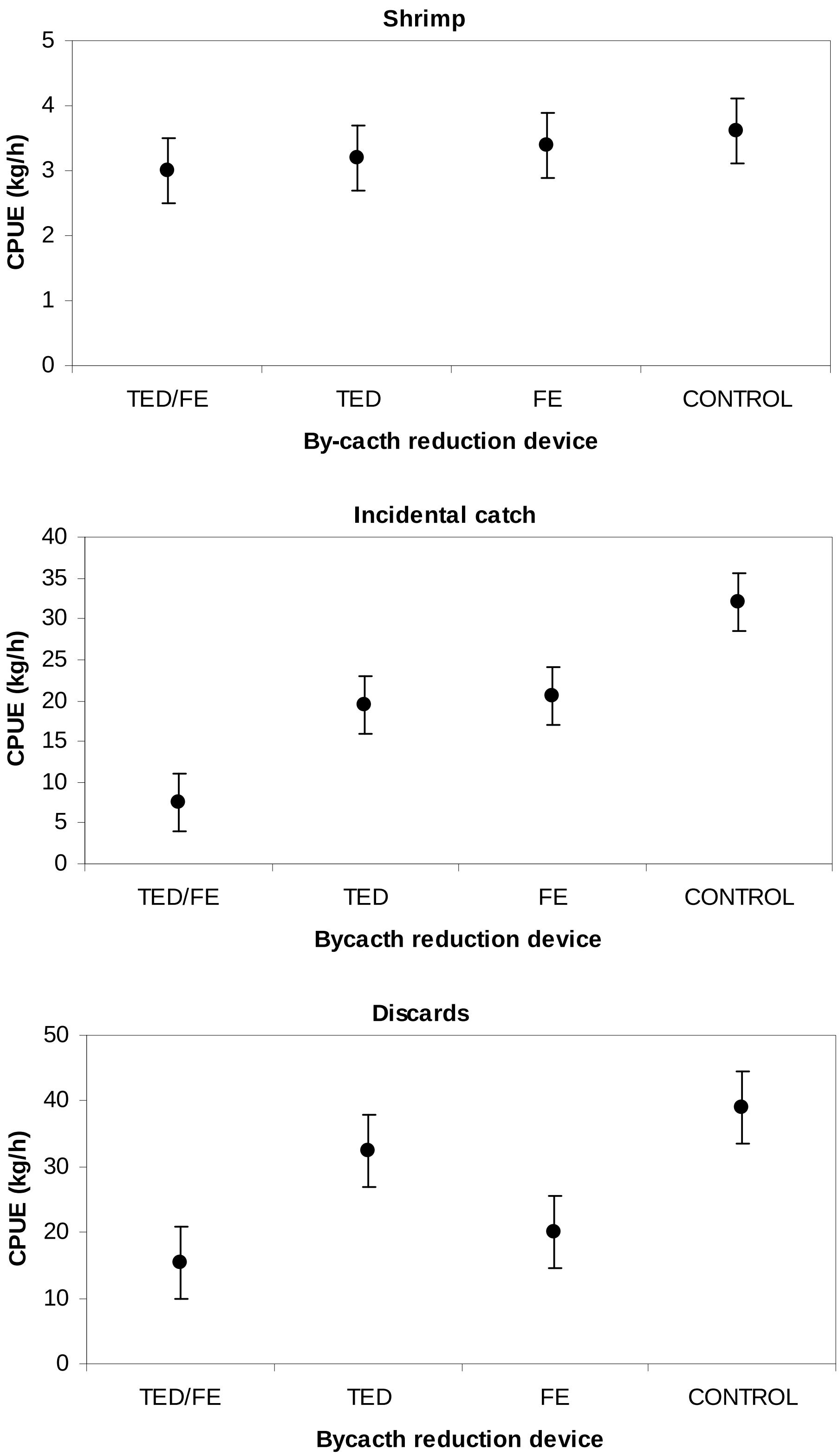

Figure 4. Abundance relative of the catch categories discriminated by BRD after fishing experiments on the Pacific coast in Colombia. Bars indicate confidence intervals of 95%. FE = fish-eye.

For the Pacific coast, abundance relative (kg/h) of incidental catch and discards differed between BRD´s ($P<0.01$; Figure 4). In this case, the effect of the BRD´s was that expected, because was not significant reduction of shrimp abundance. The TED and fish-eye showed equal reduction of incidental catch; however the additive effect of using TED and fish-eye did reduce the fish abundance considerably. Reduction of the discards showed similar effect among the fish-eye and its combination with the TED.

Quantitative reductions of discards in the Caribbean ranged from 18,7% to 57,7%, whereas for the Pacific coast the range was from 22% to 59% (Table 1). This constitutes important evidence of successful use of fish-eye and TED for conservation of the marine biodiversity, avoiding the risk of overfishing in other fisheries based in fishes. The fish-eye did exclude between 30% and 35% of the incidental catch for the Caribbean and Pacific coast, respectively. Given the commercial value of this kind of catch, the use combined of TED and fish-eye generated high probabilities of economic loss (data no presented in this report). This as result of reducing between 49,5% and 78% of the incidental catch. Nevertheless, the use of new netting materials did produce fuel saving between 17% and 25% for the Caribbean and Pacific coasts, respectively. This result generates a compensatory effect to potential economic loss by using BRD´s simultaneously in the trawl nets.

Table 1. Percentages of reduction of catch type for each BRD on both Colombian coasts.

	Catch type	**BRD**			**Fuel saved**
Coast		Fisheye	TED	Fisheye + TED	
Caribbean	Shrimp	5,2	22,5	23,3	17
	Incidental catch (fishes)	30,0	20,7	49,5	
	Discards	18,7	50,6	57,7	
Pacific	Shrimp	11,0	7,0	12,0	25
	Incidental catch (fishes)	35,0	44,0	78,0	
	Discards	40,0	22,0	59,0	

This study produced enough evidence to implement new management strategies of the shrimp fishery in Colombia, balancing conservation and productive interests. Legal introduction of BRD´s is in progress, however more extensive trials and support of the Government for changing fishing technology is requested, because of social and economic impacts on the Colombian fisheries.

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