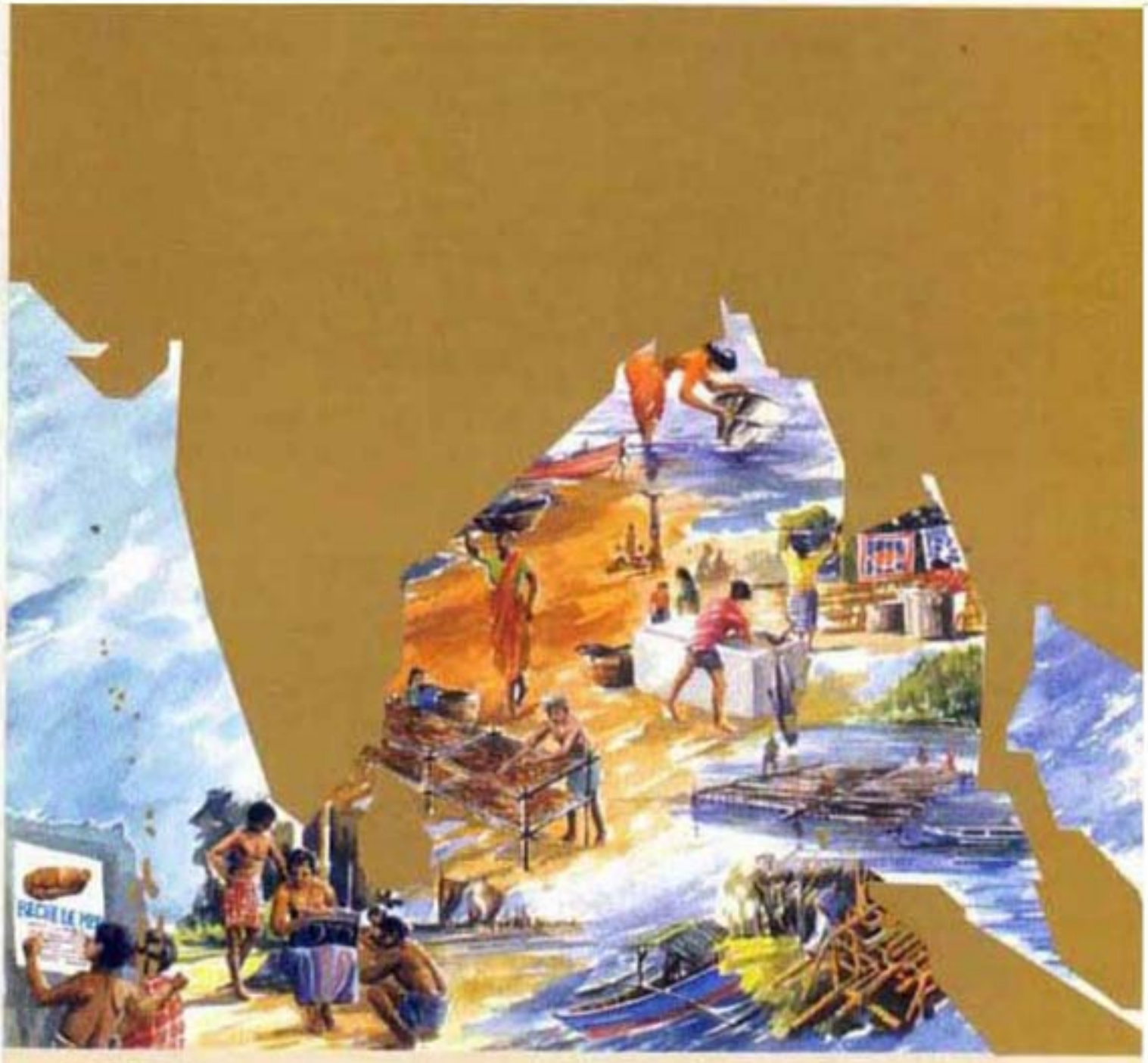
BOBP/WP/94

Biosocioeconomic Assessment of the Effect of the Estuarine Set Bagnet on the Marine Fisheries of Bangladesh



BOBP For Fisheries Development
BAY OF BENGAL PROGRAMME

Bay of Bengal Programme

BOBP/WP/94

Small-scale Fisherfolk Communities
Bioeconomjcs of Small-scale Fisheries

GCP/RAS/1 18/MUL
RAS/9 1/006

Biosocioeconomic Assessment of the Effect of the Estuarine Set Bagnet on the Marine Fisheries of Bangladesh

by

Md G Khan
Md S Islam
Md G Mustafa
Md N Sada
Z A Chowdhury

Management and Development Project, Department of Fisheries, Chittagong, Bangladesh

BAY OF BENGAL PROGRAMME
Madras, India
1994

The estuarine set bagnet (ESBN) fishery of Bangladesh is one of the country's niost important traditional fisheries and a large population of small-scale fisherfolk have been dependent on it for a long time. In the last two decades, the introduction and rapid expansion of the bottom trawl fishery and of shrimp culture have contributed to problems of interaction and competition among the fisheries which exploit the same penaeid shrimp and demersal finfish stocks. The traditional, but less efficient, ESBN fishery has not only become vulnerable, being likely to be affected by other fisheries, but may also be destructive to small penaeid shrimp and some of the finfish resources that these other fisheries exploit. The Department of Fisheries, Bangladesh, decided to investigate this issue and the Bay of Bengal Programme (BOBP) was requested to assist. The study was funded by the United Nations Development Programme (UNDP). Bioeconomic and socioeconomic surveys were undertaken in 1989/90 and a National Seminar was held in January 1992 to discuss the results.

Because of the interactive nature of many of the marine fisheries, it was necessary, for the assessment and management of any one fishery, to consider the other fisheries exploiting the same resources. Therefore, in addition to the estuarine set bagnet fishery, the fisheries employing marine set bagnets (MSBN), trammelnets (TRN), beach seines (BS), bottom longlines (BLL) and trawlnets (TWL), as well as shrimp fry-collection using pushnets (PN) and dragnets (DN), were investigated. These studies have been documented separately in BOBP working papers BOBP/WP/89 *Studies of Interactive Marine Fisheries of Bangladesh* and BOBP/WP/90 — *The Socioeconomic Condition of the Estuarine Set Bagnet Fisherfolk in Bangladesh.* The present paper is based on the results and findings of these publications and assesses the biosocioeconomic impact of the ESBN fishery on the other marine fisheries of Bangladesh. The working papers mentioned provide additional information on the respective fisheries.

The Bay of Bengal Programme (BOBP) is a multiagency regional fisheries programme which covers seven countries around the Bay of Bengal — Bangladesh, India, Indonesia, Malaysia, Maldives, Sri Lanka and Thailand. The Programme plays a catalytic and consultative role: it develops, demonstrates and promotes new technologies, methodologies and ideas to help improve the conditions of small-scale fisherfolk communities in member countries. The BOBP is sponsored by the governments of Denmark, Sweden and the United Kingdom, and also by UNDP (United Nations Development Programme). The main executing agency is the FAO (Food and Agriculture Organization of the United Nations).

This document is a working paper and has not been cleared by the Government concerned or the FAO.

May **1994**

Published by the Bay of Bengal Programme, 91 St. Mary's Road, Abhiramapuram, Madras 600 018, India. Designed and typeset for the BOBP by Pace Systems, Madras 600 028 and printed for the BOBP by MWN Press, Madras 600 005.

CONTENTS

1. *SUMMARY*

The estuarine set bagnet fishery (ESBN) of Bangladesh is one of the country's most important traditional fisheries, a large population of small-scale fisherfolk having been dependent on it for a long time. But in the last two decades, shrimp trawl operators and shrimp culturists have been complaining of damage caused, by the ESBN fishery, to resources exploited by their fisheries and to the supply of fry for culture activity. Hence, the Department of Fisheries, Bangladesh, decided to carry out an investigation of the ESBN fishery to determine whether it is a destructive fishery and, if so, what kind, and degree, of damage it caused to the resources and other fisheries. Training of scientific officers was also another objective. A biosocioeconomic assessment was undertaken with the assistance of the Bay of Bengal Programme (BOBP), under a United Nations Development Programme project, RAS/9l/006, and surveys were conducted from December 1989 to November 1990, with the analysis being carried out in 1991.

Since the ESBN fishery interacts with other fisheries, such as the pushnet (PN), dragnet (DN) and fixed bagnet (FBN) for shrimp fry-collection, beach seine (BS) and marine set bagnet (MSBN) for finfish and some shrimp, bottom longline (BLL) for croaker, and trawlnet (TWL) and trammelnet (TRN) for a number of high-valued penaeid shrimp and finfish species, these fisheries were also investigated, to some degree, for better assessment of the impact of the ESBN fishery.

It was found that the ESI3N fishery catches over 100 commercial species of shrimp and finfish, but only three penaeid shrimp *(P. monodon, P. indicus* and *M. monoceros)* and three finfish *(L. savala, H. nehereus* and *Johnius* spp.) are of importance in terms of value and abundance. These were, therefore, studied in detail to assess the impact of the ESBN fishery.

The fishing grounds of the different gear are more or less distinct and cover an area from the very shallow (Im) waters of the estuaries to the deep waters of the sea (80m). Consequently, the different fisheries act sequentially on the different st/ages in the lives of the animals selected for the study, which means that the mean sizes of the animals differ, even though the size ranges overlap to some extent.

In the marine sector, the ESBN fishery has 12,561 gear units and the highest production, though the shrimp fry-collection fishery has a much greater number of gear units (693,000). The trawl fishery, with the least number of units (54), ranks second in production, because of its high productive capacity.

The relationship between catch number, catch weight and catch value of each species differs significantly with the fishery, because of the differences in thT mean size of the animals caught by each fishery and differences in prices for different sizes. The tiger shrimp fry-collection fishery removes billions of other penaeid shrimp and valuable finfish fry and juveniles, apart from tiger shrimp fry, and, thus, destroys a great number of these other species. Such a large number of fry should not be destroyed and appropriate management measures need to be introduced.

The catch rates of not only the PN fishery but also of the ESBN in the Maiskhali area are the highest for the estuarine waters of Bangladesh (see BOBP/WP/89). The lowest ESBN catch rate is in the Kaliganj area. The largest number of species are taken by ESBN, but most of the valuable species caught by this gear are immature or juveniles.

The general trend appears to be that many of the selected species are at present being exploited beyond the maximum sustainable yield (MSY) levels by most of the fisheries, except for tiger shrimp and brown shrimp in the TWL and TRN fisheries, white shrimp in the ESBN fishery and Bombay duck in the MSBN fishery.

Analysis of each fishery with all selected species combined also reveals that the MSY and maximum sustainable economic yield (MEY) are realized below the present levels of effort and are attained at a relatively much lower level of fishing mortality in the ESBN, BS and MSBN than in the TRN and TWL fisheries.

Analysis also indicates that if the TWL fishery alone is allowed and all other interactive fisheries are suppressed, there would be a 300 per cent gain in yield and value of the catch, while if only the ESBN fishery is suppressed, the gain would be about 250 per cent in these values. On the other hand, the TRN fishery shows an extremely high gain of about ten times the yield and value if all other interactive gear are suppressed, but a smaller gain in yield and a large gain in value (300 per cent) if only the ESBN fishery is suppressed. There is no evidence that technological improvements to the ESBN gear will bring about significant improvements to the yield or the income.

The ESBN fishery engages about 55,000 fishermen, and around 85-100,000 fisherfolk are dependent on it for their livelihood. The majority of these fisherfolk, particularly the women, are illiterate, live under temporary roofs because of the destructive effects of frequent cyclones and have poor amenities except for, perhaps, primary schools. The fishing grounds, however, are adjacent to their homes and this reduces travelling and the risk of losing their gear — loss of which would result in increase in debt or loss of livelihood altogether.

Fishing is the primary source of income and about a third of the households are solely dependent on the ESBN fishery, while about two-thirds combine ESBN fishing with other fishery-related and nonfishery activities. Only 11 per cent of the households work as labour in the fishery or in nonfishery activities.

ESBN-owning households are 82 per cent of the total number of households in the study area, but only 25 per cent of ESBN owners have other fishing gear also. ESBN fishing is a family-oriented enterprise, with a high degree of participation by family members and negligible use of hired labour and motorized craft, thereby making operational costs negligible. Consequently, even with extremely poor catches during lean seasons, the ESBN fishery serves as a means of survival without actual income. Seasonality in the fishery and in income is significant.

Except in the Maiskhali area, more than 40 per cent of the ESBN fisherfolk are below the poverty line. The income disparity is not due to differences in skills, but more due to uneven distribution of fish resources in the six different geographical areas (strata) of the estuaries that were studied. Those in areas of low abundance do not earn enough surplus income during the peak seasons to compensate for the poor income during the lean seasons, unless a household owned more than two units of the gear.

The major fishery-related activity is drying of fish. There is very little scope for improving income through any improvements in this activity. Nonfishery income activities in the ESBN villages are also very limited. There is some livestock-rearing, manual labour etc, but lack of land for productive activities is a serious constraint. Only about 21 per cent of ESBN households are able to keep themselves above the poverty line with supplementary income from other fisheries and fishery-related and nonfishery activities. Some possibilities of alternative or additional income from other fisheries have been discussed, but there is very little scope for such opportunities in nonfishery activities.

Extremely low income from the ESBN fishery, repeated destruction by cyclones and high illiteracy contribute to these fisherfolk living without much hope for betterment of their livelihood, unless it be through the mercy of God. Credit facilities, if made available, may encourage some of them to shift to more lucrative fisheries. Alternatives for the ESBN fisherfolk appear to be in the fisheries sector and **not** in the nonfishery sector. In the high catch rate and high income areas (Maiskhali), ESBN fisherfolk are investing their surplus income in more ESBN, whereas, in the moderate income areas, their surplus income is being invested in other gear.

For proper management of many of the marine resources in Bangladesh, management of the ESBN fishery alone will be insufficient; the interactive fisheries also need to be regulated. The highest total catch rate and the largest percentage of penaeid shrimp, ribbonfish and croakers caught are in the Maiskhali area. Regulation of this fishery, in this area alone, preferably during the peak seasons (July-September and, to a lesser extent, February-April) could have a favourable impact on the resources of major valuable species.

The ESBN fishery involues the largest number of fisherfolk, excluding shrimp fry-collection which mainly utilizes women and children. With 37 per cent of the population under 10 years of age, 22 per cent between 10 and 20 years and only 21 per cent between 30 and 60 years, there will be a very significant increase in ESBN fisherfolk in the productive age classes by the year 2000 and they will require additional employment opportunities.

Reduction of ESBN effort or introduction of closed seasonal/area measures will not increase the income of ESBN fisherfolk, but could enhance the recruitment, catch rates and income for inter-active fisheries outside the ESBN area and into which some of the ESBN fisherfolk should be encouraged to enter.

2. *APPROACH AND METHOD*

The penaeid shrimp and finfish caught by the estuarine set bagnet and interactive gear appear in different areas and depths, depending on their age and size (see Figure 1).

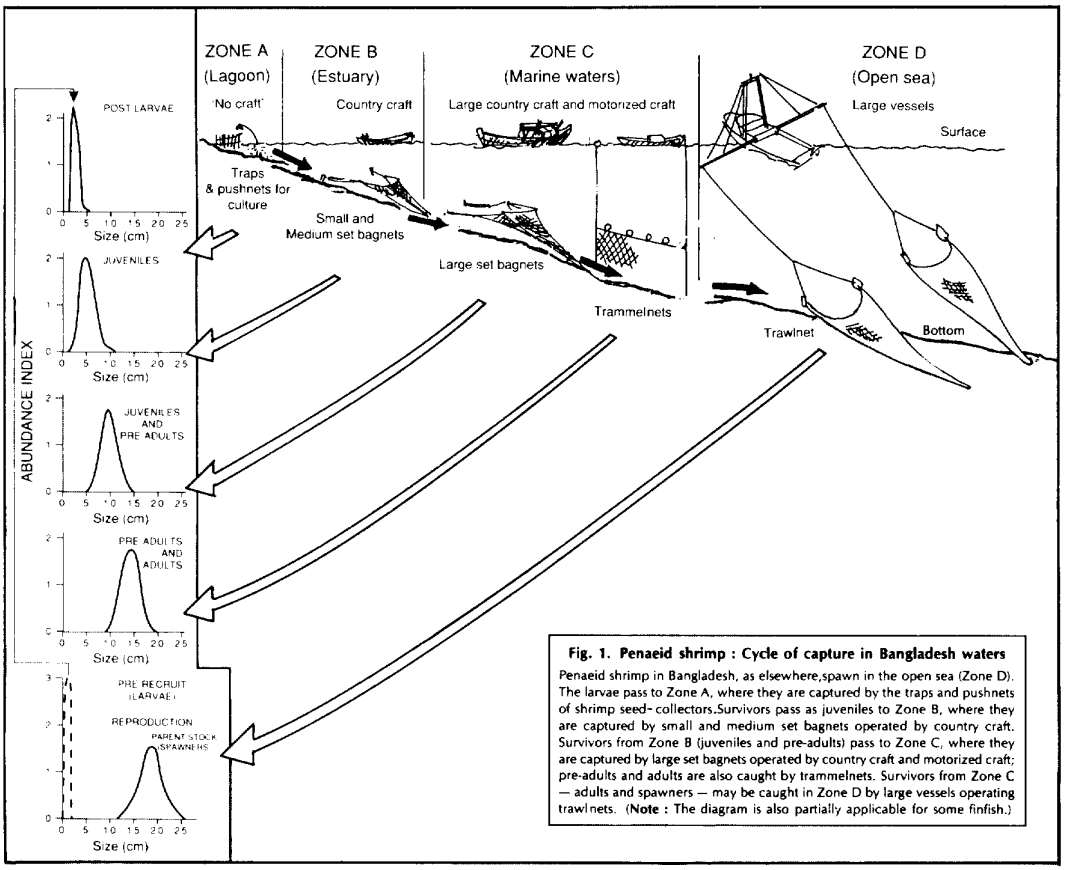


Fig. 1. Penaeid shrimp : Cycle of capture in Bangladesh waters

Penaeid shrimp in Bangladesh, as elsewhere,spawn in the open sea (Zone D). The larvae pass to Zone A, where they are captured by the traps and pushnets of shrimp seed- collectors.Survivors pass as juveniles to Zone B, where they are captured by small and medium set bagnets operated by country craft. Survivors from Zone B (juveniles and pre-adults) pass to Zone C, where they are captured by large set bagnets operated by country craft and motorized craft; pre-adults and adults are also caught by trammelnets. Survivors from Zone C — adults and spawners — may be caught in Zone D by large vessels operating trawlnets. (**Note :** The diagram is also partially applicable for some finfish.)

During their lifetime, fish and shrimp pass through different fisheries, each of which contributes to the total fishing mortality. Hence, the size of a cohort (a particular group of a species spawned during a particular season and in a particular spawning area) entering a fishery depends on the accumulated fishing mortality from all the preceding fisheries. The change in biomass of a cohort through decrease in number of animals is, to some extent, compensated by the gain in weight of the survivors.

The monthly length-frequency samples of each species from each fishery were used to obtain the total number of individuals in the catch of each length class. This was done by raising the number, in the monthly samples, in the following manner:

a) The number of individuals of a particular species of a particular length were multiplied by the first raising factor. This factor was the ratio of the total weight of the species caught by the sampled boats in a month to the weight of the actual sample taken from the boats during the same month.

b) The number of individuals calculated in (a) was raised a second time. The second raising factor, by which (a) was multiplied, was the ratio of the total production in all the boats of the fleet during the month to the weight of the total catch of the sampled boats that month.

The total number of individuals of a particular size and species caught during the month was, thus, estimated. These monthly production frequencies for all fisheries were pooled for each month to obtain better estimates of growth parameters.

The monthly frequencies were pooled to obtain the annual catch-at-length for each species, for length-based cohort and for virtual population analysis (VPA). These values were obtained for the ESBN catch and shrimp fry-collection using standard procedures, but those for the interactive fisheries were estimated with less accuracy due to limitations of manpower, facilities and time to undertake comprehensive data-collection programmes. In the case of the trawl fishery, the existing monthly length-frequency data were utilized. These frequencies were used to estimate growth parameters and fishing mortalities caused by each gear type during successive stages of the animal's life. The population sizes of selected species were obtained using the catch-at-length data for each species from the ESBN and the interactive fisheries and the virtual population analysis method of ELEFAN III (VPA-II).

The natural mortality (M), probability of capture by each gear, exploitation rates (E) and terminal fishing mortality (Fr) values were obtained using ELEFAN II (Gayanilo, Soriano and Pauly, 1989). Length Cohort Analysis (Sparre, 1987) was used to obtain Fmax (highest fishing mortality of the age or size classes exploited) values for each species in each fishery. A constant value of M was used for all fish sizes. Since very large numbers of the shrimp were removed at the post-larval stage for aquaculture, the available estimate of M is considered wrong for these stages as M is extremely high during the post-larvae stage, but for which no reliable estimate of M was available. Hence, when carrying out the analysis for species removed by various fisheries from the larval stage to the full-grown stage, the estimate of the population size prior to the exploitation of post-larvae (PL) is considered underestimated.

The number of shrimp removed at the post-larval size, the number surviving from shrimp fry-collection and the number removed successively in the ESBN and other capture fisheries have been estimated (see BOBP/WP/89) and these numbers used to assess the impact of the ESBN, and other gear, on the population of selected species. Each cohort and its passage through various fisheries in different areas was identified and used to plot the life cycles. A yield-recruit analysis was carried out with ELEFAN II for each fishery to determine the maximum yield for each species in the fishery. Growth parameters, natural and fishing mortality rates and mean length at first capture in each fishery were used for this analysis.

The economic yields and benefits were compared with the catches by the ESBN and other gear interactive with it to determine the impact of the ESBN fishery on the other fisheries and the fisherfolk involved, both from a biological and economic point of view. The results of the yield per recruit analysis are not presented, as the Thompson and Bell method of Sparre (1987) was preferred to determine the trends in yield and revenue for the selected species from each of the fisheries and to examine the impact of each fishery on each resource.

The technical characteristics of the ESBN were examined to evaluate their performance and to determine if their design could be improved, both from an economic and biological perspective, and to guide possible management-oriented decisions on their use.

The small-scale fisherfolk in Bangladesh are mostly poor. It was felt that if any regulatory measures, or changes in the fisheries, were to be introduced, their likely impact on these fisherfolk would have to be assessed in advance. Rehabilitation programmes would also have to be identified and implemented in good time to compensate affected fisherfolk. The number of households that may be affected by management measures and other existing, or potential, income-generating activities (both fishery and nonfishery) were, therefore, identified.

Further, it was felt that the success of development and management would depend on the fisherfolk's understanding of, and willing participation in, these processes. Therefore, an attempt was made to ensure that appropriate information was collected to develop material to educate fisherfolk on fisheries-oriented issues, problems and solutions and to gain their understanding and cooperation in the development and management programmes. Without this, these programmes may be unsuccessful, it was thought.

3. *FISHERIES AND SPECIES UNDER CONSIDERATION*

Except for the *Hilsa* gillnet fishery, all major fisheries in the marine sector of Bangladesh may be considered to be interactive with the ESBN fishery because they target penaeid shrimp and finfish. Penaeid shrimp, croaker and ribbonfish are the most important species in the ESBN catches. They are relatively abundant and have a high commercial value. Fisheries employing pushnet (PN) /dragnet (DN)/fixed bagnet (FBN) (for shrimp fry-collection), beach seine (BS), marine set bagnet (MSBN), trammelnet (TRN), bottom longline (BLL) and shrimp/fish trawl (TWL) have been identified as being significantly interactive with the ESBN fishery for these and other species.

The ESBN fishery catches more than 180 species of shrimp, shellfish and finfish, while the other gear mentioned above catch around 80 species, except for the **BLL** and TRN, which, generally, catch only about 15-20 species. The numbers of species or species groups identified in the catches of different gear are given in Table 1 and the relative vulnerability of common species to the interactive gear is shown in Appendix I.

Table 1. Number of species **of major varieties of finfish and shellfish caught by different gear**

Variety	*ESBN*	*PN/FBN*	*MSBN*	*BS*	*BLL*	*TRN*	*TWL*
Penaeid shrimp	15	6	5	7	0	11	3
Nonpenaeid shrimp	3	1	1	1	0	0	0
Freshwater prawn	9	4	1	4	0	0	0
Crab and mollusc	6	4	6	4	0	5	
Finfish	152	50	30	38	15	57	14
Others	0	20	2	2	0	3	0

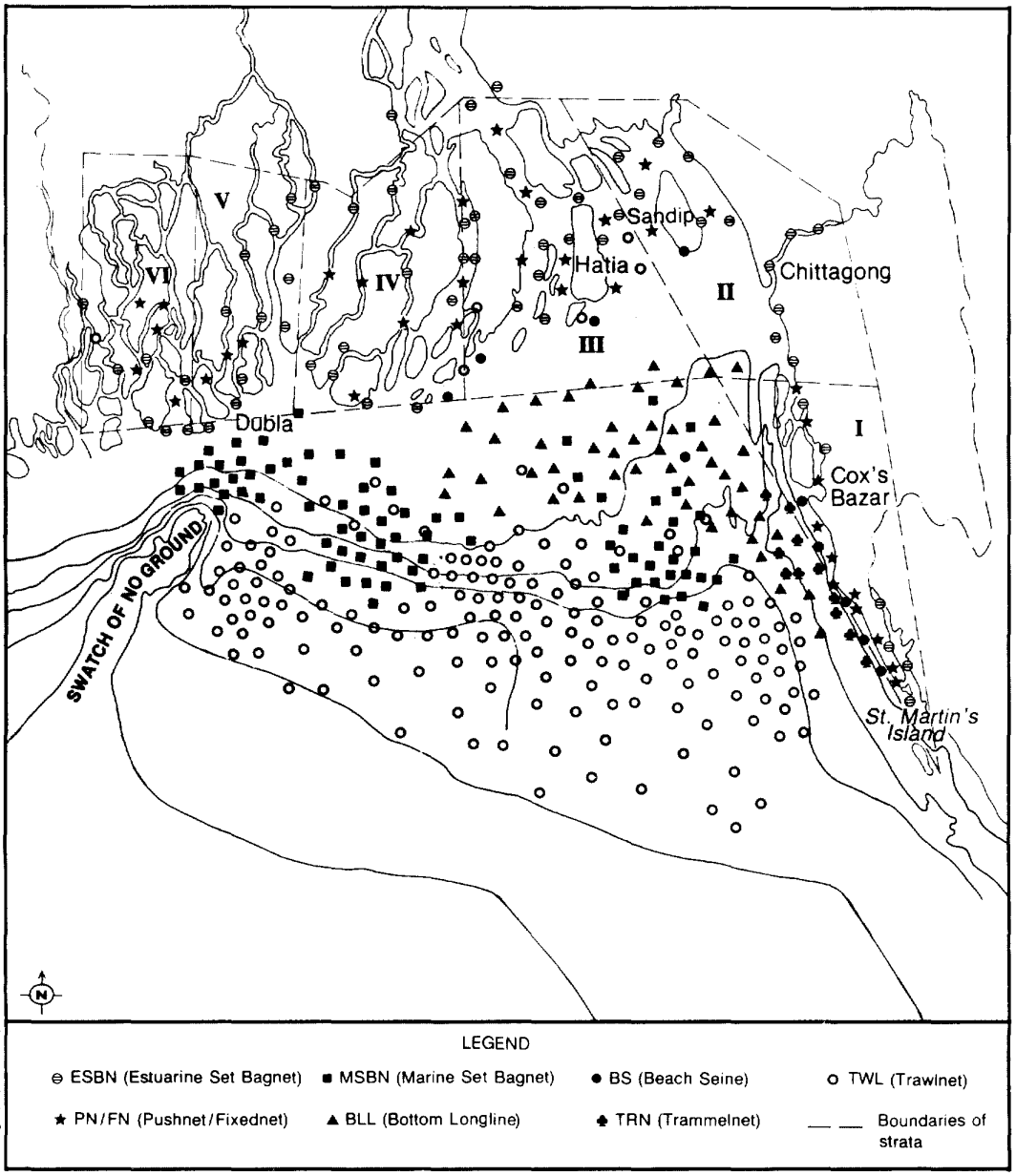
Due to limited manpower, facilities and time available, biological studies of only a few species, common to most of the interactive gear, were undertaken . These included tiger shrimp *(P. monodon),* brown shrimp *(M. monoceros),* white shrimp *(P. indicus),* ribbonfish *(L. savala),* Bombay duck *(H. nehereus)* and large croaker *(Johnius* spp.) — Belanger's croaker *(J. belangeri),* Tigertooth croaker *(J. argenteus)* and Blotched croaker *(J. maculatus).* **In the** absence of literature for identification of the juveniles of croakers and due to the difficulties in differentiating them in the early stages of their lives, the three large-sized species of this family have been recorded under *Johnius* spp.

4. FISHING AREAS

The ESBN fishery is spread throughout the channels, canals, tributaries and the estuaries of Bangladesh, wherever a brackishwater environment prevails. The gear is operated in less than 5 m depth, more or less throughout the year. The MSBN is generally larger than the ESBN and is operated at around 20 m depths, at three locations, Sonadia, Mohipur and Dubla, from October to March. Some of the large MSBN are used as ESBN during the other months.

Trammelnets are operated off the Teknaf-Cox's Bazar coast, at 5-10 m depths. The trawl fishery operates in the 30-80 m depth range. Beach seines are operated from the shoreline and cover depths of upto 8-10 in. This gear is operated in the Cox's Bazar, Chittagong, Noakhali, Barisal, Patuakhali and Khulna areas, but 62 per cent of the units are located in the Cox's Bazar area alone. Shrimp fry-collection gear are widely used in the estuaries and river mouths along the coastline, except in the Noakhali area. The fishing areas of the gear and the geographical strata studied are shown in Figure 2.

Fig 2. Area of operation of different fisheries in Bangladesh



5. FISHING EFFORT AND PRODUCTiON

The PN/FBN fishery has the largest number of gear units and the TWL the least. The former is a very simple and inexpensive gear with low productivity, while the latter is very complex and expensive and has a very high production capacity (see Table 2). The gear units in the ESBN fishery are the second largest in number and their production is almost equal to that of the TWL fleet. The number of units in the other interactive fisheries are much less than that in the ESBN fishery.

Though PN/FBN and MSBN production are less than that of the ESBN fishery, the values of their catch are much higher than that of the ESBN fishery and are second only to the TWL fishery. BS, TRN and BLL have low production levels, but BLL catches have relatively better value because its target species are exported (see Table 2).

Table 2. Fishing effort (CPUE), production and value of the catch of selected species in different fisheries (1990/91)

	Gear						
Items	*PN/FBN*	*BS*	*ESBN*	*TRN*	*MSBN*	*TWL*	*BLL*
Catching units (No.)	193,000	558	12,561	400	3852	54 (43+11)	280
Mesh size (mm)	2	sides: 18-24 mid.: 12-14	mm. 8-12 max. 12-22	40-45 150.265	12-25	45m+60m	—
Total effort	28950,000 man-days	51,787 net-days	14,703,998 hauls	34,288 net-days	580,916 hauls	7119 boat-days	25,480 hoat.days
CPUE	608 Nos/day	156 kg/day	5.1 kg/haul	48.2 kg/day	45 kg/haul	381 kg/day*	104 kg/boat/day
Total production (t)	187,386 **	8080	54,000	1754	26,111	56,217	2650
Prod. value (Tk. million•)	*406*	*89*	*286*	*43*	*391*	*600*	*147*
Penaeid shrimp production (t)	21,000 million	739	7746	41	2373	2713	—
Avg. crew/unit	2	15	3	6	3	15	9
Fisheifolk engaged in fishery	200,000	8370	37,683	2400	11,556	810	2520
Periods operated in a year (months)	5-8 (varies with location)	12 (Nov-Feb seasonal; May-Nov estuary)	10-12 (Depending on sea condition)	7 (Depending on sea condition)	6 (Oct-Nay)	10-12 (Depending on sea condition)	7 (Aug-Feb)

* For shrimp only, as most of the others are discarded. Million Nos.fday.

From an employment point of view, the PN/FBN fishery engages the largest number of individuals, but they are generally children and women; the income per individual is very low and incidental. The ESBN employs the second largest number of fisherfolk, the MSBN, PN/FBN, TRN and BLL are highly seasonal fisheries, unlike the ESBN, BS and TWL. A small percentage of the penaeid shrimp caught by the ESBN fishery is suitable for export, but the main exports are from the TWL, TRN and BLL fisheries which target exportable shrimp and croakers. The high values of shrimp and finfish for export and the low values of juveniles, small shrimp and finfish caught for the local market contribute to the large variation in the values of the catches in the various fisheries (see Table 2).

US $I = 35 Taka (appx)