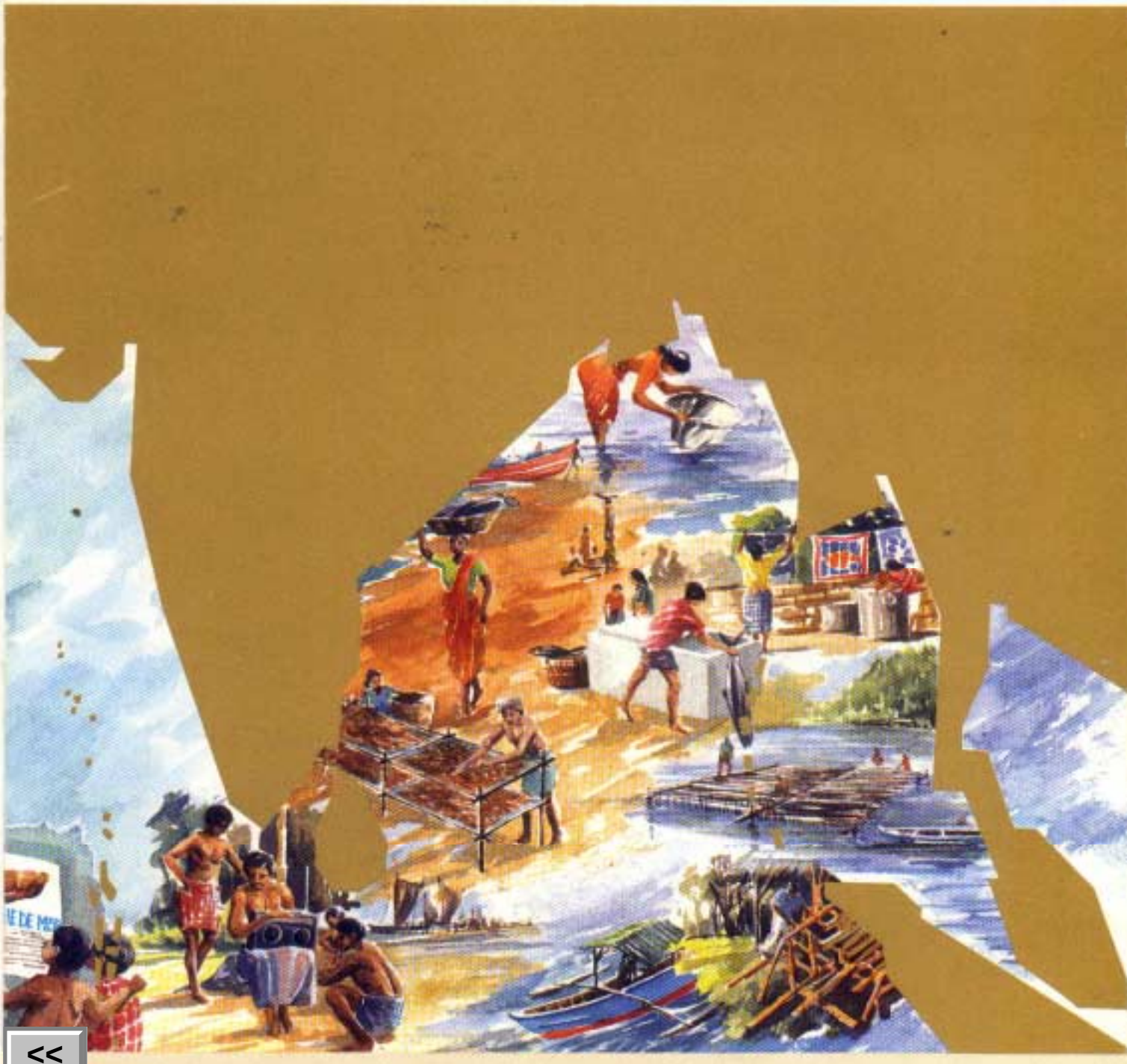
BOBP/WP/89

Studies of interactive marine fisheries of Bangladesh



BOBP For Fisheries Development
BAY OF BENGAL PROGRAMME

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Small-scale Fisherfolk Communities GCP/RAS/118/MUL
Bioeconomics of Small-scale Fisheries RAS/91/006

STUDIES OF INTERACTIVE MARINE FISHERIES OF BANGLADESH

Shrimp Fry Collection
by
S C Paul, Md. G Mustafa, Z A Chowdhury, Md. G Khan

The Estuarine Set Bagnet Fishery
by
Md. S Islam, Md. G Khan, S A Quayum, Md. N Sada and Z A Chowdhury

The Beach Seine Fishery of Teknaf
by
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by
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The Bottom Trawl Fishery
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The Bottom Longline Fishery
by
Q M Huq, Md. G Khan, Z A Chowdhury, Md. N Sarker

BAY OF BENGAL PROGRAMME
Madras, India
1993

Concerned about the effects of the estuarine set bagnet fishery on the shrimp and finfish resources and also on other marine fisheries dependent on the same resources, the Bangladesh Department of Fisheries, with the assistance of the Bay of Bengal Programme (BOBP), conducted a two-year (1989-91) biosocioeconomic assessment of the estuarine set bagnet fishery. In ordcr to make the assessments needed for management purposes, it was necessary to gather information on other interactive fisheries: the marine set bagnet, trammelnet, bottom longline and shrimp trawl fisheries. The only major marine fishery not included was the *Hilsa* fishery, which does not interact with the estuarine set bagnet fishery.

This report contains the information (catch rate, seasonality, catch, effort, biological parameters and cost and earnings) gathered in the estuarine set bagnet and other interactive fisheries, but the socioeconomic information and biosocioeconomic assessment results are published separately as BOBP/WP/90 and BOBP/REP/62.

The authors of the seven parts of this paper were all members of the Management and Development Project, Department of Fisheries, Chittagong, Bangladesh, and were assisted by BOBP's Senior Fishery Biologist, Dr K Sivasubramaniam. The investigations were done under BOBP's "Small-scale Fisherfolk Communities" project funded by DANIDA and SIDA and the reporting under "Bioeconomics of Small-scale Fisheries" funded by UNDP.

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, Shri 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).

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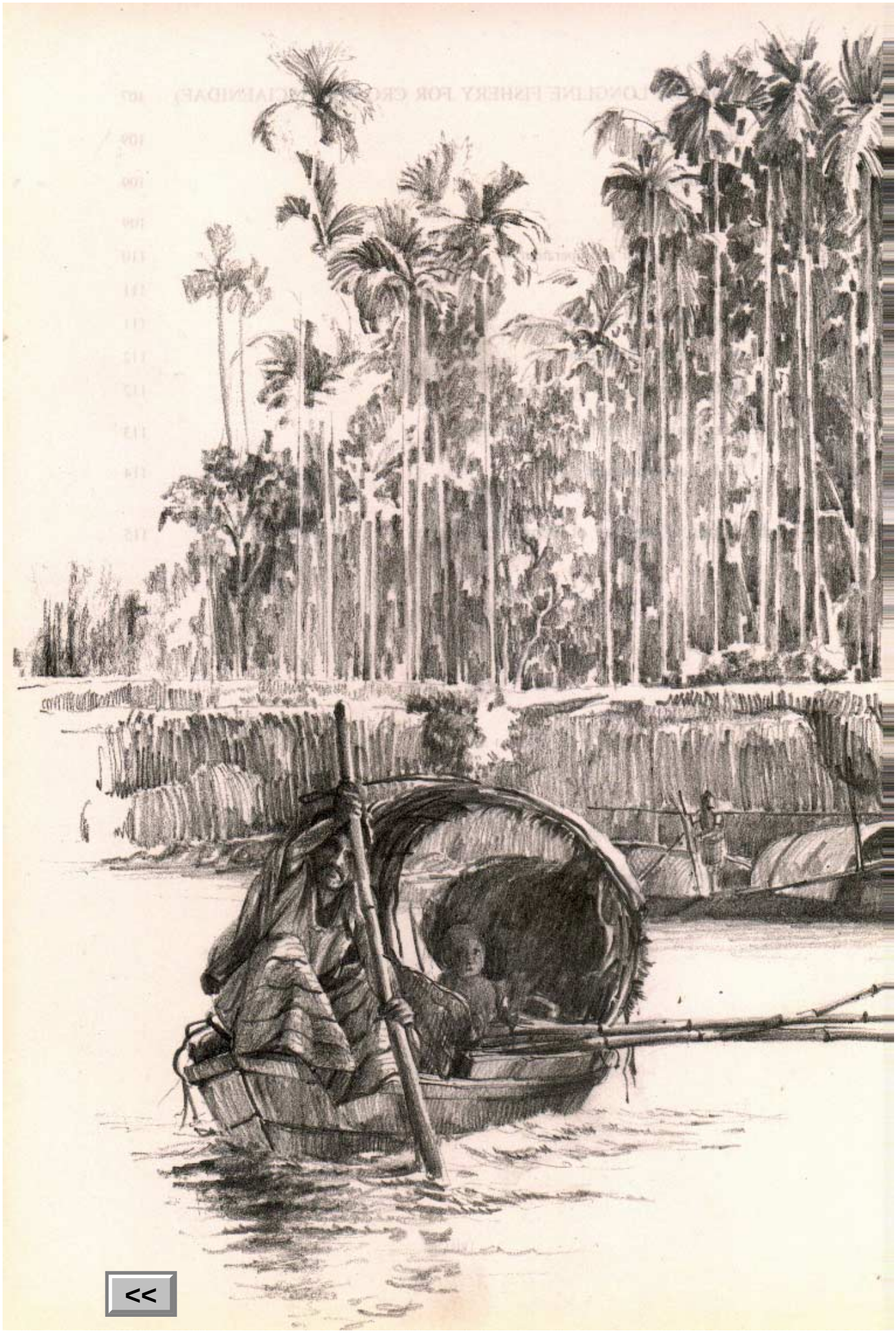

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PREFACE

Arising out of the view among certain sections of the marine fisheries, that the Estuarine Set Bagnet (ESBN) fishery in Bangladesh is destructive to the marine resources and, consequently, affects other marine fisheries, such as the shrimp trawl and shrimp culture, the Department of Fisheries in Bangladesh requested the Bay of Bengal Programme (BOBP) to assist in ascertaining the validity of this opinion and to suggest appropriate action.

The first step was to conduct a pilot study of the ESBN fishery in 1984. The results indicated that the gear was predominantly catching juveniles, immature fish and shrimp and that there was justification for a detailed investigation to quantify the impact of this fishery on the resources and other fisheries exploiting the same resources. In 1989, a case study on the biosocioeconomic assessment of the ESBN was commenced and conducted by the Marine Fisheries Survey, Management and Development Project of the Department of Fisheries, with support from BOBP.

Realizing that the ESBN fishery was catching many commercially valuable species which were also being caught by many other marine fisheries, the assessment of the impact of ESBN on the resources and bother fisheries required relevant information on the exploitation of the same resources by the other fisheries interacting with the SBN. Since the required information from other fisheries was not available, investigation of all the major interactive fisheries also had to be undertaken.

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However, considering that time, skilled personnel, funds and facilities available were all limited, only a few major species caught by the ESBN could be investigated – Speckled Brown Shrimp *(M. monoceros)*, Tiger Shrimp *(P. monodon)*, White Shrimp *(P. indicus)*, Bombay Duck *(H. nehereus)*, Ribbonfish *(L. savala)* and large Croaker *(Johnius* spp.). In Bangladesh, the primary gear used to catch one or more of these species are the pushnet/ dragnet/fixed bagnet for Tiger Shrimp fry collection, beach seine and marine set bagnet (MSBN) for the finfish species and some of the shrimp species, trammelnet primarily for shrimp, bottom trawl for finfish and shrimp species and bottom longline for larger Croakers, besides the estuarine set bagnet which catches all the selected species.

The ESBN fishery being the primary fishery investigated, the survey of this fishery was designed and conducted in a proper manner. Again, due to the limitations already mentioned, the investigations of all other interactive gear were carried out by the same group of national staff in whatever time they could spare in between the fieldwork for the ESBN fishery. In the cases of the MSBN and trawl fisheries, considerable data collected during independent surveys, conducted prior to this one, were also used in the final analysis.

This working paper contains the information on all the seven fisheries mentioned above, based on the results of the analysis of the primary and secondary data available. The report on the ESBN fishery is more detailed than the rest for obvious reasons. The descriptions of the various fisheries are arranged in the best possible sequential order in which the animals enter each fishery, from their larval stage to the adult stage. This working paper may additionally be considered useful as a good source of information on many of the marine fisheries in Bangladesh.

SHRIMP FRY COLLECTION

by

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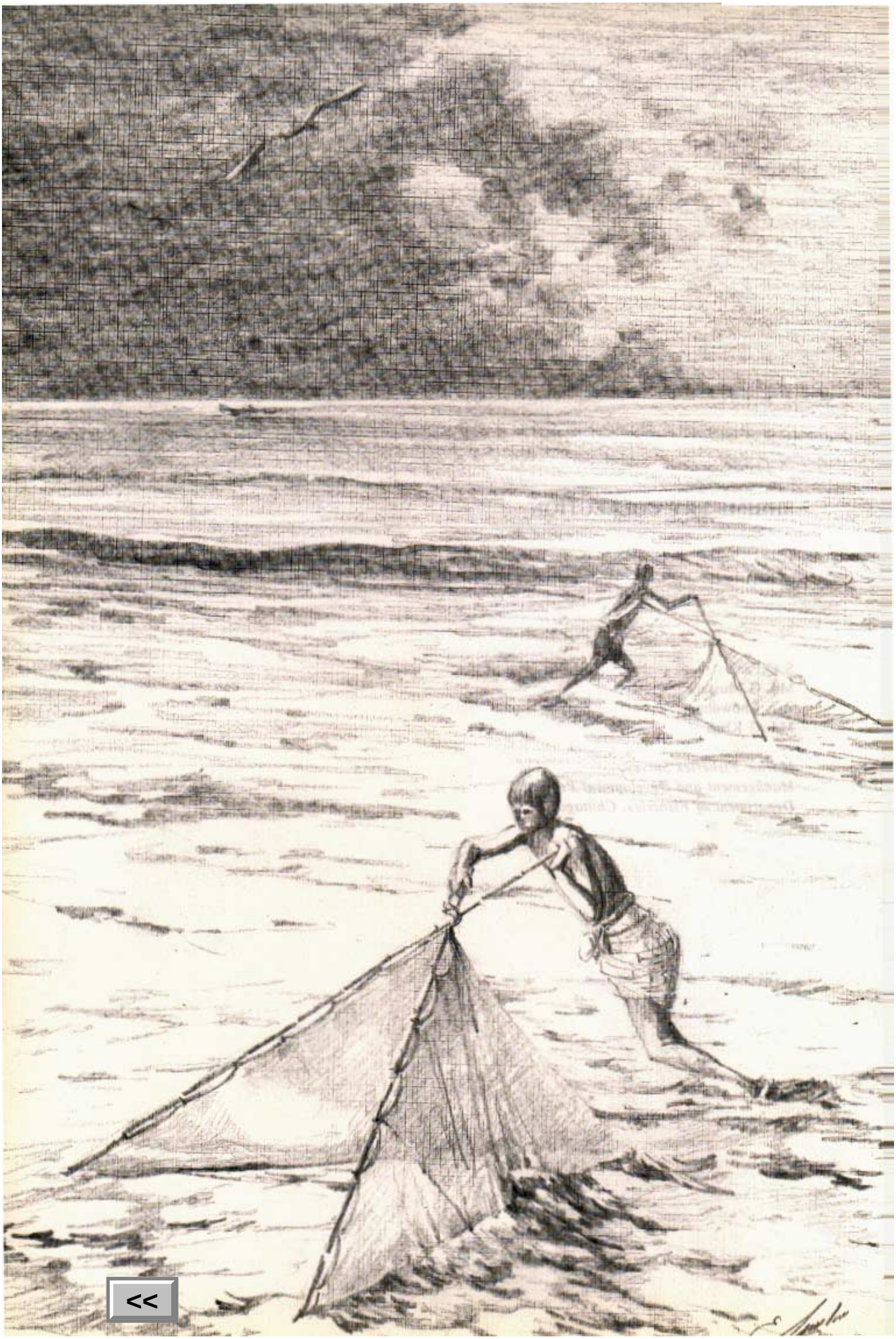

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1. *INTRODUCTION*

During the early stages of its life—cycle, the commercially important tiger shrimp (*Penaeus monodon*) is captured in different artisanal fisheries in Bangladesh. one of which is the collection of shrimp fry for culture. Innumerable shrimp post—larvae are increasingly being taken out from the shallow nursery areas in the estuarine waters. by such gear as pushnets. fixed hagnets. and dragnets. to meet the needs of the country's rapidly expanding coastal shrimp culture.

Shrimp exports have risen to third position among the foreign exchange earners in Bangladesh. Recent expansion of the farming areas to meet the demands of export and the trend of selective stocking have resulted in a tremendous deniand for shrimp post-larvae Although it is sought to increase production even further, by expanding culture activities, it may not be possible to do so on the basis of complete dependency on wild shrimp fry.

Reliable statistics (10 not exist on the number of post-larvae being trapped for culture at present. But with gradually improving culture technology, more and more shrimp farmers are collecting and stocking shrimp post-larvae, besides trapping the post-larvae in the tidal waters by closing the dykes. This latter method, however, leads to unwanted species and predators also being trapped. Many farmers, however, have changed their culture technique to keep unwanted species and predators out. They stock their shrimp ponds entirely with collected fry and exchange the tidal water in the ponds through screens.

Kenneth Larsson (1986) indicated that in the Saikhira District alone about 25.000 people were engaged in the collection of wild shrimp post-larvae. The annual collection there was estimated at 250—350 million *P. monod* on fry.

Scientists are becoming increasingly concerned about a possible threat to the sustenance of the shrimp stock posed by fry-collection, hut, in the absence of dependable and quantitative biological information, the effect of the shrimp fry-collection on the wild stock has not been assessable. A study was therefore conducted to fill this gap in the knowledge and to help identify options for management of the fry-collection. Its main objectives were:

To make a reasonable estimate of the production in the coastal areas of Bangladesh of tiger shrimp post-larvae and juveniles by fry-collecting gear that vary with season and location, and assess the present level of utilization of the catch in the shrimp culture industry.

To estimate the total number of larvae and fry of other shrimp, finfish and other organisms that are caught as incidental by-catch and destroyed by the shrimp fry-collectors.

To assess the impact on the resources and the economic consequences of the culture and capture fisheries, if the collection of *P. monodon* fry is continued.

estimate the manpower engaged in shrimp fry-collection and their income.

2. *METHODOLOGY*

2.1 *Sampling stations and areas*

The sampling statioiis along the coastal belt *of* Bangladesh were selected on the basis of a preliminary investigation, which provided information on the availability of *P. monodon* fry and the level of its commercial exploitation. The selected commercial shrimp fry-collecting stations were Teknaf. Cox's Bazar. Khepupara, Morrelganj and Debhata.

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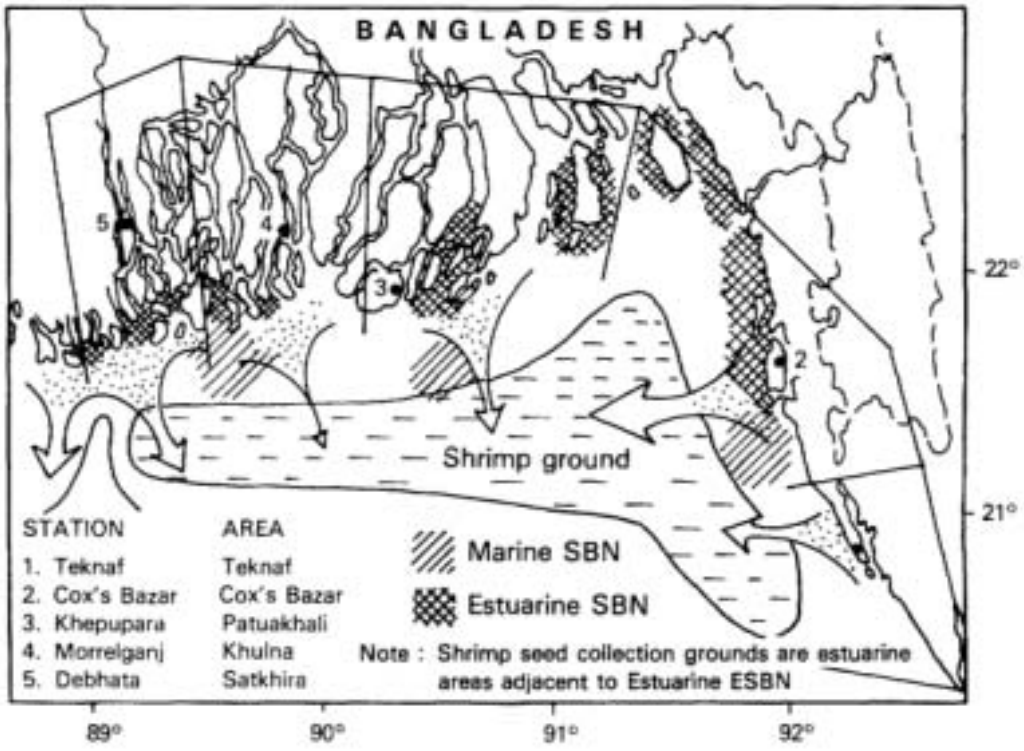
For convenience of estimating the production of shrimp fry, the tidal belt was divided into five areas, represented by the five stations selected (listed alongside).

Station	*A ea*
Teknat	TeRnal
Cox's Bazar	Cox's Bazar
Khepupara	Patuakhali
Morrelganj	Khulna
Dehhata	Satkhira

The location of the sampling stations and the boundaries of the areas are shown in Figure 1

Fig. 1. Map of coastal Bangladesh showing shrimp fry-collection areas



2.2 *Gear*

Among the fry-collection gear. the pushnel)PN) is the most common in the Teknaf and Cox's Bazar area, while the fixed hagnel (FBN) is popular in Patuakhali. Khulna and Satkhira. Locally available nylon mosquito' nets are used as netting material. A synthetic monofilament net material (HDPE: high density polyethylene) with knotless webbing of about 2 mm mesh size, is also used in Satkhira. Khulna and Patuakhali areas. This is available in the local market, priced at 20-25Tk*/m^2. Figures 2 a-c (facing page) illustrate the gear used. The dragnet, used occasionally in one area, is functionally similar to the pushnet and is. therefore, treated as such.

2.3 *Sampling procedures*

The shrimp fry-collection was studied from November 1989 to October 1990. Sampling was conducted fortnighllv. during New Moon and Full Moon, either at high tide or at low tide. depending upon the location and the commercial method of fry-collection. Data were collected by

conducting experimental operations with commercial gear. and sampling froni the commercial catches.

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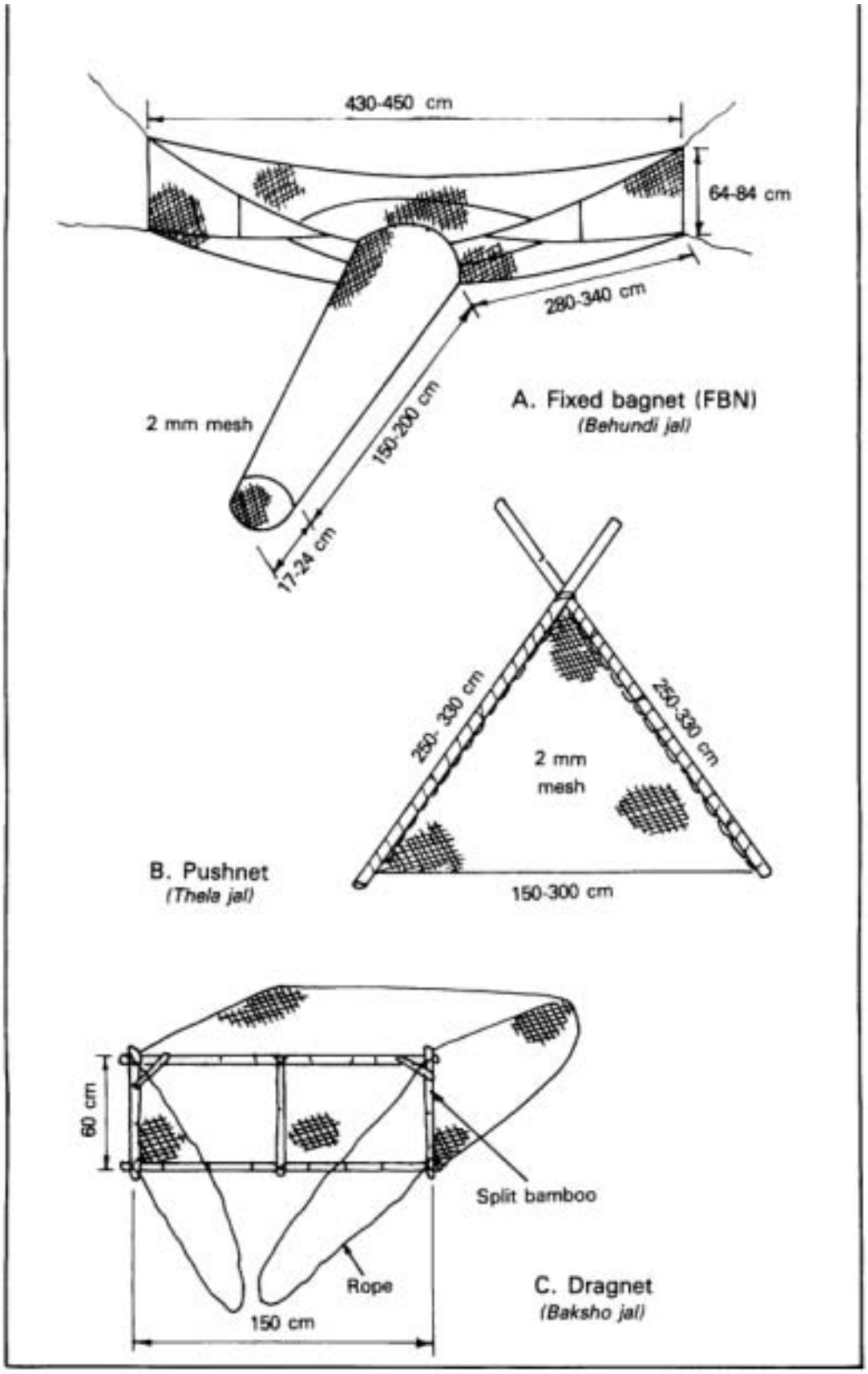
Fig. 2. Fixed bagnet, pushnet and dragnet used in shrimp fry-collection, Bangladesh



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The two data-collection methods are described below.

EXPERIMENTAL

At all stations, special tows (for PN) or specific soaking times (for FBN), each of 15 minutes' duration, were made by the biologists with the assistance of local fry-collectors. The gear used were of the same commercial type and size as normally used at the respective stations. The operations were conducted during low tide and high tide, as was appropriate, to determine monthly species composition. Samples of the catches collected every month were preserved for laboratory analysis of species, numbers and sizes.

COMMERCIAL CATCH

During commercial fry-collection operations, information was collected by sampling fortnightly the catches of. about ten fry-collectors at each sampling station. Commercial tows were of 15 minutes' duration. hut repeated a number of times each day. Questionnaires used during this study included questions on the number of tows made a day with each type of gear and the number of operational days in each area during the preceding month. Fry-collectors. whose catches were sampled, were also interviewed about this information.

Commercial catch rates were determined solely for *P. monodon*. as data on the number of fry collected per hour per gear from commercial operations were available only for this species. The species composition was analyzed only from samples taken during the experimental fishing, each month and at each station.

2.4 *Estimation of* P. monodon *(tiger shrimp) production*

Production estimation was attempted using the two methods described below.

BY RAISING THE CATCH RATE. USING ESTIMATE OF TOTAL EFFORT

The catch per hour for *P. monodon* in each area was raised through catch per day to catch per month, for each type of gear (PN and FBN), using the average number of hours towed per day and the average number of fishing days for the month. The monthly catch per unit of gear was multiplied by the estimated number of units of that type of gear in the area to estimate monthly production by that gear type in the area. The procedure was repeated for all five areas and for all the months in a year, for both types of gear, to obtain the annual total of tiger shrimp fry collected in Bangladesh.

Based on observations made by the biologists and by interviewing fry-collectors. fry traders, shrimp farmers and local fishery officers, the number of gear units operated per kilometre of shore line, each month, and the extent of the shore line used for fry-collection, were checked and the number of units of fry-collecting gear of each type was estimated for all the areas.

ANNUAL EXPORTS OF CULTURED *P. MONODON* SHRIMP

The total quantity, gradewise, of cultured *P. monodon* exported from Bangladesh in 1987 and 1988 was collected from the invoices submitted to the two Fish Quality Control Laboratories in the country. Total weight, in tonnes. of each grade was divided by 0.434 (weight of shrimp in a 1-lb block). The number of blocks was then multiplied by the lower and higher values of the respective shrimp count to obtain the upper and lower limits of the number of *P. monodon* of each grade exported annually. Estimates of the number of shrimp collected each year were back-calculated by applying the average mortality rate of shrimp reported to prevail from stocking to harvesting, in the ponds. as well as during transportation from collecting point to stocking ponds.

Mortality during transportation was estimated by interviewing a number of shrimp farmers and shrimp fry traders to find out the number of shrimp fry purchased from collectors and the number sold to farmers at the stocking site. Mortality in the ponds was similarly estimated from the number of shrimp fry stocked and the number harvested. These were checked in the different areas to make

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allowances for variations due to distances over which the fry were transported, the sizes of ponds and stocking density. Ten farms, in each area, were visited to collect this information.

2.5 Production estimates for other by-catch

Applying the ratio of the estimated number of *P. monodon* fry in the total catch and its percentage in the species composition of the catch, to the percentages of other species in the catch, the respective numbers of other larvae and juveniles caught were estimated.

2.6 *Estimation of total manpower engaged in shrimp fry-collection*

Observations of the use of the different types of gear in this fishery indicated that, generally. two persons are engaged in a pushnet operation and one person for a fixed bagnet.

2.7 *Estimation of earning*

A questionnaire was prepared and fry-collectors were interviewed on the price of tiger shrimp fry (Tk per 100 fry). These interviews at fry-collection points also sought to find out the cost of fishing gear and of the fishing operations.

The price of tiger shrimp fry varied daily and according to seasons. Therefore, monthly average prices and the estimated number of fry collected per month and per gear unit were used to estimate the gross earnings per month per unit.

The collecting gear are fabricated by the users. The cost of the raw material required, such as net, bamboo, rope, aluminium bowl, small pot (for sorting fry), kerosene oil, kerosene lamp (for night collection) etc. was obtained during the course of the interviews. It was found that there are no operational expenses; generally, the owner or his family members operate these gear and, therefore, paid labour is seldom used.

To make the cost and earning analysis by gear, the cost of the items listed above, though very small, was taken into consideration. The average life of gear and other materials was estimated to be about two years and the net revenue earning per gear was calculated by subtracting the depreciated value.

3. *RESULTS*

3.1 *Number of fry collecting gear units*

The estimated length of shoreline of each area and the number of commercial fry-collection gear in each of these areas are shown in Table I.

Table 1: Number of pushnets and fixed bagnets along the shoreline estimated to be used monthly for *P monodon* fry-collection (1989-90)

Shoreline length (km)	*75*	*310*		*276*		236		*465*		*1362*	
Area	*Teknaf*	*Coxs Bazar*		*Patuakhali*		*Khulna*		*Satkhira*		*Total*	
Month	*PN*	*PN*	*FBN*	*PN*	*FBN*	*DRAG*	*FBN*	*PN*	*FBN*	*PN*	*FBN*
November	-	-			-	-		-	1631	0	1631
December									1398	0	1398
January	646	3110		-	-	5925	5925	6990	46600	16671	52525
February	950	10885	6220	-	2077	--	-	-	-	11835	8297
March	1292	23325	1710	-	30054		1185	-	116500	24617	149449
April	646	31100	2440	-	1385	-	948	11650	17708	43396	32481
May	760	17105	-	-	-	-	-	-	11650	7865	11650
June	-	10107		-	-	-	-	20970	2796	31077	2796
July	1140	8553	6220	-		-		-	1165	9693	7385
August	2280	2643		1108		-	-	-	3728	6031	3728
September	4636	-	1224			--	-	-	-	4636	1224
October	646	2021	-	-			-	466	-	3133	-

Note: - = no fishing 0 = zero catch

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3.2 *Species composition*

Eightythree types of organisms were identified in the catch composition of the shrimp fry-collection gear. Of them, 29 were identified up to species level, 23 up to generic level and the rest placed under family name or variety/category.

The catch composition of different species and/or groups sampled in the five locations by both types of gear is presented in Table 2. Details of the species composition for the two gear are presented in Appendix I.

Table 2: **Species composition (%) in the catches of shrimp fry-collection gear *at* sampling sites**

Species/Group	*Teknaf*		*Cox s Ba:ar*		*Patuakhali*		*Khu/na*		*Satkhira*	
	PN	*FBN*	*PN*	*FBN*	*PN*	*FBN*	*DRAG*	*ERN*	*PN*	*FBN*
1. *P. inonodon*	2.3	-	4.0	1.8	0.5	0.3	0.2	0.1	0.5	0.7
2. Other penaeid shrimp	7.7	-	30.3	50.0	1.7	0.7	0.0	0.2	6.2	1.0
3. Caridean shrimp (prawn)	0.1	-	3.1	0.6	42.2	6.2	11.1	17.4	19.6	18.6
4. Finfish larvae	12.8	-	32.0	15.4	1.7	14.6	15.6	3.2	11.1	7.4
5. Zooplankton (small organisms)	77.1	-	30.6	32.2	53.9	78.2	73.1	79.1	62.6	72.3

The largest proportion of *P. monodon* fry was collected in Cox's Bazar, for both types of gear; followed by Teknaf where only PN was used. The share of other pemaeid shrimp was also high in Cox's Bazar — 50 per cent in the FBN catch, nearly all of it being Indian White Shrimp, ***P.*** *indicus*. On the other hand, its share was just under 10 per cent in the PN catches.

The share of the nonpenaeid shrimp in the PN catch was appreciably higher in Patuakhali, while in Khulna the FBN had a slightly higher share. Both gear had more or less similar shares in Satkhira. Sergestid shrimp *(Acetes* sp.) and crab larvae were the dominant components in the nonpenaeid shrimp catches by both gear.

Among the finfish, the PN catches had higher proportions of larvae of Whiting *(Silago sihama)* in Teknaf and Cox's Bazar, Anchovy *(Stolephorous* sp.) in Khulna and Croaker ***(Sciaenidae)*** in Satkhira. The FBN had higher proportions of Anchovy larvae in Cox's Bazar, Patuakhali and Khulna.

3.3 *Catch rates*

Monthwise average catch rates, by number per hour, of *P. monodon* fry (Figure 3) and numbers caught per day (Table 3 - p.12) were estimated for each gear in the five areas. The rate was the highest in Teknaf and Cox's Bazar. It was found that the catch rate in the Cox's Bazar area was remarkably high for several months in the year. The highest catch rate was 450 fry/hr by FBN in April in Cox's Bazar. Though salinity variation influences the distribution of larvae, similar catch rates were observed in significantly different salinities in the different locations. The salinity ranges in Teknaf (25‰)and Cox's Bazar (22.9°/₀₀)were distinctly higher than those for Patuakhali Khulna (2.0°/₀₀and Satkhira (6.7°/₀₀).

In spite of the variations in catch rate in the different areas for different gear, two peaks are evident, very prominently in Teknaf and Cox's Bazar, followed by Satkhira. Evidently, there are two peak spawnings each year, occurring around February/March and September, besides sporadic spawning. The former may be considered the winter spawning, the latter the summer spawning.

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Fig. **3. Seasonal variations in catch rates of tiger shrimp** fry **in pushnet and** fixed bagnet **fisheries at the five stations**

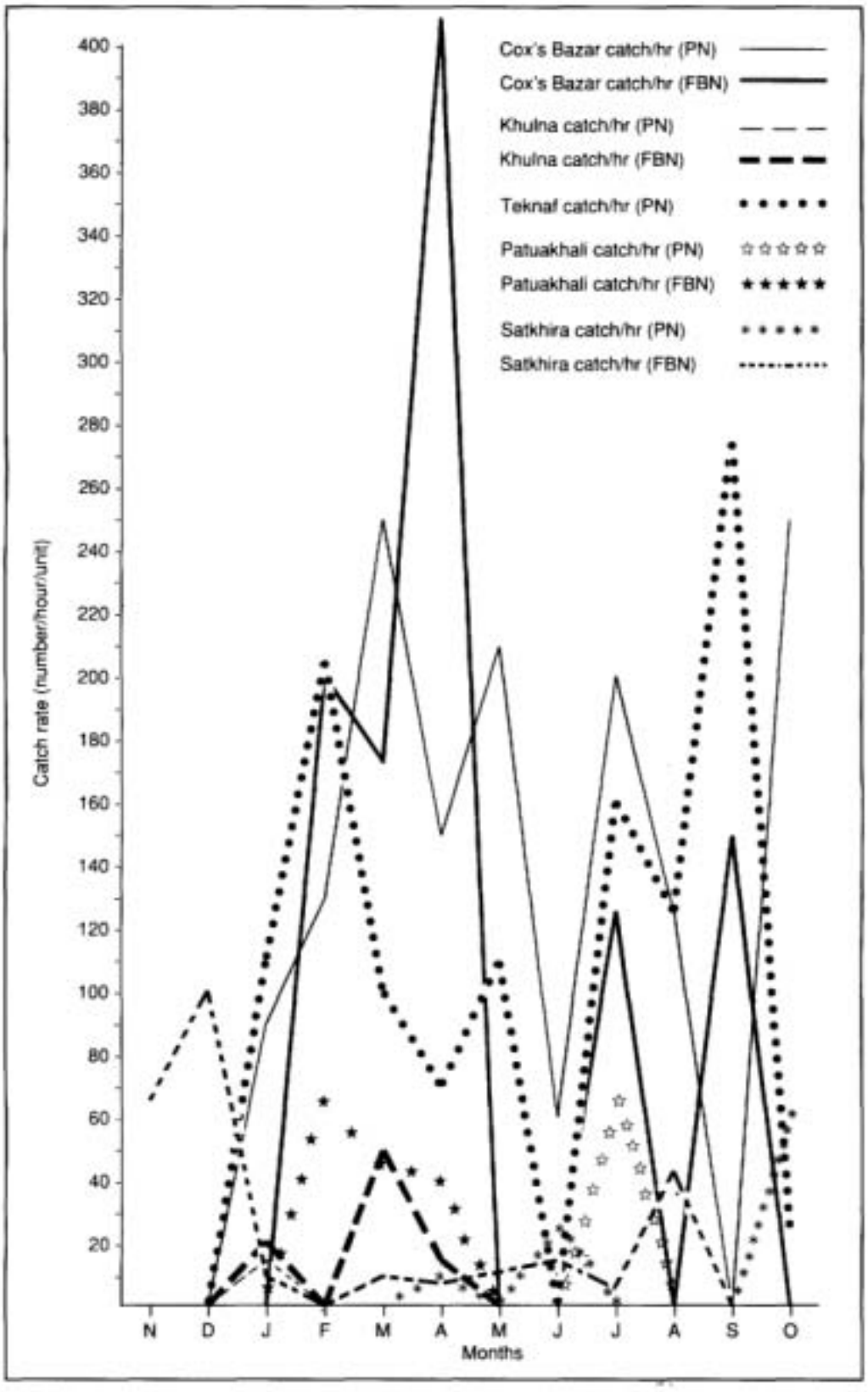

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Table 3 : **Catch rate of *P. monodon (no.Iday)* in commercial shrimp fry collection** (1989-90)

	Teknaf	*Coxs Bazar*		*Patuakhali*		*Khulna*		*Satkhira*	
Month	*PN*	*PN*	*FBN*	PN	*EBN*	*DRAG*	*FBN*	*PN*	*FRN*
November									652
December									1000
January	450	425				160	40	35	70
February	825	750	900		350				
March	650	1600	1150		170		262		70
April	450	275	900		176		77	30	37
May	500	600							79
June		367						75	64
July	820	557	360						31
August	700	650		350					300
September	1475		1067						
October	60	1600						450	

Fry-collection is not continuous throughout the year and the collection season also seems to differ between the areas (Table 3). Collection is carried out over at least ten months of the year in the Teknaf, Cox's Bazar and Satkhira areas, but only for about three or four months in the Patuakhali and Khulna areas.

3.4 *Production*

In 1989/90. the total annual production of *P. monodon* fry in Bangladesh was approximately 2,034 million (Table 4). of which 64 per cent was estimated to be contributed by the pushnet operations. Of the *P. monodon* fry-collection by pushnet, 81 per cent was from the Cox's Bazar area alone, followed by Teknaf (13%) and the Satkhira area (5%). On the other hand, both Satkhira and Cox's Bazar areas contributed equally to a total of 80 per cent of the fry collected through the fixed bagnet operation.

Table 4 : Total *P. monodon* production by shrimp fry gear in 1989-90 (in millions)

	Teknaf	*Cox's bazar*		*Patuakhali*		*Khulna*		*Saikhira*		*Total by gear*		*Grand*
Month	*PN*	*PN*	*FBN*	*PN*	*FBN*	*DRAG*	*FBN*	*PN*	*FBN*	*PN*	*FBN*	*Total*
November									74		74	74
December									13.9		3.9	13.9
January	2.6	13.2				14.2	3.5	7.3	97.8	37.3	101.3	138.6
February	7.8	89.8	06.3		16.4					97fj	22.7	220.3
March	15.1	559.8	29.5		117.5		6.2		114.1	574.9	267.3	842.2
April	2.0	59.8	111.9		5.8		1.0	8.7	15.0	70.5	133.7	204.2
May	3.8	112.8							22,1	116.6	22.1	138.7
June		74.2						43,2	2.9	117.4	2.9	120.3
July	1.2	52.4	24.6						0.7	63.6	25.3	88.9
August	7.5	30.9		3.8					21.2	52.2	21.2	73.4
September	102.6		22.5							102.6	22.5	125.1
October	0.4	58.2						2.1		60.7	0.0	60.7
Total (by gear in area)	163.0	1051.1	294.8	3.8	139.7	14.2	10.7	61.3	295.1	1293.4	740.3	2033.7
(;rand total (by area)	163.0	1345.9		143.5		24.9		356.4		2033.7		2033.7
%	8	66		7		1		18		100		100

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Approximately 66 per cent of the total *P. monodon* fry was collected from Cox's Bazar (Area II) while Satkhira (Area V) contributed only around 18 per cent and the other three areas together the balance.

By applying culture pond mortality (average 70 per cent). and transportation mortality (average 29 per cent) to the number of shrimp exported from culture ponds during 1987 and 1988, the estimate of *P. monodon* fry collected was 1680 million in 1987 and 1408 million in 1988 (Table 5).

Table *5:* Estimated production of ***P. monodon*** **fry from export data for 1987 and 1988**

Year	*Total weight exported (t)*	*Total no of* P. monodon *exported*	*Pond mortality (%)*	*Transport mortality (%)*	*Estimated no of of* P. monodon *fry (million)*
987	5574.1	357,772.871	70	29	1680
1988	6518.2	318.008.950	70	29	1408

In shrimp fry-collecting gear with very small mesh size (about 2 mm), the organisms caught are, naturally. very small in size. *P. monodon* fry were of length 7-16 mm, with a modal length of 10-12 mm.

About 21,000 million penaeid shrimp of all species are caught during the shrimp fry-collection. About 19,000 million of them are discarded on the banks of the estuaries. Tiger shrimp fry are not thrown away. Of the discarded varieties, the Indian White Shrimp was observed to be the predominant penaeid shrimp, amounting to about 10,000 million.

They were almost entirely caught in the Teknaf and Cox's Bazar areas. From the 187,000 million individuals caught annually (Table 6), finfish larvae and juveniles amounting to about 20,000 million and others (including nonpenaeids, planktonic organisms etc) exceeding 100,000 million are also lost during the sorting process for tiger shrimp larvae. Nearly 50 per cent of the finfish larvae/juveniles and 76 per cent of the plankton discarded were from the Satkhira area.

Table 6: Production of total number of all organisms (except tiger shrimp) by commercial shrimp fry-collection, 1989-90 (in millions)

	Tenkaf	*Cox's ha:ar*		*Patuakhali*		*Khulna*		*Satkhira*		*Total by gear*	
Month	*PN*	*PN*	*FBN*	*PN*	*FBN*	*DRAG*	*FBN*	*PN*	*FBN*	*PN*	*FBN*
November	.	.	.	-	-	.	-	.	10,247.1		10,247.1
December		.	.	..		.	.	.	2348.1		2348.1
January	116.8	1019.3	.	.	-	4725.3	1012.1	1157.8	9686.2	7019.2	10,698.3
February	174.8	3224.2	339.8	.	76.9	.	.	.	.	3399.0	416.7
March	24.2	2653.3	531.3	.	3814.7	.	1820.1	.	76,006.8	2677.5	82,172.9
April	0.3	184.1	9541.7	.	7307,4	.	363,9	2903.9	5180.9	3088.3	22,393.9
May	318.2	3287.8	.	-	-	.	.	.	8158.6	3606.0	8158.6
June	.	645.3	-	.	.	.	.	9567.1	576.1	10,212.4	576.1
July	35.7	710.5	5216.0	.	.	.	.	.	515.0	846.2	5731.0
August	3422	454.0	.	595.8	-	.	.	.	5161..6	1392.0	5161.6
September	5860.9	.	575,9	..		.	.	.	.	5860.9	575.9
October	4.8	507,0		.	-	.	.	293.2	.	805.0	0.0
Total (by gear in area)	6977.9	12,685.5	16,204.7	595.8	11,199.0	4725.3	**3196.1**	**13,922.0**	**117,880.4**	38,906.5	148,480.2
Grand total (by area)	6977.9	28,890.2		11,794.8		7921.4		131,802.4		187,386.7	
%	3.7	15.4		6.3		4.2		70.4		100	

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3.5 *Number of shrimp fry-collectors*

The simple assessment undertaken indicates that 120,00-200,000 persons may be engaged in shrimp fry-collection during March/April. This number declines to 2,000-10,000 between September and December (see Table 7).

Table 7: **Total manpower engaged in shrimp fry-collection in the coastal belt of Bangladesh (1989-90)**

	Teknaf	*Cox's Bazar*		*Patuakhali*		*Khulna*		*Satkhira*		*Total*	
Month	*PN*	*PN*	*FBN*	*PN*	*FRN*	*DRAG*	*FRN*	*PN*	*FBN*	*PN*	*FBN*
November									1631	0	1631
December									1398	0	398
January	1292	6220				11850	5925	13980	46600	33342	52525
February	1900	21770	6220		2077					23670	8297
March	2584	46650	1710		30054		1185		116500	49234	149449
April	1292	62200	12440		1385		948	23300	17708	86792	32481
May	1520	34210							11650	35730	11650
June		20214						41940	2796	62154	2796
July	2280	17106	6220						1165	19386	7385
August	4560	5286		2216					3728	12062	3728
September	9272		1244							9272	1244
October	1292	4042						932		6266	

3.6 *Economics of shrimp fry-collection*

Table 8 shows monthly average price per 100 *P. monodon* fry in the different areas. It varies from Tk 2 to 38, depending on the location and season. Monthly price fluctuations are mainly influenced by availability and stocking periods.

The input costs for PN and for FBN are summarized alongside.

Owners and family members operate these gear and, therefore, there are no labour costs involved.

Assuming two years' life for these materials, the annual cost of the PN is Tk 202.50 and of the FBN Tk 455.00. Net income per gear varies between the different are as and for each gear type (see Table 9 facing page). In Teknaf and Cox's Bazar, the annual earning from the PN is Tk 7,689 and Tk 7,630 per gear respectively. For the same gear, it is only Tk 494 in Khulna, Tk 791 in Satkhira and Tk 43 in Patuakhali. The annual income per FBN in Cox's Bazar is Tk 6,200, but is much less elsewhere: Patuakhali Tk 3,721, Satkhira Tk 3,344 and Khulna Tk 2,056.

Table 8: Price (Taka/100) of *P. monodon* fry (1989-90)

Month	*Teknaf*	*Cox's Bazar*	*Patuakhali*	*Khulna*	*Satkhira*
November					11
December					8
January	17	15		29	15
February	15	17	30		
March	15	12	35	38	35
April	12	14	12	30	30
May	12	IS			36
June		10			10
July	9	10			10
August	10	7	7		12
September	6	3			
October	10	2			9

Input	*Cost*	
	PN (Tk)	*FRN (Tk)*
Net	210	600
Bamboo	20	60
Rope	10	75
Float	—	10
Enamel bowl	150	150
Sorting pot	5	5
Kerosene lamp	10	10
Total	405	**910**

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Table 9: Monthly gross and net revenue per gear in shrimp fry-collection in Tk (1989-90)

	Teknaf	Cox,s Bazar		*Patuakhali*		*Khulna*		*Satkhira*	
Month	*PN*	*PN*	*FBN*	*PN*	*FBN*	*DRAG*	*FBN*	*PN*	*FBN*
November									502
December									800
January	709	744				6%	174	157	315
February	279	1444	2565		2284				
March	1755	1440	2070		1368		1991		343
April	394	260	1080		524		346	225	255
May	600	990							683
June		734						206	106
July	886	766	396						62
August	770	878		245					684
September	1438		544						
October	60	576						405	
Total (Gross revenue)	7891	7832	6655	245	4176	696	2511	993	3750
Total (Net revenue)	7689	7630	6200	43	3721	494	2056	791	3295

During the off-season, when there is no fry-collection activity, the people engage themselves in other activities. *e.g.* casual labour, rickshaw-pulling, earth-cutting. other fishing, wood-cutting, work in the salterns etc.

4. DISCUSSION

The total number of tiger shrimp fry collected annually by commercial collectors, as estimated from culture shrimp export data, was 1680 million in 1987 and 1408 million in 1988. This is considered to be slightly underestimated, because all *P. monodon* produced from shrimp farms may not necessarily be exported; a very small quantity is consumed locally and another small portion, treated as undersized/soft-shell, is not supposed to be exported. There are other reasons also for the export figures not reflecting the total production.

In 1983/84, the area under shrimp farming was 52,000 ha, but in 1988/89 it had more than doubled, to 108,000 ha. The proportionately increasing demand to meet the needs of the rapidly growing shrimp farming industry may encourage fry-collectors to collect more fry from the wild. Considering all factors, it is conjectured that an estimated production of 2035 millions would be needed to meet the demand for 1989/90.

As the demand for wild fry increases, the recruitment to deep sea stocks of *P. monodon* and other penaeid species, destroyed in the process of fry-collection, may be affected. The destruction of large quantities of fry of many valuable species of finfish and shellfish, particularly in Area V (Satkhira). may also be harmful to many stocks that support a number of important fisheries. Further increase in effort in *P. monodon* fry-collection, to cope with the growing demands of shrimp culture, would, therefore, require careful consideration.

About 75 per cent of the total *P. monodon* fry-collection is from the Cox's Bazar and Teknaf areas. This eastern stretch of coast seems to be one of the main nursery-grounds for *P. monodon* post-larvae and other penaeid larvae.

Van Zalinge (1986, pers. comm.) reported that the catch rate of P. *monodon* in Satkhira was around 2,000 fry/day/gear during the peak season (Feb-Mar), in 1982. Larsson (1986) and Funegaard

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(1986) estimated 200 fry/day/gear (all types mixed) for the peak season in 1986. However, their average for the whole year appeared to be around 70 fry/day/gear. Yet, 20-25,000 collectors were estimated to be involved in this activity in Satkhira.

During the present study, the year-round catch rate estimated for *P. monodon* at Satkhira was 35 fry/day for PN and 70 fry/day for FBN. At the same time, approximately 60,000 or more collectors were engaged in this activity, more than double the number reported in 1986. The Satkhira area is adjacent to the Sundarbans Reserve Forest and is regarded as a very important nursery for shrimp and finfish. It appears that fry-collection is increasing in the Satkhira area to meet the increasing demand. On the other hand, fishing pressure by larval net is relatively low in the Cox's Bazar area. where the shrimp farming area is one-fourth that of Satkhira.

In the present study. the estimated average mortalities of 29 per cent for *P. ntonodon* during transportation, from collecting points to stocking points, and of 70 per cent in culture ponds would indicate that only 433 million individuals would have been harvested from the 2035 million fry estimated to have been collected in 1989/90. If these two mortality values were lowered to 20 per cent and 50 per cent respectively, the yield would be nearly 814 million shrimp. *i.e.* the **projected 1989/90 yield** level could **be achieved with approximately half** the **quantity of fry** collected, allowing the other half, with its incidental by-catch component, to increase the recruitment to other shrimp and finfish fisheries.

Significant losses from mortalities occur during transportation because of transport on bicycles and pots/canisters, and the numerous transfers and holding points before the fry reach the ponds. There are also heavy losses immediately after stocking because appropriate stocking densities are not always maintained. Fry are also not sufficiently acclimatized to pondwater conditions before stocking.

Significant reduction in fry-collection could be achieved if

- sorting of fry.
- holding of fry at collection points,
- handling of larvae,
- containers for transportation,
- controlling temperature in transport,
- the means of transport. and
- stocking techniques

are improved.

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APPENDIX I

Species composition in pushnet and fixed bagnet (% of numbers)

	Pushnet					Fixed bagnet			
Species/Group name	*Teknaf*	*Cox's bazar*	*Patuakhali*	*Khulna*	*Satkhira*	*Cox's bazar*	*Patuakhali*	*Khulna*	*Satkhira*
Penaeus ***monodon*** (Tiger Shrimp)	2.3	4.0	0.5	0.2	0.5	1.8	0.3	0.1	0.7
P. indicus (Indian White Shrimp)	7.7	9.6	0.0	0.0	0.0	49.9	0.6	0.0	0.0
Metapenaeus monoceros (Brown Shrimp)	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.!	0.4
M. brericornis (Yellow Shrimp)	0.0	0.0	1.6	0.0	1.5	0.0	0.0	0.0	0.2
Parapenaeopsis stylifera (Kiddi Shrimp)	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.1
P. sculptilis (Rainbow Shrimp)	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.1
Other penaeids (Other shrimp)	0.0	20.7	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Penaeid shrimp	7.7	30.3	1.7	0.0	6.2	50.0	0.7	0.2	1.0
Palacemon stvliferus (Roshana Prawn)	0.0	0.0	0,0	0.2	0.0	0.0	0.3	0.0	0.0
Macrohraehium sp. (Prawn)	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.3	0.3
M. rosenbergii (Giant River Prawn)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0Θ	0.0
Macrobrachium sp. (Other River Prawnj	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.3	0.0
Other caridean (Other prawn)	0.1	3.1	42.0	10.6	19.6	0.6	5.9	16.8	8.1
Caridean shrimp (Nonpenaeid shrimp)	0.1	3.1	42,2	11.1	19.6	0.6	6.2	17.4	18.6
Eleutheronema tetradactvlum (Threadfin)	0,0	(.0	0,0	0.0	0.0				
E.thoracata (Threadfin	0.0	0.0	0,0	0.0	0.0	0.0	0.0	0.0	0,0
A.miops	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C.dussumieri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Cynoglossus sp. (Tonguesole)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Anguilla Eel)	0.2	0.3	0,0	0.0	1.4	0.0	0.1	0.0	0.7
G. griseus	0.1	1.7	0.0	0.1	0.0	0.0	0.0	0.3	1.2
Gohiidae (Gobs)	0.0	0.0	0.0	2.3	0.5	1.1	0.0	0.6	2,2
Hemiramphus sp. (Halfbeak)	0.!	0.0	0.0	0.0	0.0	—	—	—	—
Sciaenidae (Croaker)	0.3	0.5	0.9	0.0	8.3	0.0	0.0	0.0	0.5
Late,c calcarifer (Giant Perch)	0.4	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0,0
Leiognathu.c sp. (Ponyfish)	0.0	0.7	0.0	0.0	0.0	0.5	0.0	0.0	0.0
Mugilidae (Mullet)	0.1	0.1	0,0	2.0	0.2	0.6	0.0	0.0	0.2
Pomadasvs maculation (Slipmouth)	0.9	1.8	0.0	0.0	0.0	0.8	0.0	0.0	0.0
Setipina sp.	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1
Stolephorous fri Anchovy)	0.0	2.3	0.0	8.2	0.1	4.9	13.9	1.7	0.1
Sardine//a sp. (Sardine)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
Sillago sihama (Whiting)	10.4	12.8	0,0	0.0	0.0	1.6	0.0	0.0	0.0
Therapon sp. (Therapon)	0.0	0.3	0,0	0.0	0.0	0.1	0.0	0.0	0,0
Other finfish larvae	0.!	10.3	0,7	3.0	0.5	5.6	0.6	0.0	1,6
Finfish larvae	12.8	32.0	1.7	15.6	11.1	15.4	14.6	3,2	7.4
Jellyfish	5.4	7.8	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Squilla	0.3	0.1	0.0	0.0	0.0	0.7	0.4	0.0	0.5
Crab	6.8	2.8	5.9	0.0	1.1	24.3	55.5	18.5	22.2
Acetes (Sergestid shrimp)	16.8	0.6	12,8	0.1	1.5	0,4	0.8	1.5	4.7
Other zooplankton	47.6	19.3	35,2	73.0	59.9	6.8	21.4	59.1	44.9
Plankton + **other organisms**	77.I	30.6	53.9	73.1	62.6	32.7	78.2	79.1	72.3

Note: Species listed with zero percentage occur with percentage values below **0.1%**
= not found.

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THE ESTUARINE SET BAGNET FISHERY

by

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6. INTRODUCTION

According to the fish catch statistics of Bangladesh (Anon. 1988-89), the annual marine fish production is about 235,000 t. About 96 per cent of it, or 226,000 t, is reported to be contributed by artisanal fisheries. Of this, 63,000 t, or 28 per cent, is produced by set bagnets *(behundi jal).* About 46,000 t, or 73 per cent of the set bagnet production, has been reported to be from the estuarine set bagnet (ESBN) fishery, while the balance is from the seasonal, marine set bagnet (MSBN) fishery:

The ESBN fishery covers a vast coastal area. It embraces almost all the brackishwater bodies, channels, tributaries and also the open sea waters in some areas where there is a heavy outflow of freshwater from the major rivers of Bangladesh. Given the characteristics of the estuarine environment, the set bagnet makes an efficient gear for capturing a wide range of finfish and shellfish species. **But** it at the same time captures a wide size-range of these animals, including juveniles. Therefore, the operation of such a gear in the estuaries and the shallow waters of the sea, which are generally the nursery grounds for most marine finfish and shellfish, is considered harmful to the resources, except for a few estuarine species like Sergestid Shrimp *(Acetes indicus)* (Khan *et* al, 1988). Evidence of its destructive nature is also shown in the work of Ahmed (1979, 1981 and 1984), Islam (1987) and Chowdhury (1987).

In view of what many consider the destructive nature of the ESBN and the general concern for conservation of the marine fishery resources, the Bay of Bengal Programme was requested to assist in investigating this fishery to assess its destructiveness and identify what management steps should be taken,'if required. Consequently, a pilot survey was conducted in 1987, and the results proved the need for a more detailed investigation (Islam *et al,* 1988).

The set bagnet, a traditional fishing gear in the Bay of Bengal region, is still being operated by small-scale fisherfolk in Bangladesh, India, Indonesia, Malaysia, Myanmar and Thailand, with some regional variations in design and mode of operation. However, the gear is more dominant in Bangladesh (Figure 4) than in any of the other countries. This paper discusses the craft, gear, operation, fishing effort, production, seasonality in catch rates, species and size composition of catches in the ESBN fishery, as well as some biological characteristics and parameters of major penaeid shrimp and finfish, based on a study conducted in 1989/90.

Fig *4.* The set bagnet ol Bangladesh

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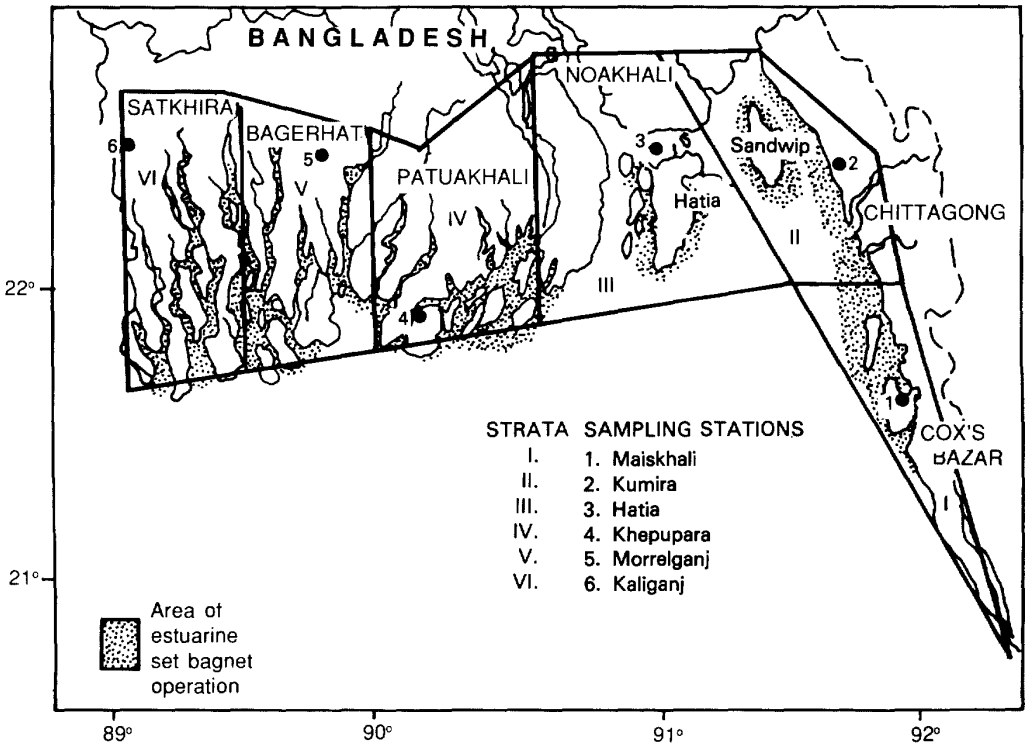
7. METHODOLOGY

7.1 *Sampling stations*

On the basis of the frame survey conducted in October and November 1989, six sampling stations were selected to represent the six areas covering the 650 km coastline of Bangladesh, as well as the estuarine tributaries (Figure 5). The selection of the stations was also influenced by their accessibility to the field staff conducting the investigations. The sampling stations identified for detailed data collection are listed alongside.

No.	*Area*	*Sampling village/station*
I	Cox's Bazar	I. Maiskhali (Ghorakghata base)
II	Chittagong	2. Kumira
III	Noakhali	3. Hatia (Harni base)
IV	Patuakhali	4. Khepupara
V	Bagerhat	5. Morrelganj
VI	Satkhira	6. Kaliganj

Fig 5. Areas of set bagnet (estuarine) operation in Bangladesh with sampling stations



7.2 *Classification of nets*

During the frame survey, an assessment was made of the total number of nets and craft engaged in the ESBN fishery at the selected stations. The differences in the lengths of the nets were used to identify four size categories. During the subsequent study, the classification was made on the basis of the area of the mouth opening, instead of the length of the net; it appeared that, besides the codend mesh etc., the area of the mouth would be of greater significance to performance. It also became evident from the preliminary study (Islam *et al,* 1987) that, among the nets used in Bangladesh, there was no significant correlation between the area of the mouth opening and the length of net. For sampling purposes, the nets were classified into four sizes based on the measurements of the mouth opening (see alongside).

Gear size cafegory	*Width of mouth (m)*	*Area of mouth (m^2)*
Gla	<6	<IS
GIb	6-10	15-50
GIc	10-15	50-90
GId	>15	>90

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The width of the mouth is the distance between the two poles at either end of the mouth. This measurement also determines the area of the mouth, since it is rectangular. The distance between the poles was convenient to measure when observing catches at fishing locations.

7.3 *Sampling programme*

The sampling programme was executed at the six stations by biologists of the Marine Fisheries Survey Management and Development Project based at Chittagong and Cox's Bazar, who formed six groups with two in each group. Regular sampling started in December 1989 and continued till November 1990, with data being collected every week, every month, at each station.

STRATIFIED SAMPLING OF CATCH AND EFFORT

Catch and effort data, with details of number of craft, number and types of nets, depths of water, number of hauls/day, starting time, ending time, soaking time, and total catch by craft were collected at the fishing ground. Data were collected for about 25 hauls, at each station. each month. Information on total landings for a number of boats and the number of hauls per day, estimated number of fishing days per month, species composition of catch (by weight), and value (Taka) for each species caught was collected at the landing sites.

STRATIFIED SAMPLING OF BIOLOGICAL DATA

Monthly length-frequency samples were taken for about twenty important species, stratified by gear. The sampling programme was aimed at measuring about 200 individuals of each species per month, though poor catches sometimes did not permit this. These samples were raised to the catch, and then to the monthly landings at the station and, finally, to the area level production of the species-catch at length. The catch at length for all areas were pooled for length-based analysis of the population. Length ranges and predominant sizes were noted for as many species as possible, apart from those for which length frequencies were measured. Sampling was done mainly on board, but there was also some sampling at the landing stations. In addition, sampling for sex ratio, length-weight relationship, stomach contents and gonad maturity was attempted, whenever possible, for about ten species.

For taxonomic work, Dall (1956), Day(1989). Fischer and Bianchi (1984). George (1969) and Shafi and Quddus (1982) were consulted.

COSTS AND EARNINGS

Data on costs and earnings were collected in the field, during catch and effort sampling, and interviews with fishermen provided information on variable costs such as crew share/fixed wage, food, fuel, lubricants, water, ice, repair and maintenance of craft/gear. and expenditure. Fixed cost included capital investments on craft, gear and equipment, average life, depreciation, interest payable on loans/credit, insurance etc. About 50 per cent of the owners of the gear units sampled for catch and effort were interviewed each month and at each station for costs and earnings information as well.

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ENVIRONMENTAL DATA

Salinity, temperature, turbidity, depth etc. were recorded monthly at each station.

During the sampling programme, the lunar phase, which influences tidal amplitude, was taken into consideration. It was found that the tides considerably influenced the catch rate and the species composition. The sampling of catch and effort was, therefore, executed according to the lunar months, from spring tide to neap tide, to obtain a good average catch rate. The sampling schedule followed is given in Table 10 (see facing page).

7.4 Data processing and analysis

Each group of biologists returning from a field sampling visit processed the collected data, which were subsequently refined through intergroup discussions every month. According to the sampling plan, two out of the six groups were always in the field. This was particularly done to ensure good briefing of the groups scheduled to visit the stations the following month and also to ensure regular processing of the data collected. All processing of data and basic analysis was done manually. Computers were used only for more advanced analysis of growth parameters and fish population dynamics.

ANALYSIS OF CATCH RATE AND PRODUCTION

Catch rate (kg/haul) and catch composition were analyzed separately for each station on a monthly basis, stratified according to gear class. For production estimation, the monthly mean catch rates were multiplied by the average number of fishing days for each month, the average number of hauls per fishing day each month and the estimated number of Units of each class of the set bagnets at each station. This monthly production estimate for each station was then raised to the area level using the estimated number of nets in each area. The composition of the different size-classes of nets at each station was applied to the number of units at the area level.

COST AND EARNINGS ANALYSIS

Most fishermen gave their annual costs and these were averaged and computed as monthly esti-mates for the cost and earnings analysis. Monthly depreciation for the gear and craft (by size categories) was calculated simply by dividing the average of the original cost by the average life span (in months) of the respective gear and craft.

The monthly gross revenue for each species or group of shrimp or finfish caught by a unit was obtained by multiplying the monthly mean catch rate of that species. or group, by the average price of that species/group. the number of fishing days and the average number of hauls per day for that month.

ANALYSIS OF LENGTH-FREQUENCY AND BIOLOGICAL DATA

Length-frequency data was analyzed for growth, mortality, recruitment and selectivity patterns. using ELEFAN and LFSA programmes with an IBM-compatible microcomputer.

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Table 10: Schedule of sampling at the six stations

First Quarter

Lunar Month	*Maiskhali* *Hatia*	*Kumira* *Morrelganj*	*Khepupara* *Kaliganj*	
	4th	1st	2nd	3rd
1.	C+F 22.11.89	B+E 01.12.89	A+D 07.12.89	—
2.	B+E 22.12.89	A+D 31.12.89	C+F 05.01.90	—
3.	A+D 20.01.90	C+F 28.01.90	B+E 04.02.90	—

Second Quarter

		Maiskhali *Hatia*	*Kumira* *Morrelganj*	*Khepupara* *Kaliganj*
22	4th	1st	2nd	3rd
4.	—	F÷C 20.02.90	E+B 05.03.90	D+A 12.03.90
5.	—	E+B 28,03.90	D+A 04.04.90	F+C 11.04.90
		D+A 26.04.90	F+C 03.05.90	E+B 10.05.90

Third Quarter

	Khepupara *Kaliganj*		*Maiskhali* *Hatia*	*Kurnira* *Morrelganj*
22	4th	1st	2nd	3rd
7.	A+D 17.05.90	—	C+F 03.06.90	B+E 10.06.90
8.	C+F 16.06.90	—	B+E 02.07.90	A+D 09.07.90
9.	B+E 10.07.90	—	A+D 31.07.90	C+F 07.08.90

Fourth Quarter

	Kumira *Morrelganj*	*Khepupara* *Ka/iganj*		*Maiskhali* *Hatia*
22	4th	1st	2nd	3rd
10.	E+B 14.08.90	D+A 23.08.90	—	F+C 06.09.90
11	D+A 13.09.90	F+C 21.09.90	—	E+B 05.10.90
12.	F+C 12.10.90	E+B 21.10.90	—	D+A 04.11.90
13.	B +E/C+F 11.11.90	D+A 17.11.90	—	—

Note: Alphabets (A to F) indicate the six groups of biologists who did the field work.

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8. *RESULTS*

8.1 *Characteristics and operation of the set bagnet*

THE NET

The set bagnet is a fixed, tapering net, resembling a trawlnet, set in the tidal stream by attaching it to holdfasts. It has a rectangular mouth which is kept open by two vertical bamboo poles. The net is held in position, against the current, by linking the extended sides of the net (wings) to holdfasts by means of long bamboo poles or hollow drums and steel wires. The holdfasts are two wooden stakes embedded some distance apart in the seabed, so that the net is parallel to the direction of the tidal current (Figure 6).

The set bagnet catches those species of fish which drift with the current or do not swim fast enough to stem the current and, thus, maintain a fixed position in relation to the seabed. During each slack-period, the net rises to the surface (because of the bamboo poles used for opening of the net and the bamboos serving as sweeplines) and is emptied: it is then turned over to face the opposite direction and made ready for fishing again (Figure 6). Due to the difficulties in embedding the wooden stakes in the sea bed, this method of fishing is restricted to a maximum water depth of about *25m* (Akerman, 1986).

The net is made up of four panels. The mesh size decreases from 140-20mm at the mouth to 22-5mm at the codend. The length of the net varies from 8.5m to 41m and the height of the mouth opening is 2-7m. Particulars on size, material and costs of different nets found in different stations during the present study are given in Table 11 (see facing page).

Fig **6. Operation of set bagnet *(behundi jal)***

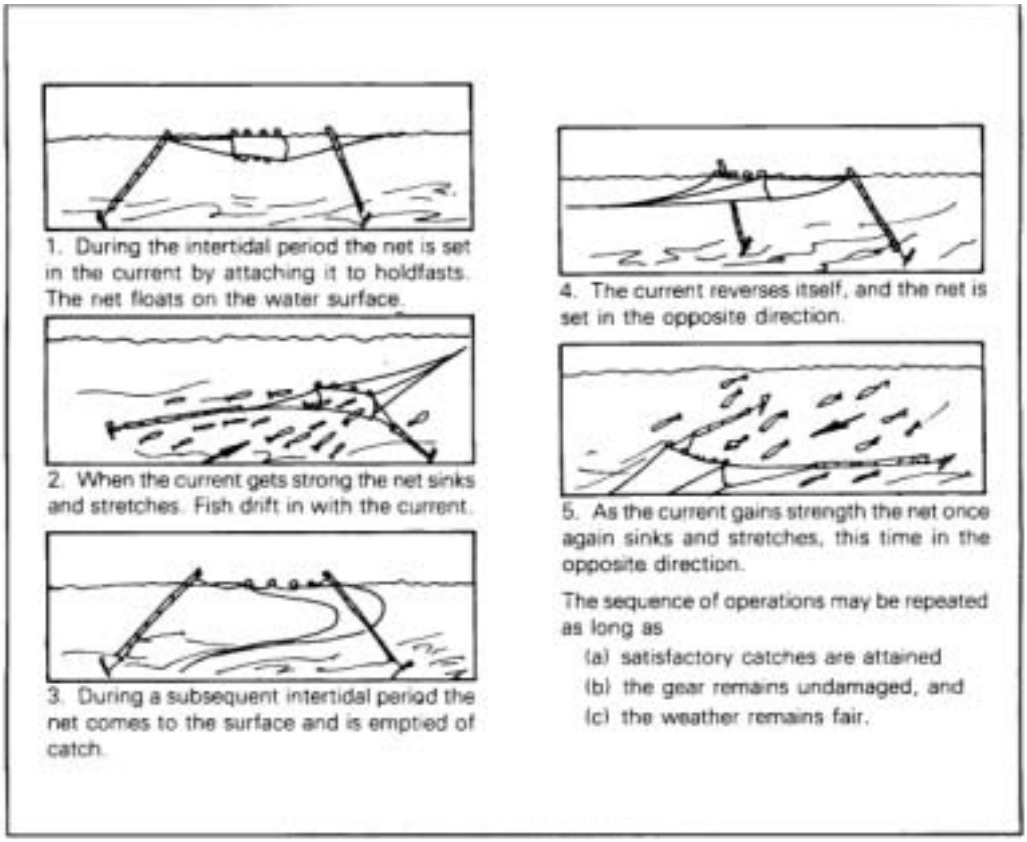

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Table 11: Characteristics of the estuarine set bagnets operated in different stations

	Station	Gear size category (Code)	Mouth opening width (pole to pole) in	Mouth opening height (m)	Length of net (m)	Cod-end mesh si:e (mm)	Material	Arg. life (vrs)	Ori ginal cost (Tk)	Replacement cost (Ti)
I	Maiskhali	GIb	8.3-10.0	5.0-6.2	22.8-36.6	12	Nylon	6-7	5000 - 11000	5000 - 25000
		GIc	10.6-12.3	6.0-6.8	35.5-41.1	12.13	Tyrecord	6-7	3500 - 35000	20000 - 35000
11	Kumira	Gla	3.6-6.0	2.6-3.5	13.0-20.0	10.15	PA & PE	8-12	7500 - 14000	0000 - 6000
		GIb	8.5	3.0-3.5	18.2-20.0	10-IS	..	10-15	10000 - 14000	14000 - 17000
III	Hatia	Gla	5.1-5.9	3.0-6.1	12.3-18.0	12-22	Nylon	5-7	5000 - 15000	8000 - 20000
		GIb	6.2-10.0	3.6-5.5	5.3-22.9	11-16	..	5-7	7000 - 15000	9000 - 25000
IV	Khepupara	Gla	5.4-5.5	1.8-2.7	11.4-11.6	10-12	PA & PE	3-5	2250 - 3000	4000 - 6000
		GIb	6.9-9.1	3.2-3.7	23.3-32.0	8-12	lyre cord	4-6	4000 - 12000	4500 - 15000
		GIc	11.4	4.6	34.3	10		5-6	4500 - 8000	5500 - 85000
V	Morrelganj	GIb	7.5-9.0	2.0-3.0	11.5-16.5	8-IS	Nylon	4.12	4000 - 7000	8000 - 12000
		Glc	ll.0-I5.0	3.0-5.5	17.5-30.0	10-IS	Tyrecord	7-10	9000- 5000	18000- 20000
		GId	20.0	5.0	40.0	10-IS	..	10	20000 - 25000	25000 - 35000
VI	Kaliganj	GIa	5.4-5.8	2.7-5.4	12.6-27.0	10	Nylon	7-IS	2000 - 8000	3500 - 8000
		GIb	6.3-7.2	2.7-5.4	13.5-27.0	8-14	..	6-20	3000 - 10000	5000 - 5000

NB: Length of a single wing is more or less equal to pole-to-pole width of the mouth opening of the estuarine SBN.

About 12.560 set bagnets were estimated to be operating in the estuarine areas of Bangladesh, out of which more than half were in Cox's Bazar and Chittagong. Details are given in Table 12. Of the gear size categories. Gla and GIb were the dominant ones (37 per cent each), followed by GIc (24 per cent). The Glc and Gid categories were operated mainly in the seasonal MSBN fishery, but some of these nets were also operated in the estuarine sector during the rest of the year. The Gla nets were dominant in Chittagong and Noakhali, GIb in Cox's Bazar, Chittagong and Patuakhali and Gic in Cox's Bazar.

Table 12: Distribution of set bagnets of different sizes in the six strata (percentages in parenthesis)

		Number of unit.c of gear by size tategory					
No.	*Stratum*	*Gla*	*Glh*	*Gic*	*Gid*	*Total*	*Percentage distri-bution by area*
I	Cox's Bazar	—	958	2274		3232	26
			(30)	(70)		(100)	
II	Chittagong	1994	1087	—	—	3081	25
		(65)	(35)			(100)	
III	Noakhali	1420	609	—	—	2029	16
		(70)	(30)			(100)	
IV	Paluakhali	613	1533	613	—	2759	22
		(22)	(56)	22)		(100)	
V	Bagerhat	—	183	167	63	413	3
			(44)	(41)	(15)	(100)	
VI	Salkhira	592	455	—	—	1047	8
		(57)	(43)	—	—	(100)	
	Total	**4619**	**4825**	**3054**	**63**	**12561**	100
		(37)	**(38)**	**(24)**	**(1)**	**(100)**	

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CRAFT IN THE ESTUARINE SET BAGNET FISHERY

The majority of the craft used in the ESBN fishery were nonmotorized. But in Kumira, as in the MSBN fishery. some motorized boats are also used as carrier boats.

In this study, the fishing craft were grouped into four classes, based on their overall length: Class I = up to Sm. Class 2= 5-8m, Class 3 = 8-12 m and Class 4 = above 12 m. Particulars of the different types and classes of craft and the minimum number that operated at different stations are given in Table 13.

Table 13: Characteristics and numbers of fishing craft used in estuarine SBN fishery at different stations

No.	*Stations*	*Type*	*CODE*	*Length range (m)*	*Engine (lip)*	*Minimum number used in the fishery*	*Crewi Craft (no)*	*Gear Craft (no)*	Ar. *Life (yr.)*	*Original cost (Th)*	*Replacement cost (Tk)*
1	Maiskhali	Dugout	1C2	5.1-8	—	323	2-3	05-1.0	7-10	5000-8000	10000.20000
		..	1C3	8.1-12	—	540	2-3	..	8-12	6000-15000	18000-20000
		SBN craft	4C2	5.1-8	—	753	2-3	..	5-7	3000-12000	5000-16000
		..	4C3	8.1-12	—	1616	2-3	..	5-8	2500-10000	7000-15000
2	Kumira	Row	3C2	5.1-8	—	36	34	5.7	20	25000	35000
		..	3C3	8.1-12	—	104	4	5-7	20	30000	40000
		Dugout	1C2	5.1-8	—	16	3-4	5-7	25	40000	50000
		..	1C3	8.1-12	—	232	4	5-7	25	50000	70000
		Motorized country craft	6C3	8.1-12	12	12	4	—	15	60000	70000
		Motorized boat	7C3	8.1.12	24	40	4-S	—	10	40000	40000-50000
3.	Hatia	Dugout	1C3	8.1.12	—	48	2-3	2-4	30-70	1500.7000	20000-21000
		SBN craft	4C2	5.1-8	—	48	2	2-4	12	3000	8000
		..	4C3	8.1-12	—	194	3	2-4	8-12	4000-12000	9000-21000
4.	Khepupara	SBN craft	4C2	5.1-8	—	1104	2	1.2	2-5	800-7000	1000-7500
		..	4C3	8.1-12	—	276	2.3	1-2	3-4	3000-7000	5000-8000
S.	Morrelganj	SBN craft	4C2	5.1-8	—	It	1	1-2	6-7	3000-7000	10000-13000
		..	4C3	8.1-12	—	143	1-3	1-2	4-20	2000-20000	4000.35000
			4C4	>12.1	—	53	2-3	1-2	5-20	6000-33000	8000-35000
6	Kaliganj	SBN craft	4C3	8.1-12	—	363	2	1-2	7-30	1000-16000	4000-16000
		..	4C4	>12.1	—	161	2	1-2	15-40	5000-9000	10000.20000

The cost of the craft of the same class/type varied by station, probably due to differences in the price of timber which depends on type and quality. The average life of a craft also varied. Since the cost mainly depends on the quality of timber used, dugouts always cost more and last longer than others.

8.2 *Species composition*

A total of about 185 species or groups of species of finfish and shellfish were identified in the ESBN catches. These included 15 penaeid shrimp, 3 nonpenaeid shrimp, 9 freshwater prawn, 3 crab, 3 molluscs, 90 pelagics and 62 demersal finfish. The annual average species composition by area and gear size class is given in Table 14 (facing page).

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Table 14: Annual percentage composition of species (by weight) at different stations

S. No.	Species	Maiskhali		Kumira		Hatia		Khepupara			Morrelganj			Kaliganj	
		Glb	Glr	Gla	Glb	Gla	Glb	Gla	Glb	Glc	Glb	Glc	Gld	Gla	Glb
A.	SHRIMP														
I.	*Penaeidae* (Shrimp)														
	P. monodon (Tiger Shrimp)	1.2	0.9	-	-	0.0	-	0.1	0.2	0.8	0.0	0.0	0.0	0.2	0.3
	P. indicus (White Shrimp)	0.1	0.!	-	-	1.4	-	0.5	2.1	2.2	0.0	-	-	-	-
	M. monoceros (Brown/Speckled Shrimp)	1.0	1.4	0.1	0.0	3.2	1.5	1.9	2.2	1.3	2.2	0.2	0.0	1.2	0.9
	M. brevicornis (Yellow Shrimp)	3.4	4.7	0.3	0.2	0.2	2.3	7.2	8.7	10.4	15.4	.4	0.4	5.2	6.2
	M. spinulatus (Spinulated Shrimp)	0.0	0.1	0.4	0.5	2.1	0.3	-	0.1	0.1	-	0.0	0.0	0.0	0.2
	P. sculptilis (Rainbow Shrimp)	1.4	0.8	1.2	1.0	0.1	2.1	0.5	2.1	2.1	0.5	0.1	0.1	3.5	2.2
	P srylifera (Kiddi Shrimpl	8.6	4.9	0.4	0.9	-	0.1	1.9	1.9	1.9	0.5	0.0	0.0	2.6	2.3
	Other penaeids	2.7	1.3	0.0	-	-	-	0.8	0.3	0.0	-	-	-	0.5	1.1
	Subtotal	8.5	14.3	2.3	2.7	6.9	6.3	12.6	17.5	18.8	18.6	1.8	0.5	13.3	13.2
2.	***Palaemon)dae*** (prawn)														
	M, rosenbergit (Giant River Prawn)	0.0	0.7	0.0	-	0.4	0.3	0.9	0.2	-	1.3	0.1	0.1	0.2	0.1
	P. styliferus (Roshana Prawn)	.4	t.6	2.8	2.6	10.7	14.1	2.8	2.6	2.4	1.6	0.2	0.0	4.9	4.3
	Other Palacmonides	0.7	0.5	0.3	6.5	13.4	11.3	7.2	6.1	5.0	15.1	1.1	0.5	7.4	8.9
	Subtotal	2.1	2.8	3.1	9.0	24.6	25.7	10.9	8.9	7.4	8.0	.4	0.6	2.5	13.3
3.	*Acetes indicus* (Sergestid Shrimp)	8.5	6.8	16.7	10.9	0.6	0.3	13.1	5.7	9.2	3.4	0.3	0.1	1.5	0.5
B.	**CRAB**	3.1	3.0	3.0	7.6	2.3	1.7	2.6	2.5	1.5	2.0	91.8	94.8	23.7	31.4
C.	FISH														
1.	***Ariidae*** (catfish)	0.1	0.1	3.7	3.8	1.2	1.7	0.4	0.6	2.0	0.1	0.0	-	0.3	0.2
2.	*Engraulidae* (Anchovies)														
	S.tri (Anchovy)	76	5.9	0.1	0.1	0.1	0.2	7.6	8.5	7.4	.5	0.1	-	0.1	0.0
	S taty (Hairfin anchovy)	0.5	0.2	0.3	0.2	0.6	2.3	1.3	0.9	-	0.3	0.0	0.2	0.1	0.1
	C. dussumieri (Grenadier Anchovy)	2.!	1.8	1.5	2.0	1.4	1.4	9.6	13.6	13.4	1.1	0.5	0.0	19.6	12.4
	Thryssa spp. (Anchovy)	1.1	2.8	-	-	0.4	0.3	0.1	0.!	0.0	0.3	0.0	.0	0.0	0.7
	Subtotal	11.3	10.6	1.9	2.2	2.5	4.2	18.6	23.1	20.8	3.1	0.6	1.2	19.8	13.2
3.	***Carangidae*** (Trevallies)	1.7	0.4	-	-	-	-	-	-	-	-	-	-	-	-
4	***Clupeidae*** (Shad/Herrings)														
	H. ilisha (Hilsa Shad)	0.3	0.1	1.0	1.6	-	-	0.2	0.3	0.0	0.2	0.0	0.0	-	-
	Other clupeids	12.5	9.3	0.7	1.0	0.7	0.5	1.2	4.4	4.4	6.0	0.5	0.3	0.2	0.2
	Subtotal	12.8	9.3	1.7	2.6	0.7	0.5	1.4	4.7	4.4	6.2	0.5	0.3	0.2	0.2
5.	***Gobiidae*** (Goby)	0.7	1.0	31.0	26.9	36.2	33.1	28.6	15.1	15.1	16.8	1.0	0.1	8.7	8.2
6.	***H. nehereus*** (Bombay Duck)	7.8	6.3	20.5	18.5	4.2	3.6	0.0	0.2	0.0	0.0	0.0	-	2.3	2.4
7.	*Magilidae* (Mullet)	4.1	3.1	0.0	0.0	0.6	0.2	1.6	1.4	.4	4.1	• 0.4	0.1	0.2	0.3
8.	*P. hasta* (Javelin Grunter)	0.1	0.1	-	0.0	-	-	-	0.1	0.1	0.0	-	-	-	-
9.	*Polynemidae*)Threadfinl														
	P. paradiseus (Paradise Threadfin)	-	-	1.3	1.1	1.5	4.7	0.1	0.4	0.5	0.4	0.1	0.3	0.1	0.1
	H, tetradactylum (Four Finger Threadfin)	0.9	0.5	0.1	0.0	0.1	0.3	0.1	0.1	0.0	0.5	0.0	-	0.1	0.3
	Subtotal	0.9	0.5	1.4	1.1	1.7	4.9	0.2	0.5	0.5	0.9	0.1	0.3	0.2	0.4
10.	*Sillaginidae* (Sillago)														
	S. domina (Gangetic Whiting)	0.2	0.2	0.1	2.5	1.0	2.6	-	0.5	0.7	0.3	0.0	0.1	-	00
	S. sihama (Silver Whiting)	0.2	0.3	0.1	0.0	-	-	-	0.1	0.0	-	-	0.0	-	0.0
	Subtotal	0.3	0.5	0.2	2.5	.0	2.6	0.0	0.6	0.7	0.3	0.0	0.1	0.0	0.0
11	***Sciaenidae*** (Croaker)	5.8	7.4	3.0	2.8	7.3	7.6	3.2	5.6	11.0	8.3	1.0	0.7	3.9	3.6
12.	*P. **argenteus*** (Pomfret-silver)	0.0	0.1	0.1	0.7	-	-	-	-	-	-	-			-
13.	*L. savala* (Hairtail)	2.4	1.8	0.6	0.9	0.3	0.2	1.0	0.6	-	-	-	-	0.1	0.0
14.	Other finfish	11.6	25.3	10.9	7.7	10.0	7.4	5.9	11.8	6.8	17.8	1.0	1.3	9.0	8.0
15.	Other invertebrates	8.1	6.5	0.0	0.0	0.1	-	0.0	1.1	0.1	0.3	-	-	4.3	5.1
	Grand total	**100.0**	100.0	100.0	100.0	**100.0**	**100.0**	**100.0**	100.0	100.0	100.0	100.0	100.0	100.0	100.0

<<

The proportion of shrimp in the catches were high in Maiskhali, Khepupara and Kaliganj, and in the Glb net in Morrelganj. The Yellow Shrimp *(M. brevicornis)* was the dominant species in Khepupara, Morrelganj and Khaliganj and the Kiddi Shrimp ***(P. styliferа)*** in Maiskhali.

The contribution of freshwater prawn, mainly the Caridean Roshana Prawn, was highest in Hatia (25 per cent) and lowest in Maiskhali and Kumira. The different gear classes had more or less similar contributions within each area.

Abnormally high catches of swimming crabs in one month in Morrelganj (for GIc and Gid classes) and, to a lesser extent, in Kaliganj have given this group a very high value in the total percentage composition, particularly in Morrelganj.

Among the finfish, the Anchovy *(Engraulidae)* showed high contributions in Khepupara (19-23 per cent), Kaliganj (13-20 per cent) and Maiskhali (11 per cent). The dominant species were ***C.*** *dussurnieri* in Khepupara and Kaliganj and S. *fri* in Maiskhali.

Catches of shad/herrings *(Clupeidae)* were relatively significant (11 per cent) in Maiskhali only.

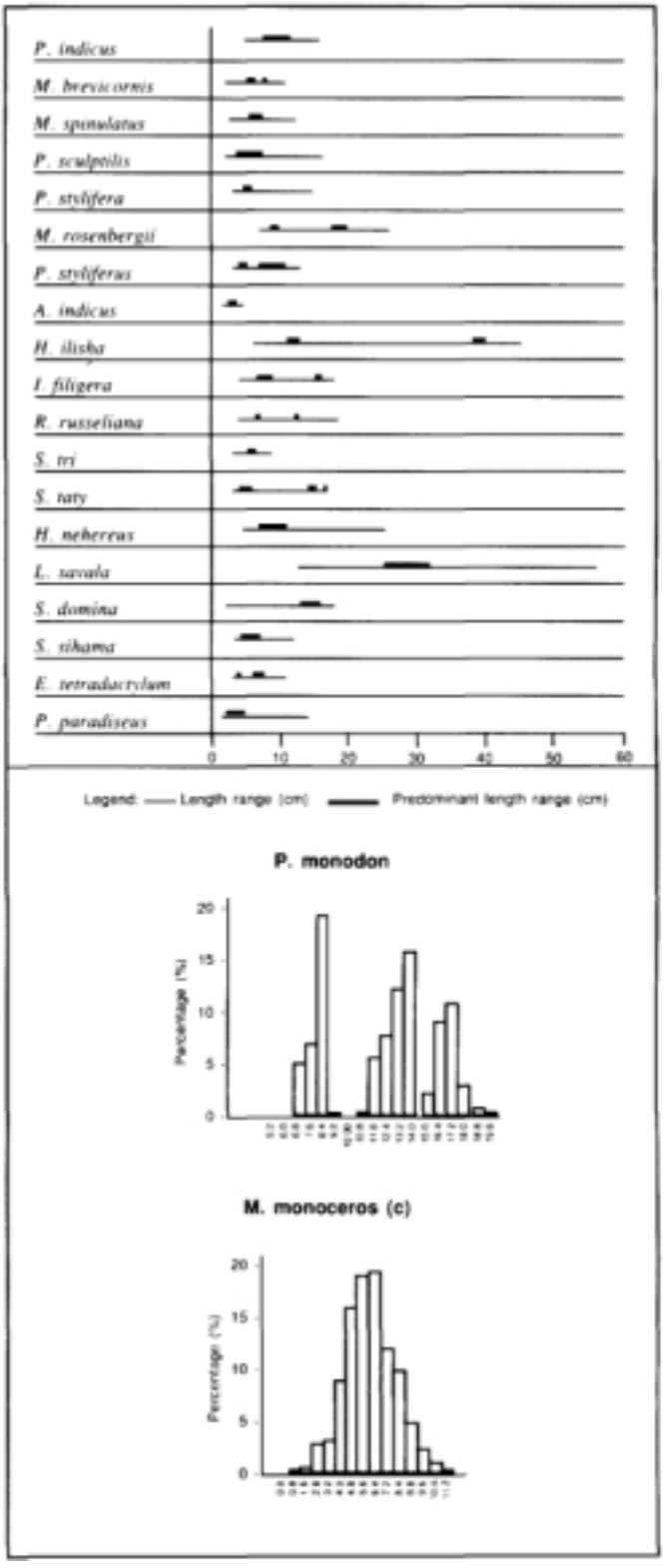
Goby *(Gohiidae)* catches were prominent in Kumira, Hatia and Khepupara.

Bombay Duck catches were high in Kumira (20 per cent), followed by Maiskhali (7 per cent).

8.3 *Size composition of major species*

The sizes of major shrimp and finfish caught in the ESBN are shown in Figure 7.

Fig 7. Length range (cm) of major shrimp and finfish caught by estuarine SBN and frequencies of annual production in size classes of *P. monodon* and *M. monoceros*



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The penaeid shrimp were mostly in the 2-15 cm range. except for the Tiger Shrimp *(P. monodon)* which were 5-20 cm. Annual length frequency for the whole area (pooled data) showed two peaks, one at 8 cm and the other at 11-15 cm. which indicated that they were mostly juveniles and immature. The predominant length of Brown Shrimp was 5-7 cm but there were several of smaller sizes, some even as small as 1 cm. They included a large proportion of juveniles and immature ones. Based on field observations during trawl surveys, Tiger Shrimp and Brown Shrimp are considered to mature when they are about 18 cm and 9 cm respectively.

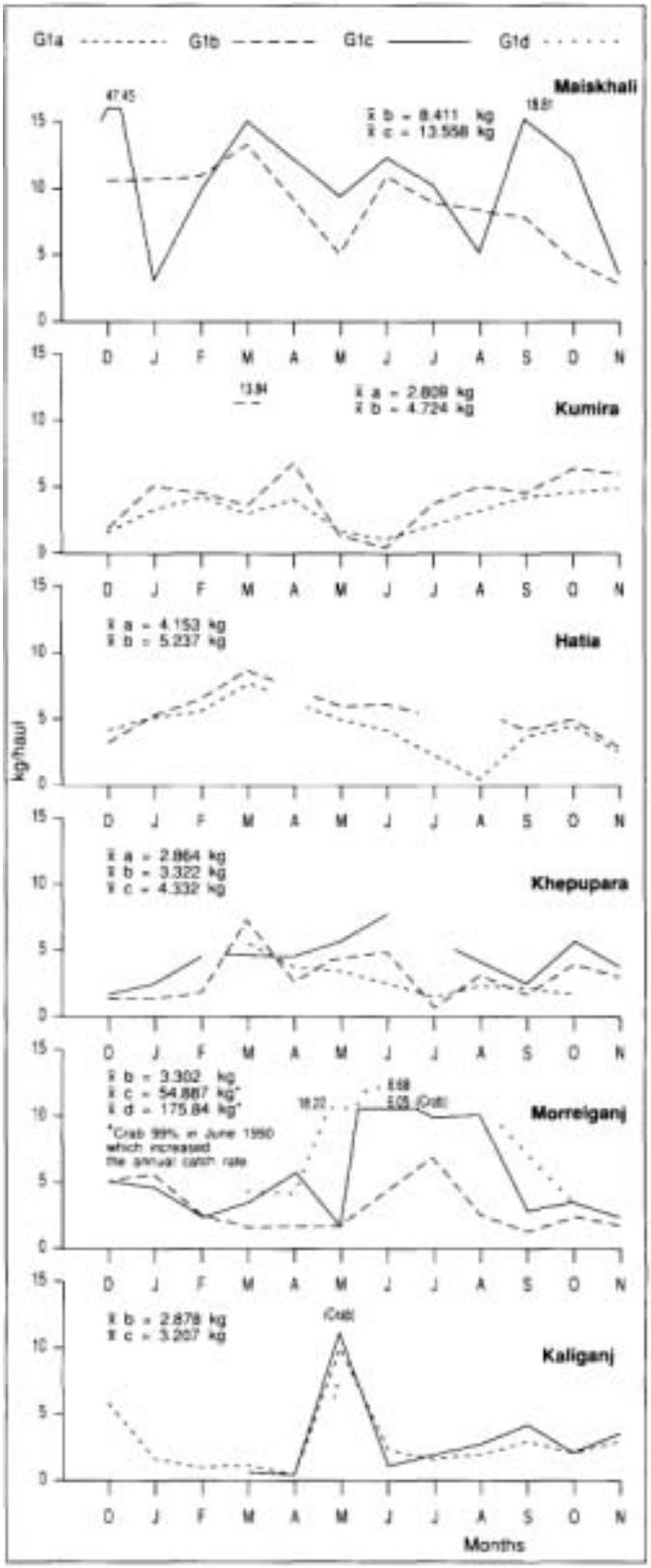
The size range of the Freshwater Giant Prawn ***(M. rosenhergii)*** caught in the set bagnet in the estuarine waters was 6-26 cm. This included juveniles and adults. The predominant sizes were 8-9cm and 16-18cm. Unusually, egg-bearing females were found at stations in the western part of Bangladesh.

A comparison of the size ranges of most of the finfish caught, with the maximum sizes recorded for these species in the region, indicated that the ESBN was mainly catching juveniles.

8.4 *Catch rates*

The monthly mean catch rate by different gear size classes in all areas (Figure 8a) exhibited numerous peaks in different months without any clear indication of any one peak being dominant. This could probably be due to the presence of numerous species catches which have peak catch rates in different months (Figures 8 b-k).

Fig 8a. Seasonal variations in the catch rates for ALL species caught at the six stations



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Student 't' test (Bishop, 1983 and Mustafa, 1984) was applied to the mean catch rates of different gear size classes in different areas but for the same months, to establish whether the efficiency of the net was influenced by the area of the mouth opening. The results of the analysis showed statistically significant differences. According to these results, the differences in the mean catch rate between the gear size classes Gla, GIb, Gic and Gid were in the ratio of 1:1.5:3:3 respectively.

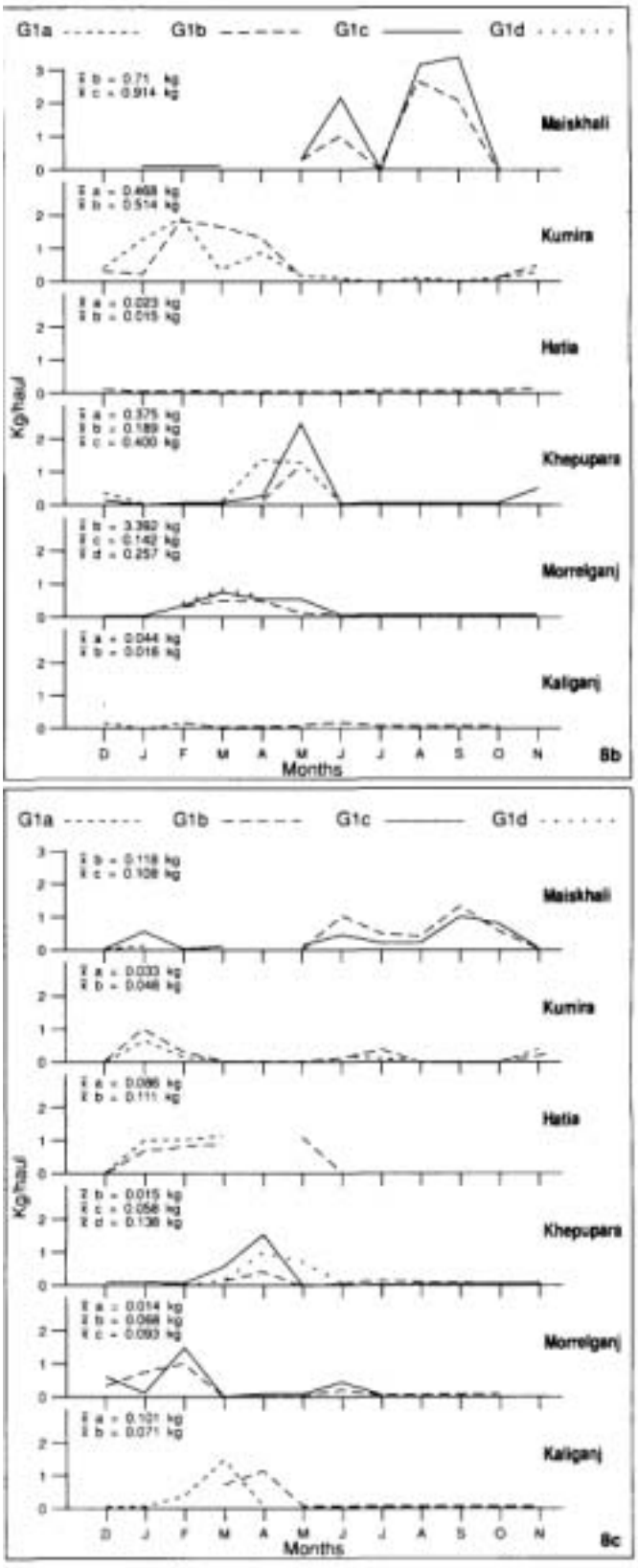
The highest mean annual catch rates (kg/haul) were recorded **in** Morrelganj for GIc *(54.9)* and GId (175.8). However, these high catch rates were due to unusually high catches of crab in June. If the crab rates were ignored, then the highest catch rates were in Maiskhali 6.4 in Glb and 13.6 in GIc.

The catches of major shrimp and finfish species varied considerably by area, gear size and season. The following observations can be made:

Sergestid Shrimp ***(Acetes indicus)*** showed high catch rates (2-3 kg/haul) in three areas, but very low or negligible rates in the other three areas. The abundance is highly seasonal, with different seasons in different areas but limited to about five months of the year (Figure 8b).

Rainbow Shrimp *(P. scuiptilis)* showed peak catch rates of 1-1.5 kg/haul in practically all areas; the peaks were generally in the first half of the year. but a greater peak was also observed during the last quarter in Maiskhali. The seasonality is significant, because the catch rates during other months are negligible (Figure 8c).

Fig 8b & c. Seasonal variations in the ESBN catch rates for *Acetes indicus* (b), and *P.sculptilis (C)*



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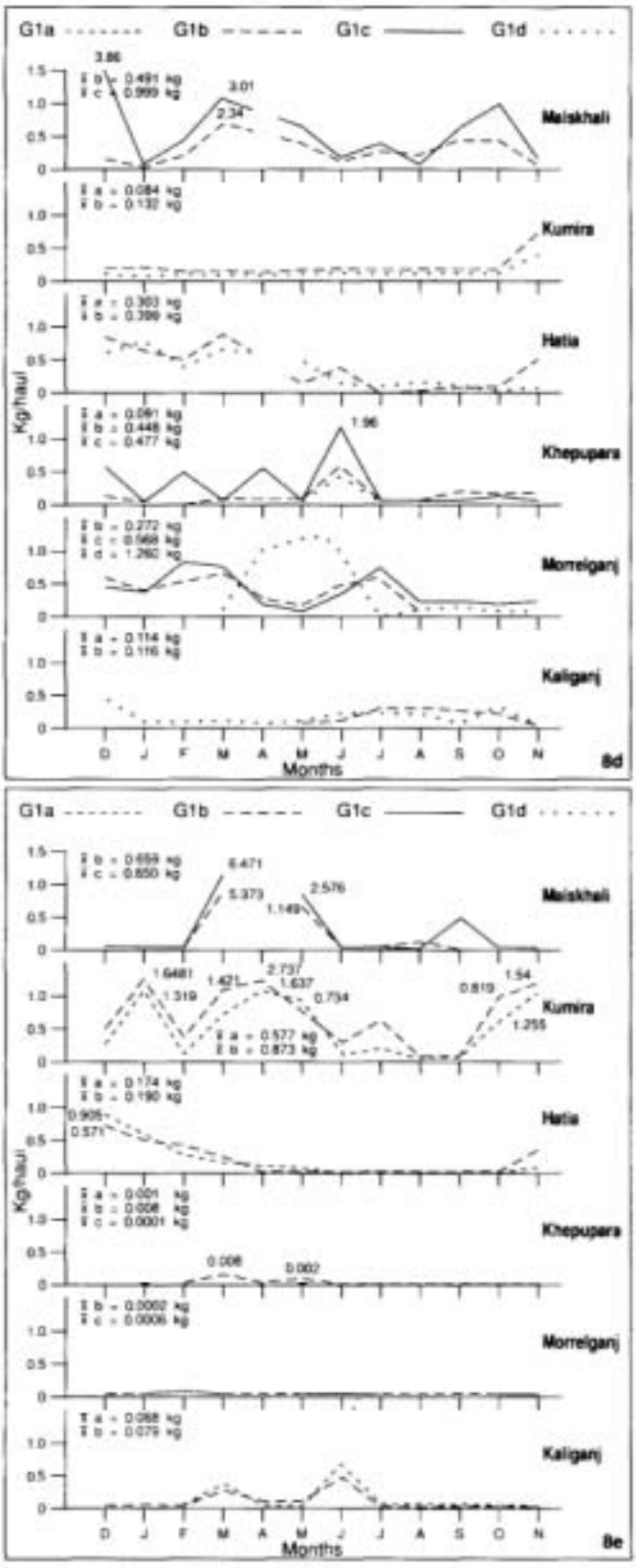
Croakers were rather evenly distributed and caught year-round in all areas. The highest catches in Maiskhali, reaching peak of 2-4 kg/haul. The catch rates in the GId nets in Morrelganj deviate from the general picture (Figure 8d).

The Bombay Duck *(H. nehereus)* was mainly caught in the eastern areas during the first half of the year (Figure 8e).

Fig 8d & e. Seasonal variations in the ESBN catch rates for Croaker (d), and *H.nehereus* **(e)**



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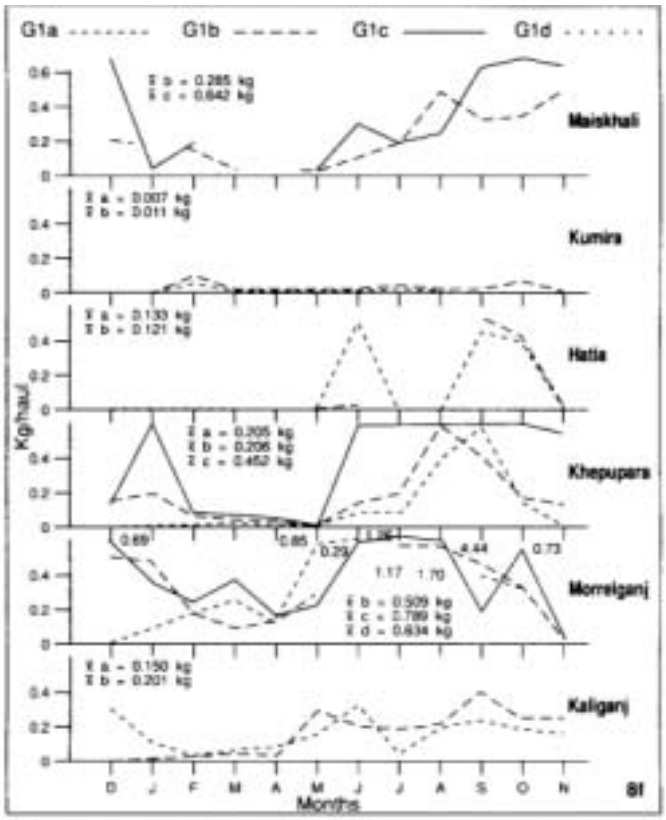
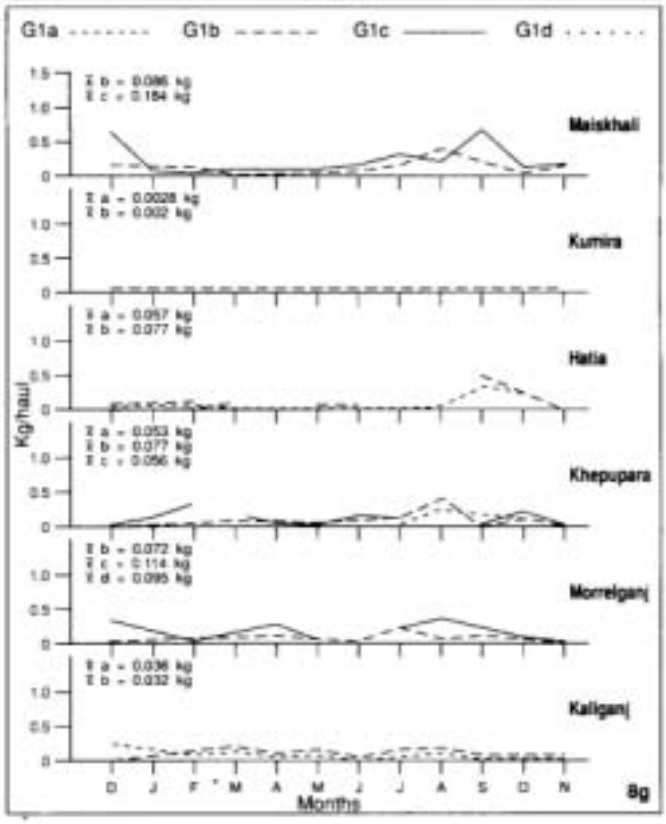
– Yellow Shrimp *(M. brevicornis)* reached catch levels of 0.2-1 kg/haul at all stations except Kumira during peak season, which generally covered the second half of the year (Figure 8f).

– Brown Shrimp *(M. monoceros)* catches were generally very low, reading only 0.1-0.2 kg/haul during a short peak period in August-September (Figure 8g).

Fig 81 & g. Seasonal variations in the ESBN catch rates for *M.brevicomis* (f), and *M. monoceros* (g)





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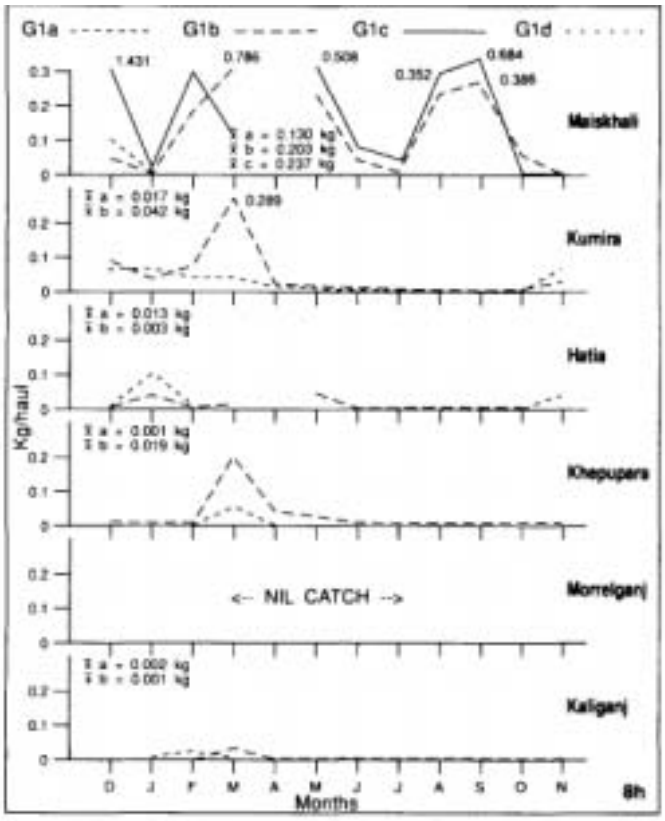
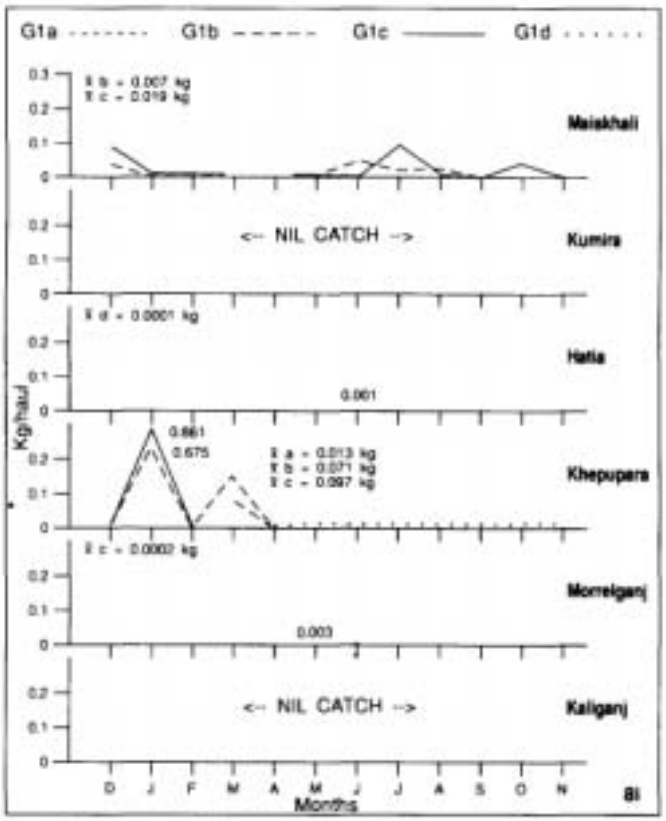
— Hairtails and Ribbonfish *(L. savala)* were mainly caught in Maiskhali. There were fewer catches in Kumira and they gradually became less, going westwards, till there was almost nil catch in Morrelganj and Kaliganj. The catch in Maiskhali reached peaks of 0.5 to 0.8 kg/haul during several months of the year (Figure 8h).

— White Shrimp *(P. indicus)* was caught in significant amounts in Khepupara between December and April, with peaks around 1 kg/haul being reached in January. Elsewhere, the only significant catches were in Maiskhali — averaging about 0.05 kg/haul during the second half of the year. There was almost nil catch in the other areas (Figure 8i).

Fig 8h & i. Seasonal variations in the ESBN catch rates for *L.savala* (h), and *P indicus* (i)





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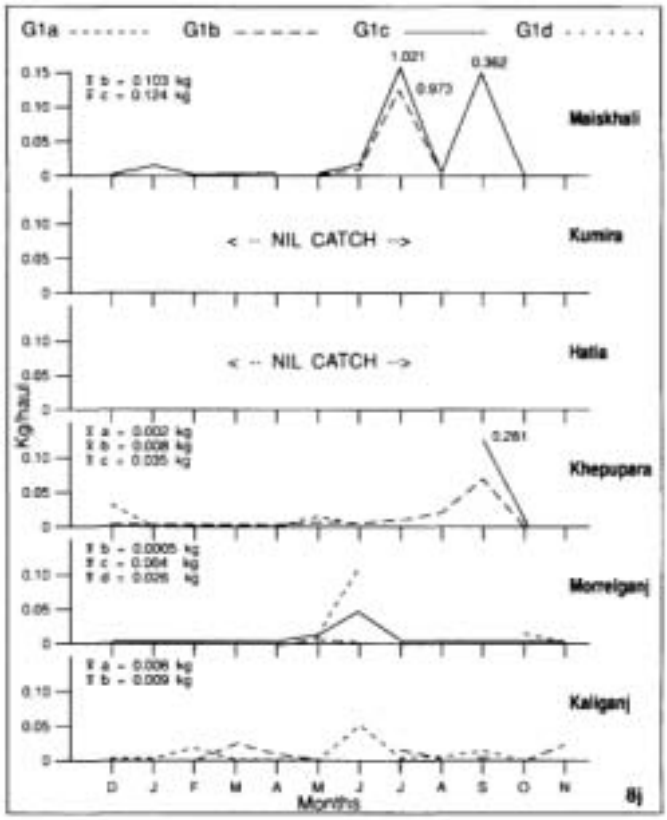
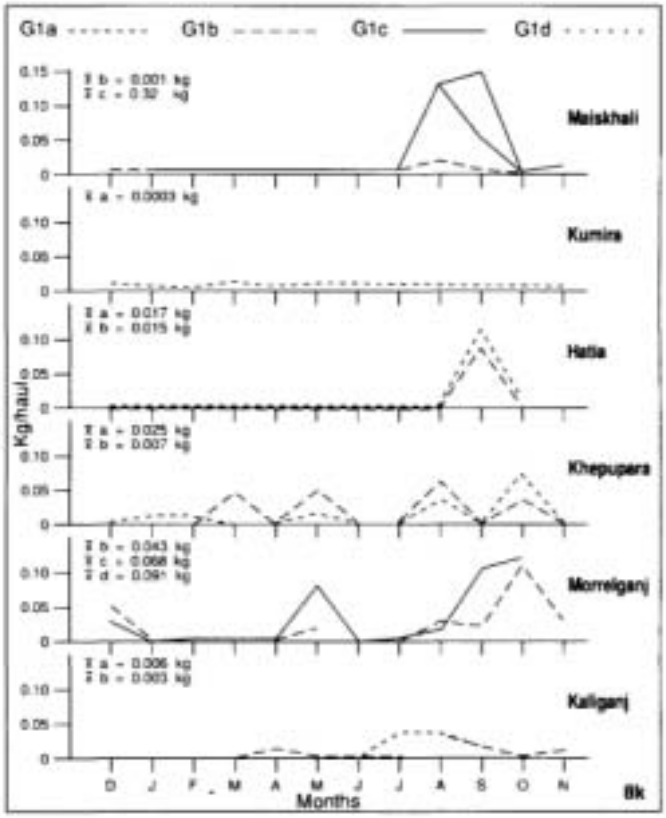
– Tiger Shrimp *(P. monodon)* catches were made year-round in all areas of the estuarine set bagnet fishery, but they were in very small quantities. In almost all areas the catch was less than 0.1 kg/haul. The only exceptions were in Maiskhali, where catches between 0.5 and 1 kg/haul occurred between June and September, and in Khepupara where there was a catch of nearly 0.3 kg/haul in September (Figure 8j).

– Freshwater Prawn ***(M. rosenhergii)*** catches were also low, the only significant catches again being in Maiskhali between July and October with a peak of nearly 0.7 kg/haul **in September. This** was also the peak period in the other strata, where catches **were negligible.** (Figure 8k).

Fig 8j & k. Seasonal variations in the ESBN catch rates for *Pmonodon* (i), and *M.rosenbergii* (k)





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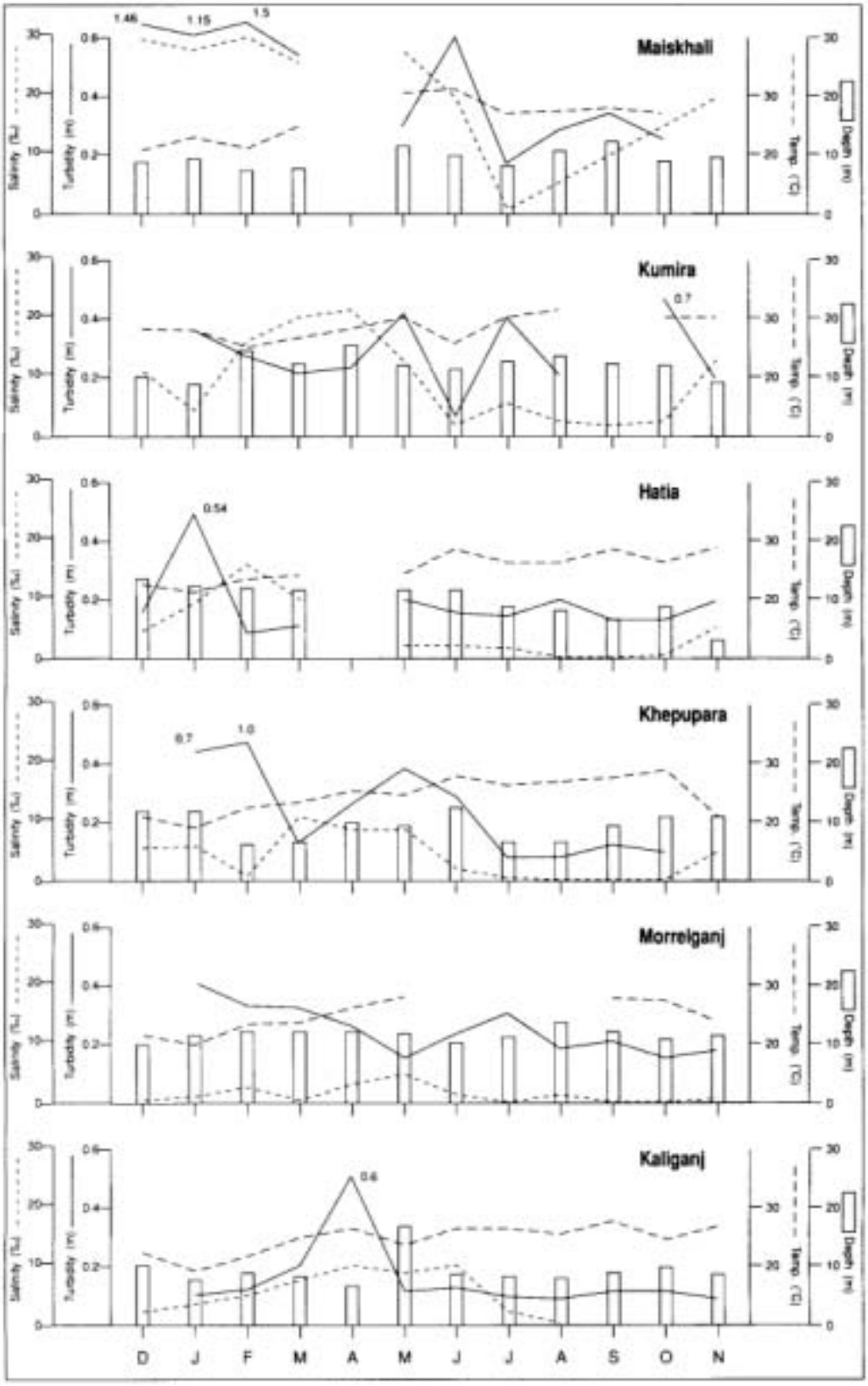
Catch rates of selected species by area and gear class are summarized in Table 15. Tiger Shrimp had highest abundance in Maiskhali (71.5 per cent) with a peak in July, White Shrimp in Khepupara (87.3 per cent) during December-May, Brown Shrimp evenly high in Maiskhali (30 per **cent),** Morrelganj *(25* per cent) and Khepupara (20.4 per cent) throughout the year and Yellow Shrimp in Morrelganj (44.5 per cent). Among finfish, Ribbonfish *(L. savala)* was highly abundant in Maiskhali (81.1 per cent) during December to May. Bombay Duck was equally highly abundant in Maiskhali (45 per cent) and Kumira (42 per cent) in November-April. Sergestid Shrimp was dominant in Maiskhali. From all information gathered, it would seem that Maiskhali is the area of highest abundance of many of the valuable species, including croakers, especially during December-March.

Table 15: Density of major species as catch rates (kg/haul) by gear and station

Species		Station/Gear													
		Maiskhali		Kumira		Hatia		Khepupara			Morrelganj			Kaliganj	
		Gib	Gle	Gla	Glb	Gla	Glb	Gla	Glb	Glc	Glb	Glc	Gld	Gla	Glb
P. monodon	CPUE	0.1	0.1	—	—	—	—	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P. indicus	CPUE	0.1	0.1	—	—	0.0	0.0	0.0	0.1	0.1	—	0.0	—	—	—
M. monoceros	CPUE	0.1	0.2	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
M. breycornis	CPUE	0.3	0.6	0.0	0.0	0.1	0.1	0.2	0.2	0.4	0.5	0.8	0.6	0.1	0.2
P. sculptilis	CPUE	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
M. rosenbergii	CPUE	0,1	0.1	0.0	—	0.0	0.0	0.0	0.0	—	0.0	0.1	0.1	0.0	0.0
Acetes	CPUE	0.7	0.9	0.5	0.S	0.0	0.0	0.4	0.2	0.4	0.1	0.1	0.3	0.0	0.0
H. nehereus	CPUE	0.7	0.8	0.6	0.9	0.2	0.2	0.0	0.0	0.0	0.0	0.0	—	0.1	0.1
Johnius spp.	CPUE	0.5	1.0	0,8	0.1	0.3	0.4	0.1	0.5	0.3	0.6	1.3	0.1	0.1	—
L. sarala	CPUE	0.2	0.2	0.0	0.0	0.0	0.0	0.0	—	—	—	—	0.0	0.0	0.0

<<

Fig 9. Monthly mean salinity (‰), temperature (°C),turbidity (m) and fishing depth (m) for ESBN



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8.5 Effects of environmental conditions

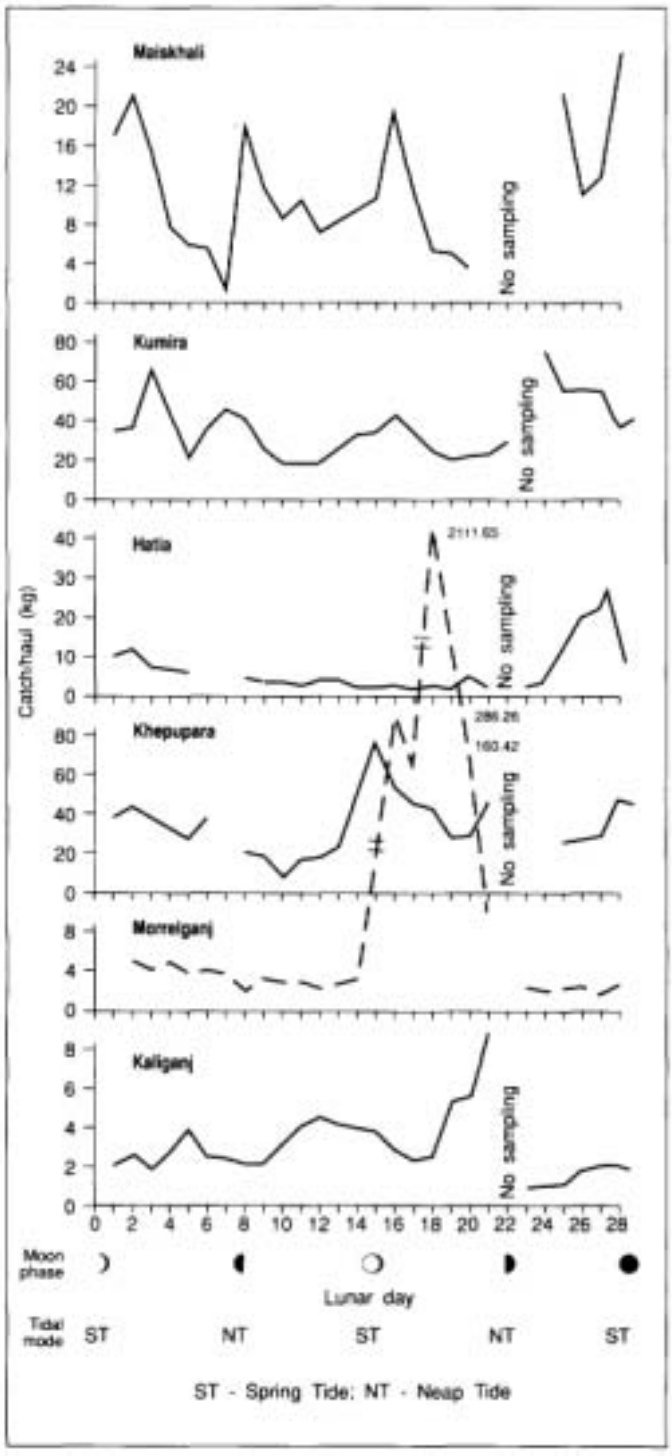
Data collected on the physico-chemical parameters of surface water and the fishing depth at the sampling stations are shown in Figure 9 (facing page) and reveal.

- The total catch rate increased with increase of salinity at Hatia and Khepupara stations. But no clear trend was visible in the other stations.
- No clear evidence of any effect of temperature on the catch rate was observed.

Waters of greater turbidity were found in the rainy season, but not in Maiskhali and Kumira. The catch rate decreased with increase of turbidity in all stations except Kaliganj, where such a trend was not clear. Perhaps, the salinity becomes too low for many of the animals in the estuary during the rainy season.

Fishing depth increased in the rainy season, but not in Maiskhali and Hatia. The fishermen may have been shifting their operations away from the relatively low saline shallow water areas. Any influence of fishing depth on catch rates was not clearly evident from the available data.

Fig 10. ESBN catch rate variation with lunar periodicity



The variations in the overall monthly catch rate with the lunar periodicity are shown in Figure 10 for the different areas. The catch rates were relatively higher during the spring tide when the high tide water moved from the sea into the estuary. However, differences in the magnitude of this effect were observed at different stations, probably due to significant differences in the distances of the stations from the coastline. The relationship was distinctly evident in Maiskhali and somewhat in Kumira, but not so in Morrelganj, Kaliganj, Khepupara or even Hatia. Consequently, partial correlation, rather than perfect correlation has been established from the results obtained.

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Another factor to be considered is that numerous species are involved and the lunar effect and influence of the tidal flow may be acting differently, both in kind and degree, on different species. Consequently, the resultant overall catch rate values may fail to exhibit good correlation. There may also be differences in the behaviour of the organisms, in relation to the ascending and descending phases of the spring tide, but this was not clearly evident in the results and, hence, the effects were assumed to be almost the same.

8.6 *Production*

The estimated monthly production, including finfish, penaeid shrimp and others, by different gear classes, in the different strata is presented in Table 16.

Table 16: Monthly production of ESBN by **area and gear class (in tonnes)**

		Month												
Station	*Gear type*	*Dec. 89*	*Jan. 90*	*Feb. 90*	*Mar. 90*	*Apr. '90*	*Mar 90*	*June 90*	*July 90*	*Aug. '90*	*Sept. '90*	*Oct. '90*	*Nor. '90*	*Total*
Coxs Bazar	Gla	—	—	—	—	—	—	—	—	—	—	—	—	0.0
	GIb	239.4	—	653.6	662.8	421.5	180.3	538.4	315.0	296.3	301.0	859.4	121.0	4588.6
	GIc	2955.8	155.2	1479.0	2114.3	1517.8	921.3	1413.9	947.4	537.4	10904.7	6417.7	418.9	29783.3
Subtotal		3195.3	155.2	2132.6	2777.0	1939.3	1101.6	1952.3	1262.4	833.7	11205.8	7277.1	539.9	34372.0
Chittagong	Gla	58.7	68.3	62.0	62.4	98.9	57.6	47.7	110.6	31.9	40,0	360.0	87.8	1085.8
	GIb	34.7	65.4	42.0	96.2	85.1	28.5	24.4	122.4	26.9	24.8	314.2	64.4	929.0
Subtotal		93.4	133.7	104.1	158.6	184.0	86.1	72.1	233.0	58.8	64.7	674.1	152.2	2014.8
Noakhali	GIa	114.6	61.8	197.1	660.9	389.8	118.7	5.3	3.7	3.2	26.6	30.2	1.5	1613.4
	GIb	39.0	24.7	105.0	337.0	199.5	62.1	3.7	—	—	12.2	27.8	1.6	812.6
Subtotal		153.6	86.5	302.1	998.0	589.3	180.7	9.0	3.7	3.2	38.9	58.0	3.1	2426.0
Patuakhali	Gla	—	—	—	995.7	527.6	139.0	116.3	37.8	70.5	233.6	147.3	—	2067.8
	GIb	787.6	150.9	212.9	2540.6	160.7	463.9	604.1	171.7	284.3	497.8	625.3	203.1	6702.8
	GIc	327.7	565.0	117.4	—	239.8	190.7	396.4	—	—	271.6	419.7	116.0	2644.2
Subtotal		1115.3	716.0	330.2	3536.3	928.1	793.6	1116.8	209.5	354.8	1002.9	1192.3	319.2	11414.9
Bagerhat	Glb	13.3	9.3	3.5	3.3	7.8	5.4	—	28.6	12.3	4.9	4.5	5.8	98.5
	GIc	11.5	7.3	3.6	7.4	22.4	5.2	9666.8*	29.7	35.1	7.9	5.3	7.9	9810.0
	GId	—	—	—	2.3	6.6	18.3	13870.0*	—	—	—	2.1	—	13899.4
Subtotal		24.8	16.5	7.1	3.0	36.8	28.9	23536.8	58.3	47.4	12.8	11.9	13.7	23807.9
Satkhira	GIa	101.4	63.3	33.9	17.2	5.6	255.8	32.4	18.0	31.0	13.8	10.1	57.1	639.6
	Gb	—	—	—	18.4	6.7	294.9	23.9	28.0	56.4	129.4	8.8	71.2	637.8
Subtotal		101.4	63.3	33.9	35.7	12.3	550.8	56.3	46.0	87.4	143.1	18.9	128.3	1277.4
Total	Gla	274.7	193.3	293.1	1736.2	1021.9	571.2	201.7	170.2	136.6	314.0	547.5	146.3	5406.6
(1.6)	GIb	1113.9	250.3	1017.0	3658.4	881.3	1035.0	1194.5	665.7	676.2	970.0	1840.0	467.1	13769.3
	GIc	3295.1	727.4	1599.9	2121.7	1780.0	1117.1	11477.1	977.1	572.4	11184.2	6842.7	542.8	42237.6
	GId	0.0	0.0	0.0	2.3	6.6	18.3	13870.0	0.0	0.0	0.0	2.1	0.0	13899.4
Total		4683.7	**1171,1**	**2910.0**	**7518.6**	**3689.8**	**2741.6**	**26743.3**	**1812.9**	**1385.3**	**12468.2**	**9232.3**	**1156.3**	**75312.9**

*** Crabs were about 99% of the catch composition**

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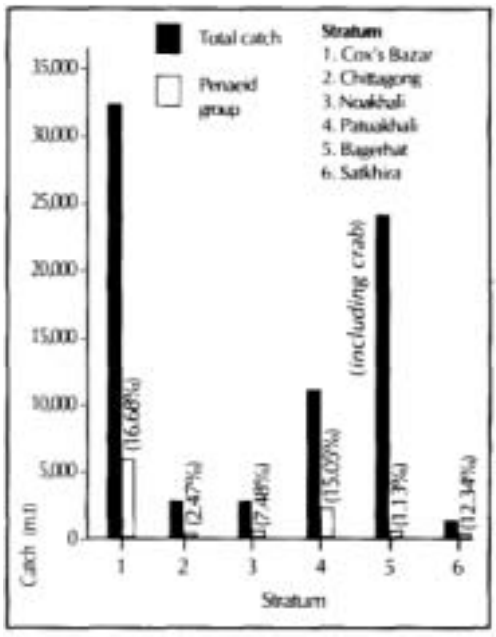
The annual production of all the areas combined was about 54,000 t if the abnormally high catches of crab in Bagerhat in June are disregarded. Cox's Bazar accounted for as much as 65 per cent and Patuakhali 21 per cent (see Figure 11). The bulk of the catch was caught in the Glc nets (62 per cent) and GIb nets (26 per cent).

The peak catches (9-12,000 t) were in September and October with the bulk from the Cox's Bazar area. There was another peak in March, of 7500 t, to which Cox's Bazar and Patuakhali contributed almost equally. The lowest catches were in January, July, August and November.

The total production of penaeid shrimp in the ESBN fishery was estimated at 7,746t (see below). Gear class contributed most (68 per cent) of this production, especially in Cox's Bazar. Which contributed 87 per cent of the total penaeid catch.

Fig 11. **Annual production of ESBN in** Bangladesh (Dec. **'89 - Nov.** '90)



Gear class	Area/Coy's Ba:ar	Chittagong	Noakhali	Patuakhali	Bagerhat	Satkhira	TOTAL
Gla		24	85	261	—	72	442
GIb	776	25	53	954	18	86	1912
Glc	4638	—	—	502	178	—	5318
GId	—	—	—	—	74	—	74
TOTAL	5414	49	138	1717	270	158	7746

8.7 *Biology of major species*

GROWTH PARAMETERS

Growth parameters for major species, estimated using ICLARM'S (1989) ELEFAN I Program, version 1.11, are summarized in Table 17 (overleaf) and the length frequencies and growth curves are shown in Figures 12a-s (see pages 42, 43, 44, 45). For some species, such as Gangetic Whiting *(Sillago domina),* Silver Whiting *(Sillago sihama),* penaeid shrimp *(Metapenaeus spinularus),* Hairfin Anchovy *(Setipinna taty,* Russel 's Smoothback Herring *(Raconda russeliana),* and Fourfinger Threadfin *(Eleutheronema tetradactylum),* the availability of length frequency data was limited to less than six months of the year due to the highly seasonal occurrence or to the very small sample sizes due to low abundance and poor catch rates. In such cases, the parameters derived must be considered as very preliminary estimates. In the case of many other species, the size range in the catch was fairly wide, with sufficient modal groups, so that the analysis was more reliable (Figures 12a-s).

MORTALITY AND EXPLOITATION RATES

ICLARM'S ELEFAN II Program (1989) was used to estimate these values (Table 17). Abnormalities were observed in certain cases, in the estimates of mean length at which a species becomes fully recruited to the fishery and also in the plotting of points for a catch-curve, to estimate total mortality rate, probably due to limitations in length frequency data. Such cases are indicated in Table 17, by an asterisk. *(Text continued on p. 45.)*

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Table 17: Growth and mortality estimates of some species of shrimp and finfish exploited by ESBN

S/No.	Species	L_{∞}	K	Z	M	F	E	Lc
1	*P. monodon*	31.4	.72	9.8	1.42	8.38	.85	13.8
2	* *P. indicus*	22.8	.55	5.0	1.30	3.70	.74	5.9
3	*M. monoceros*	19.8	.44	4.8	1.17	3.65	.76	5.9
4	*M.hrericornis*	15.6	.31	5.2	.99	4.24	.81	4.8
5	*Metapenaeus* spinulalus	20.1	.39	6.9	1.08	5.90	.85	5.3
6	*P. stylifera*	14.4	1.67	6.!	3.06	3.0	.49	2.8
7	*P. sculptilis*	16.9	.76	5.9	1.75	4.15	.70	4.3
8	* *M. rosenbergii*	35.5	.34	2.8	.84	1.96	.70	7.3
9	*P. styliferus*	15.4	.63	4.8	1.59	3.2	.67	3.7
10	*Acetes indicus*	5.0	.73	3.5	2.40	1.10	.31	2.0
11	*H. nehereus*	34.9	.38	4.7	.9!	3.75	.81	6.3
12	*L. sara/a*	93.0	.29	3.2	.58	2.62	.82	22.6
3	*S. taty*	21.3	.53	2.!	1.28	.80	.28	4.6
14	* *S. sihama*	27.4	.39	3.9	.99	3.00	.75	5.1
15	*Raconda russeliana*	23.6	.43	3.2	1.09	2.10	.66	4.!
16	*Stolephorus tn*	16.8	.65	10.6	1.59	9.00	.85	3,4
17	* *Eleutheronema tetradactv/um*	38.1	.18	4.4	.85	3.50	.87	5.3
18	*Polynemous paradiseus*	21.6	.52	6.0	1.28	4.72	.79	2.7
19	*S. domina*	43.3	.38	3.6	.86	2.70	.76	8.5

* **Cases where abnormalities were noted.**

Fig 12a. Length frequency and growth curve of P. *monodon*

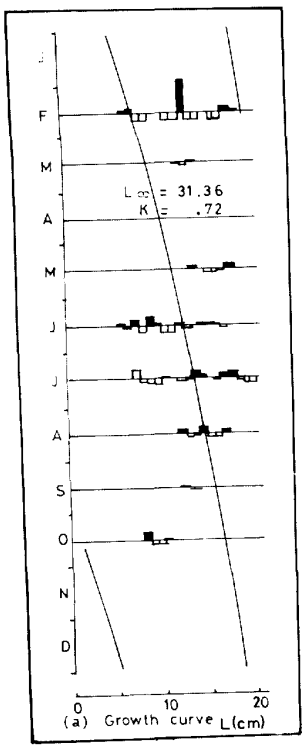

Fig 12b. Length frequency and growth curve of *P. indicus*

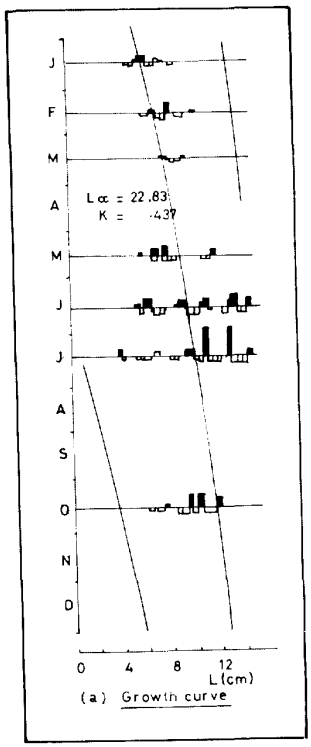

Fig **12c. Length frequency and growth curve of *M. monoceros***

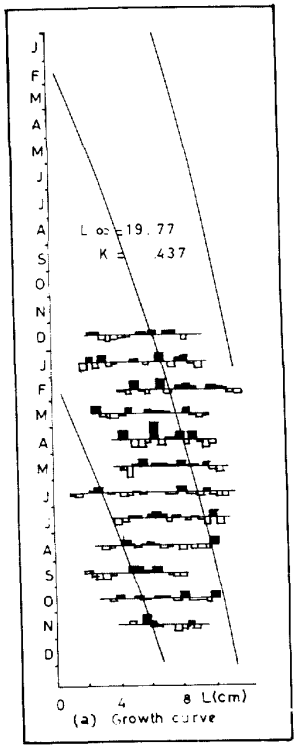

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Fig 12d. Length frequency and growth curve of *M. brevicornis*

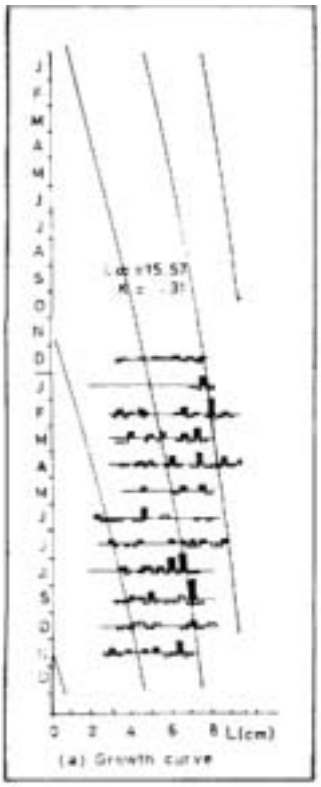

Fig 12e. Length frequency and growth curve of *P. stylifera*

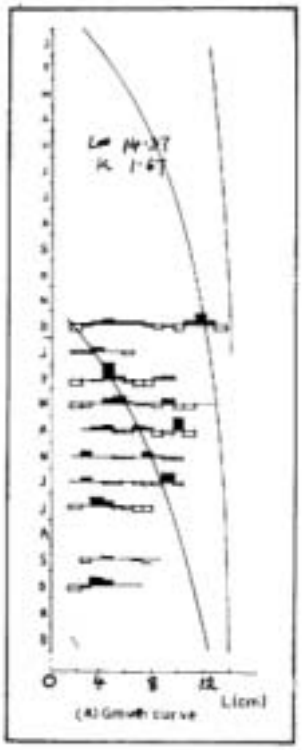

Fig 12f. Length frequency and growth curve of *P. sculptilis*

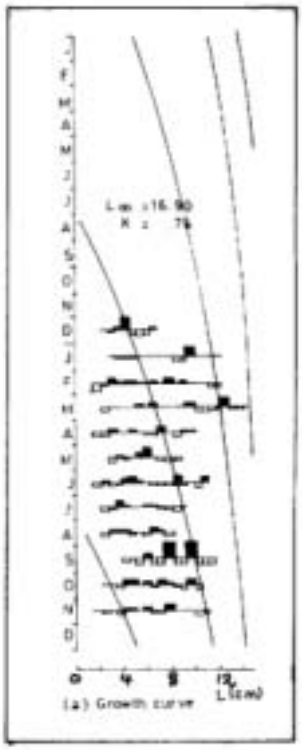

Fig 12g. Length frequency and growth curve of *M. rosenbergil*

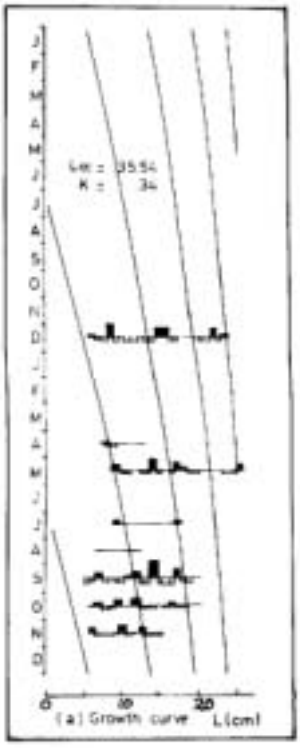

Fig 12h. Length frequency and growth curve of *P. styliferus*

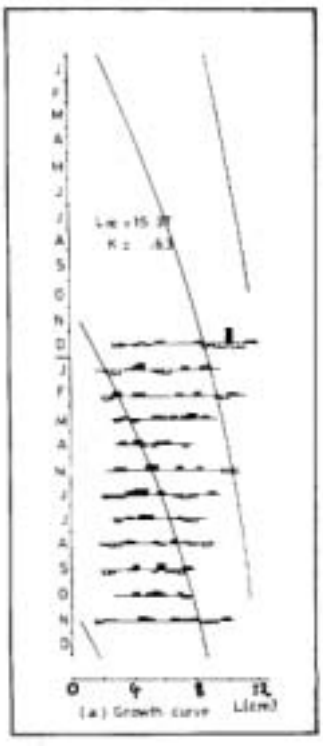

Fig 12i. Length frequency and growth curve of *A. indicus*

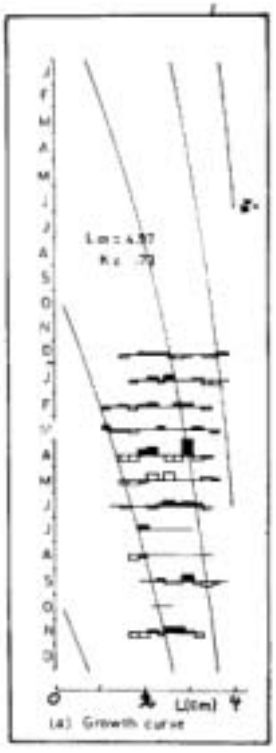

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Fig 12j. Length frequency and growth curve of *H. nehereus*

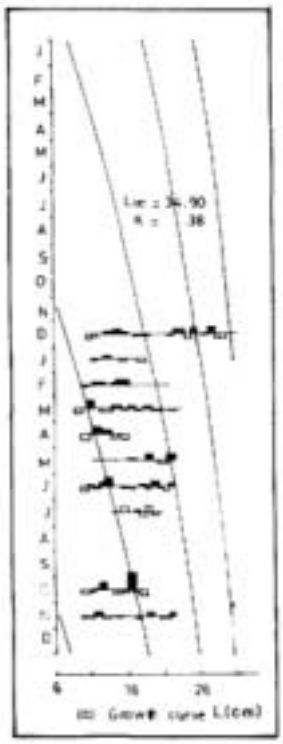

Fig 12k. Length frequency and growth curve of *L. savala*

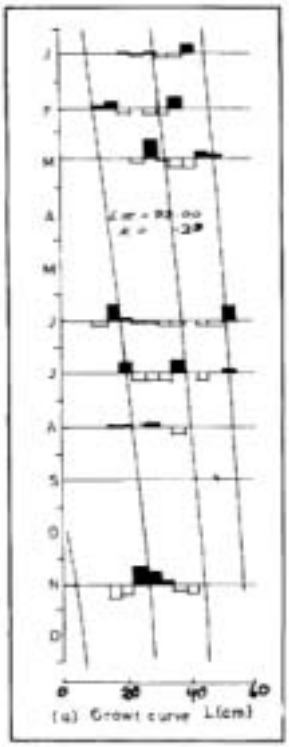

Fig 121. Length frequency and growth curve of *S. taty*

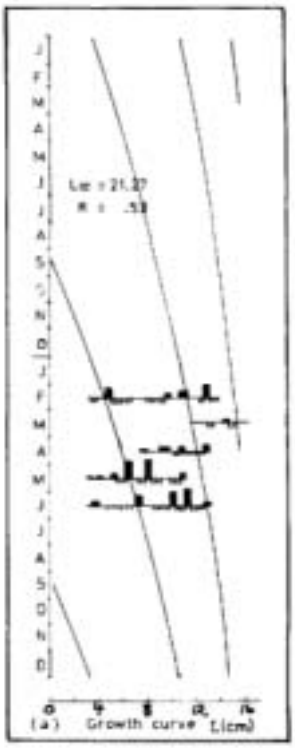

Fig 12m. Length frequency and growth curve of *S. sihama*

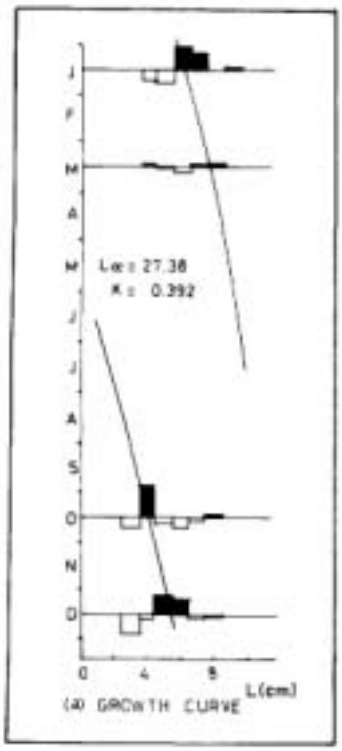

Fig 12n. Length frequency and growth curve of *M. spinulatus*

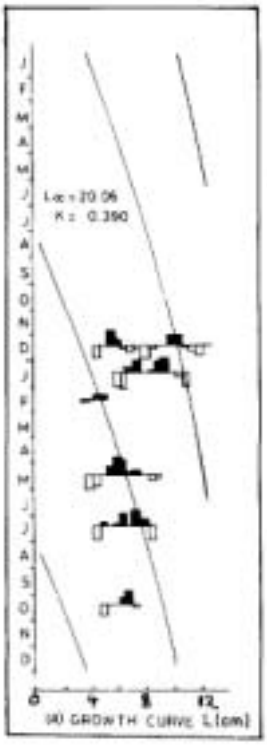

Fig 12o. Length frequency and growth curve of *R. russellana*

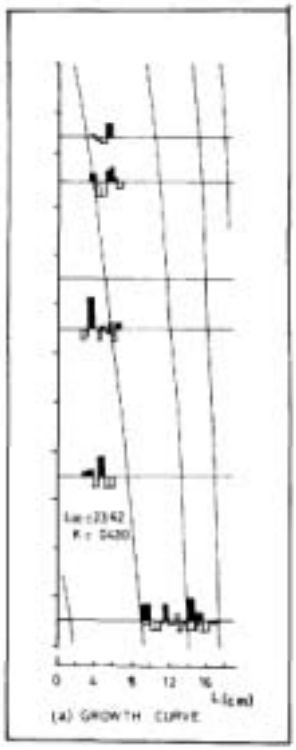

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Fig 12p. Length frequency and growth curve of S. *tri*

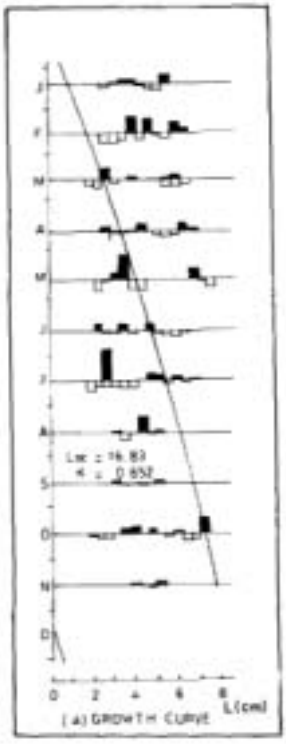


Fig 12q. Length frequency and growth curve of *E. tetnadactvlum*

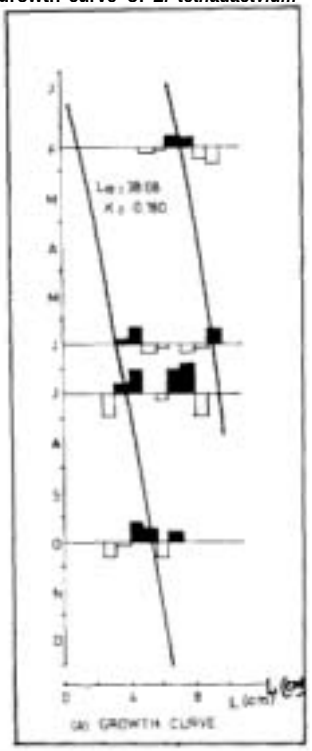
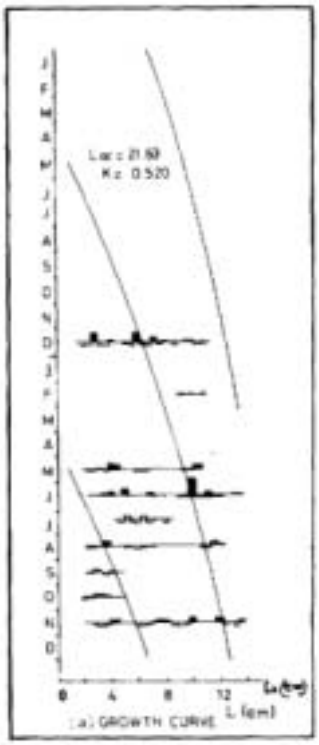
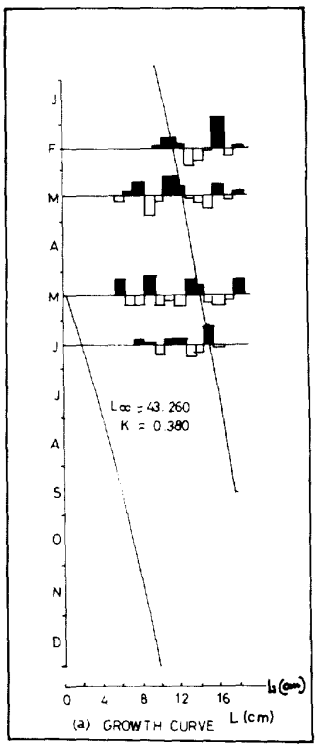


Fig 12r. Length frequency and growth curve of *P. paradiseus*



Exploitation rate was observed to be very high for most species. This may have been influenced by the predominance of very small sizes of animals caught by ESBN, compared to the asymptotic length (L_{∞}) estimated for the respective species as well as by the poor representation of larger sizes in the catch. Absence of larger sizes in the catch is not due to death but because the large sizes are in deeper waters and not 'available' to this estuarine fishery. The mean-length at first capture also clearly proves the preponderance of juvenile and immature fish and shrimp, except in the case of a few species like Sergestid Shrimp and Anchovy, whose adults are 'available' to the ESBN. In the latter cases the estimated exploitation rates indicate underexploitation of the resources.

Fig 12s. Length frequency and growth curve of ***S. domina***



RECRUITMENT PATTERN

Practically all the species studied exhibited two major recruitments each year. Though spawners were observed year round, there were two periods when there appeared to be significant increase in spawning activity — towards the end of the winter season (December-March) and at the end of the summer season (July-September).

Even though there were two recruitments, they were seldom of equal strength. Tiger Shrimp had a stronger recruitment in July and September, Brown Shrimp in May/June, Yellow Shrimp around May and Kiddi Shrimp mainly in January/February. Rainbow Shrimp and Freshwater Prawn came into the ESBN catches mainly around October. Bombay Duck and Ribbonfish were primarily recruited during August/September and April/May, respectively. Sizes at recruitment and size ranges 'available' to this fishery are also evident from Figures 12 a-s.

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8.8 *Economics of the fishery*

COST AND EARNINGS

Figure 13 illustrates the monthly variations in the costs and earnings at the six stations. Annual gross and net income, cost, income to crew and number of fishing months. by each size and class of set bagnet, in each station, are also presented in these figures.. The Gla class net used in five of the stations had an annual net profit ranging between Tk 24,969 and Tk 33,342, indicating relatively small differences among strata, but the highest net income was from Hatia, over 11 months of operation, and the lowest was from Kumira, over 12 months of operation. However, in Kumira, hired labour was used and the total cost was higher than in Hatia where the labour was mostly provided by members of the owner households.

GIb class net was operated in all six stations and the annual net income ranged from 1k 19,540 to Tk 95.739. Maiskhali recorded the highest income over ten months' operation and Kaliganj the lowest income over nine months of operation. All other stations fell between these two. Morrelganj, with Tk 37.814 net profit, appeared to have incurred the highest operational cost, using hired labour.

Glc class nets were operated only in three stations and, again, Maiskhali had the highest net annual income of Tk 179,159 over Il months of fishing, while Khepupara exhibited the lowest income of Tk 37,278 in 12 months. Gld class nets were used only in one estuarine station — Morrelganj — and the annual net profit was Tk 20,517 for four months' fishing in the estuary. The average net income, in each station for each class of gear per active fishing month, were as follows:

SBN Area / *gear class*	*1* *Maiskhali*	*2* *Kumira*	3 *Hatia*	4 *Khepupara*	*5* *Morrelganj*	*6* *Kahganj*
Gla	—	2.080	3.031	3.745	—	2.296
GIb	9.573	3.336	3.384	3.475	3,437	2,171
GIc	16.287	—	—	4.I42	4,560	—
GId	—	—	—	—	5,129	—

Except for extremely high values in Maiskhali, the others seem to fit into a pattern. Ratios of average net income from all classes of nets for all stations combined, excluding Maiskhali, was 1:1.1:1.5:1.8.

In most stations, there were two troughs in the income line — one in May/June and the other in November/December. These tend to correspond with the beginning of the SW. Monsoon and the N.E. Monsoon, respectively. In Maiskhali, whenever crew were engaged, they were paid Tk 400-600 per month and food provided free of cost. In Kumira and Khepupara, too, the crew were hired at a rate of 600-1000 and 250-600 Tk/rnonth, respectively. The food provided free of cost to the crew was valued at 450-500 Tk/month per ESBN unit. Other operational costs are minimal: most ofthe craft used in this fishery are nonmotorized and, generally, family members are engaged as labour.

VARIATION OF UNIT VALUE OF SPECIES

The price of mixed species of finfish and shrimp range from 1k. 11 to 40 with some variation between stations (see Table 18 p. 48). In each station, price varied by 30-40 per cent, but this variation by season was not the same in all stations. When valuable species were sold, the prices differed more significantly between stations. They were probably influenced by a mixture of factors, such as size of the animal, quantity landed, marketing facilities at the station and seasonal demand for fish.

Prices were high in Maiskhali. In this station, marketing, transportation and communication systems are relatively better developed. The socioeconomic condition of the fisherfolk is also better. In

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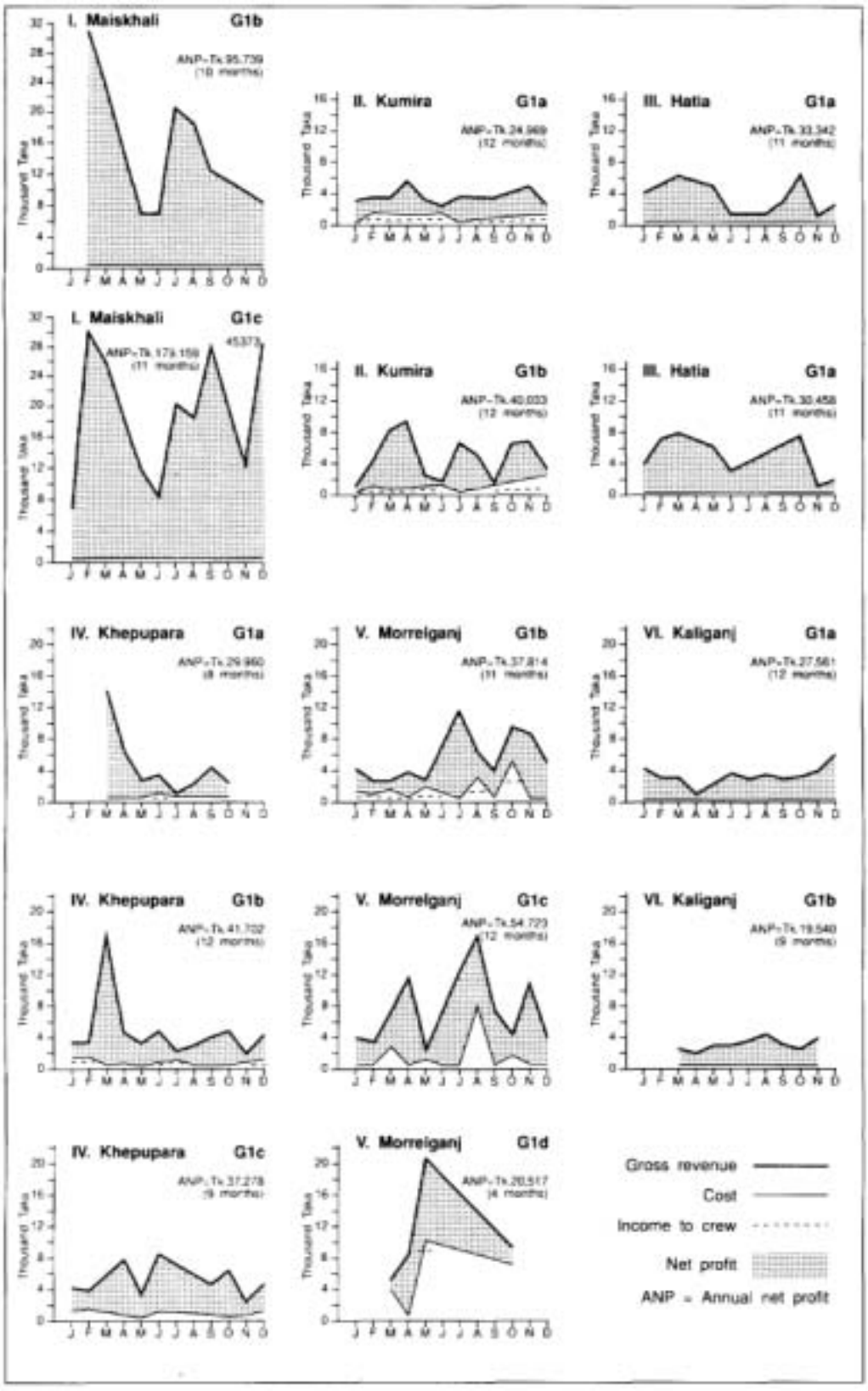
Fig 13. Monthly cost-benefit analysis of ESBN at different stations per gear size category



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Kaliganj, due to low catch rate and higher demand, the fishermen got good prices for mixed shrimp. The finfish price was also about that in Maiskhali. In Kumira, values were moderately high. A reasonable landing, marketing and transportation system exists there too. On Hatia island, fishermen got relatively lower prices because the marketing. transportation and communication. systems were poor. Power supply was also only for a few hours at night, with the help of a generator. Large shrimp and prawn also got relatively low prices. In Khepupara. also, fish was sold at a low price. In Morrelganj, mixed shrimp and fish were sold at low prices, somewhat similar to those in Hatia:

Table 18: Average monthly price (Tk/kg) of species groups in different stations for ESBN catches

Species name	*Station*	*Jan*	*Feb.*	*March*	*April*	*Mar*	*June*	*July*	*Aug.*	*Sept,*	*Oct*	*Nov.*	*Dec.*
Mixed shrimp and fish	Maiskhali	30	30	25	20	—	IS	30	27	27	30	30	30
	Kumira	24	22	25	25	25	35	27	18	20	15	17	26
	Hatia	17	19	18	18	—	2!	25	23	21	28	24	IS
	Khepupara	20	25	23	20	15	22	23	14	20	12	IS	18
	Morrelganj	IS	20	25	24	9	18	22	30	24	18	30	11
	Kaliganj	30	22	30	40	30	20	25	23	20	30	25	26
Penaeus monodon	Maiskhali	—	—	—	—	—	200	250	—	38	80	—	—
	Kumira	—.	—	—	—	—	—	—	—	—	—	—	—
	Hatia	—	—	—	—	—	—	—	—	—	—	—	—
	Khepupara	—	25	—	—	210	22	140	—	—	—	—	—
	Morrelganj	—	—	—	—	250	175	—	—	—	250	—	230
	Kaliganj	—	220	210	230	230	—	60	200	260	—	—	40
Macrobrachium rosenbergii	Maiskhali	—	—	—	—	—	—	—	270	50	150	150	—
	Kumira	—	—	200	—	—	—	—	—	—	—	—	
	Hatia	—	—	—	—	—	—	—	—	120	130	—	
	Khepupara	60	50	—	—	60	—	—	60	—	140	—	—
	Morrelganj	—	—	—	—	280	282	—	—	220	220	124	138
	Kaliganj	—	—	—	160	—	—	150	ISO	150	—	30	60
Metapenaeus monoc eros	Maiskhali	—	40	—	—	—	—	—	40	—	—	—	—
	Kumira	—	—	—	—	—	—	—	—	—	—	—	—
	Halis	—	—	35	—	30	—	—	—	—	—	—	—
	Khepupara	—	—	—	—	—	—	—	—	-..	—	—	—
	Morrelganj	—	—	—	—	80	—	—	—	50	—	—	—
	Kaliganj	—	—	—	—	—	—	—	—	—	—	—	—
M. *brevicornis*	Maiskhali	—	40	—	—	—	—	—	—	—	—	—	
	Kumira	—	—	—	—	—	—	—	—	—	—	—	
	Hatia	—	—	—	25	—	25	—	—	—	—.	—	—
	Khepupara	—	—	—	—	—	—	—	—	—	—	—	—
	Morrelganj	—	—	—	—	—	—	—	—	—	—	—	—
	Kaliganj	—	—	—	—	—	—	—	—	—	—	—	—
Acetes spp.	Maiskhali	7	—	—	—	7	8	—	6	7	8	7	—
	Kumira	6	7	7	8	8	7	—	5	S	6	6	6
	Hatis	3	5	—	—	—	—	—	—	—	—	—	4
	Khepupara	—	—	—	7	4	—	—	—	—	—	4	4
	Morrelganj	—	4	4	8	4	—	—	—	—	—	—	—
	Kaliganj	6	4	5		4	4	—	4	4	—	—	4

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9. *DISCUSSION*

The extensive use of set hagnets in the estuaries of Bangladesh niay not have a parallel in any other country in the Bay of Bengal region using this gear. The large number of species caught by ESBN in Bangladesh is also very significant. when compared **to** the number of species caught by other marine fisheries. According to Pillay and Ghose (1962). freshwater prawn were more dominant in the set bagriet catches in India than the marine penaeid shrimp, but this was not the case in Bangladesh. Even among the penaeid shrimp, only the presence of the Brown Shrimp was reported in India and there was no record of either the Tiger Shrimp or the White Shrimp, as in Bangladesh. This was probably due to differences in the environmental conditions in which the gear is operated

Observations made on species caught in ESBN during the present study are supported by Chowdhury 1987), Islam (1987) and Islam *et al.,* (1987). Observations made on the relative abundance of mature and immature shrimp and finfish are also in agreement with those of Ahmed (1979) and Islam *et al* (1 987).

The total production by ESBN estimated in this study. excluding the crab catches, is 11 per cent higher than the available statistics of the Department of Fisheries. This may be due to the fact that, in the present sludy. production was estimated on the basis of stratified sampling according to sizes of gear based on area of the mouth opening and on sampling spread throughout the year in six strata across the entire coastline.

The present study has shown that all estuarine set bagnet fisheries in Bangladesh do not generate similar earnings. They (lifter not only according to the area of fishing even for the same size and class of net used. but also according to the different size classes of the nets operating in the same area. The variations in the monthly earnings appear to he even more significant than variations in the earnings among different size and classes of the gear or strata.

In the marine sector. an increase in mesh size may be considered helpful in reducing the catch ot uveniles without affecting the income from the opertation (Akerman 1986). However. in the estuarine areas, with the predominance of juveniles. it may be difficult to realize the same revenue or better revenue if the mesh size is increased. On the other hand, a seasonal reduction in the fishing effort of thk gear in selected estuarine areas and **during** months when juveniles of valuable species of shrimp and finfish are predominant, would reduce destruction of juveniles, help to conserve the resources and increase the yield from them.

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THE BEACH SEINE FISHERY OF TEKNAF

by

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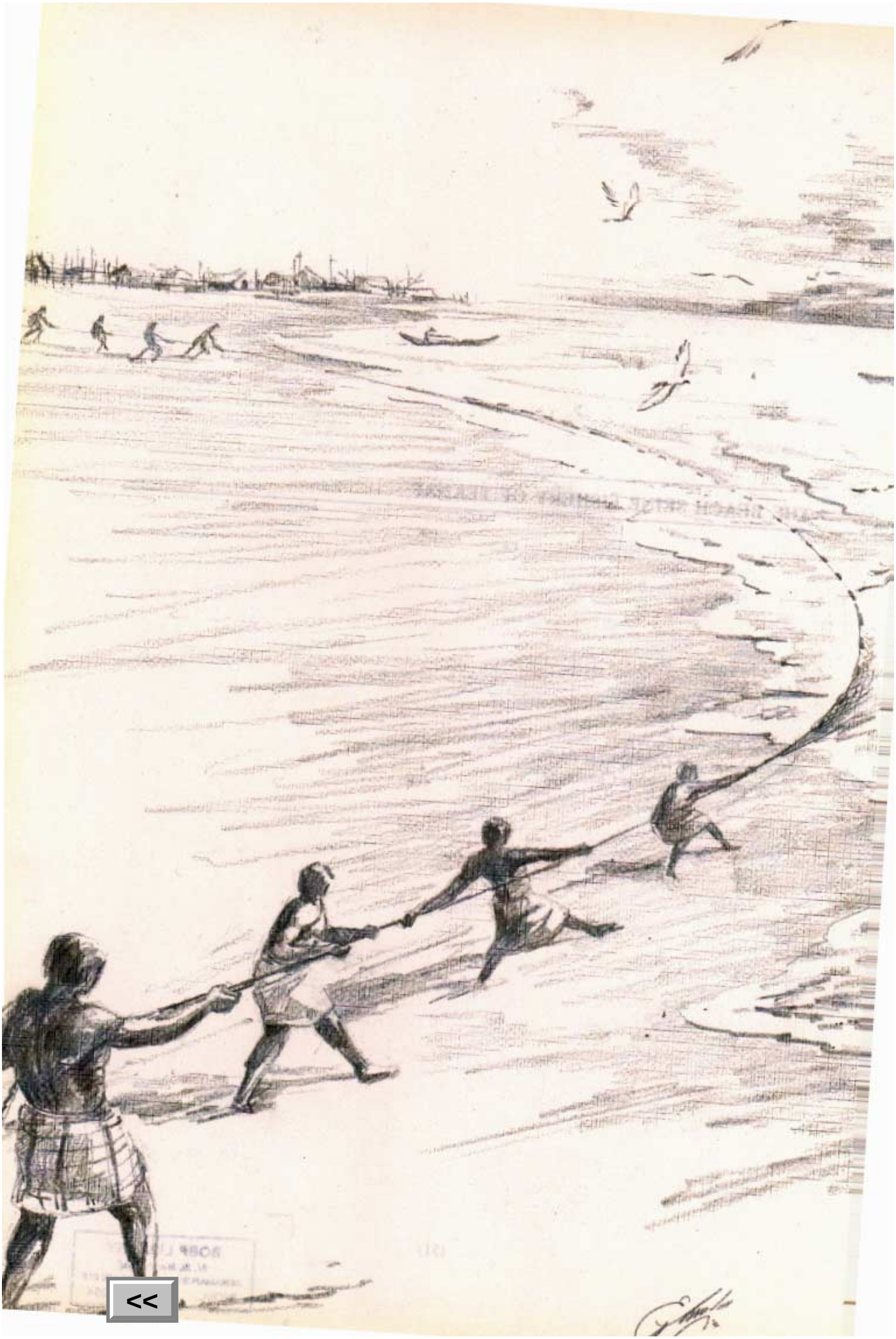

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11. *INTRODUCTION*

The numerous tributaries, tidal canals, brackishwater lagoons and estuaries, each with such distinct hydrological features as nutrient-rich soil and water, high oxygen content, low salinity, tidal current, shallow water depth etc., have naturally evolved as ideal nursery grounds for many marine fish and shrimp and some of freshwater origin. Beach seines operated in (his zone, like many other artisanal gear, use nets of very small mesh. They are mainly used to catch the juveniles and pre-adult species of Croaker, Bigeye Shad, other Clupeids. Anchovy. Ribbonfish, Brown Shrimp, Pink Shrimp and other miscellaneous fish in the estuaries and along the coast of Bangladesh.

According to the results of a frame survey of the marine artisanal fisheries (Anonymous 1984/85), there are 558 beach seines in Bangladesh. The number of nets operated in different areas is given in Table 19. There are no records of any scientific work on the beach seine fishery's production or on the biology of the species harvested by it in Bangladesh. The present study appears to be the first attempt. It reports on the species composition, catch rate, size range and predominant sizes of fish caught in Teknaf in the Cox's Bazar area.

Table 19: Distribution of beach seine nets in different areas

Area	*Cox's Bazar*	*Chittagong*	*Noakhali,*	*Borisal*	*Patuakhali*	*Khulna*	*All areas (Total)*
Number	346	60	24	22	0	96	558
Per cent	62	11	4	4	2	7	100

12. *THE BEACH SEiNE AND ITS MODE OF OPERATION*

The beach seine is an encircling type of net (locally referred to as b*er jal.* The specifications of the beach seine nets used in the Teknaf area are given in Figure 14,

Fig **14.** The **Bangladesh beach seine - Its specifications**

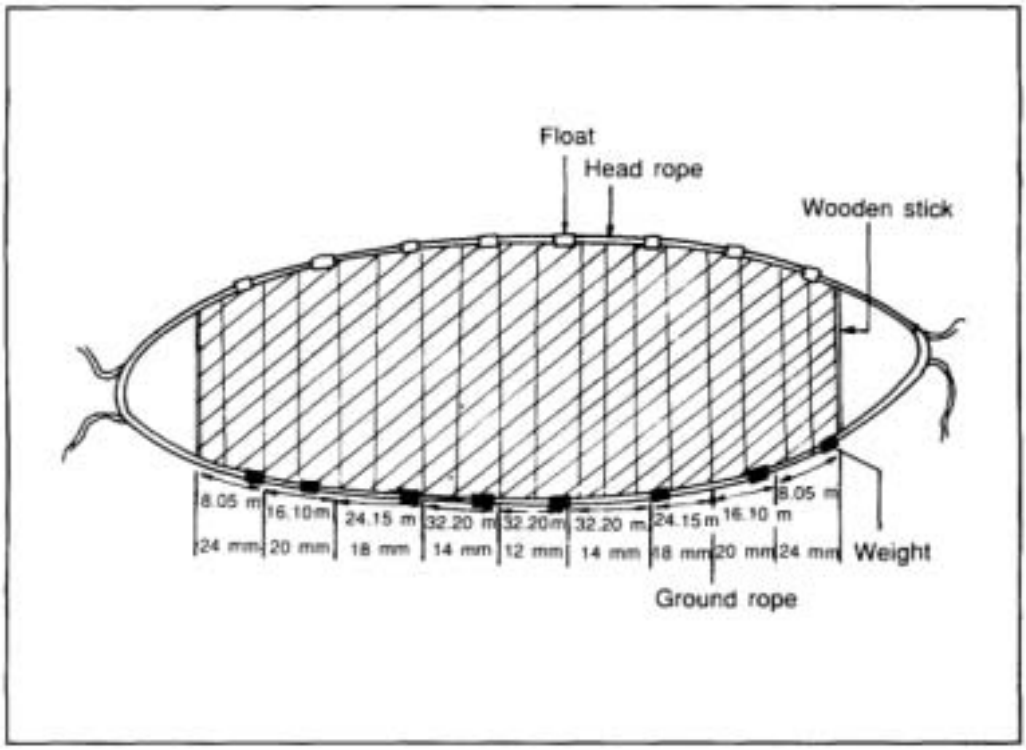

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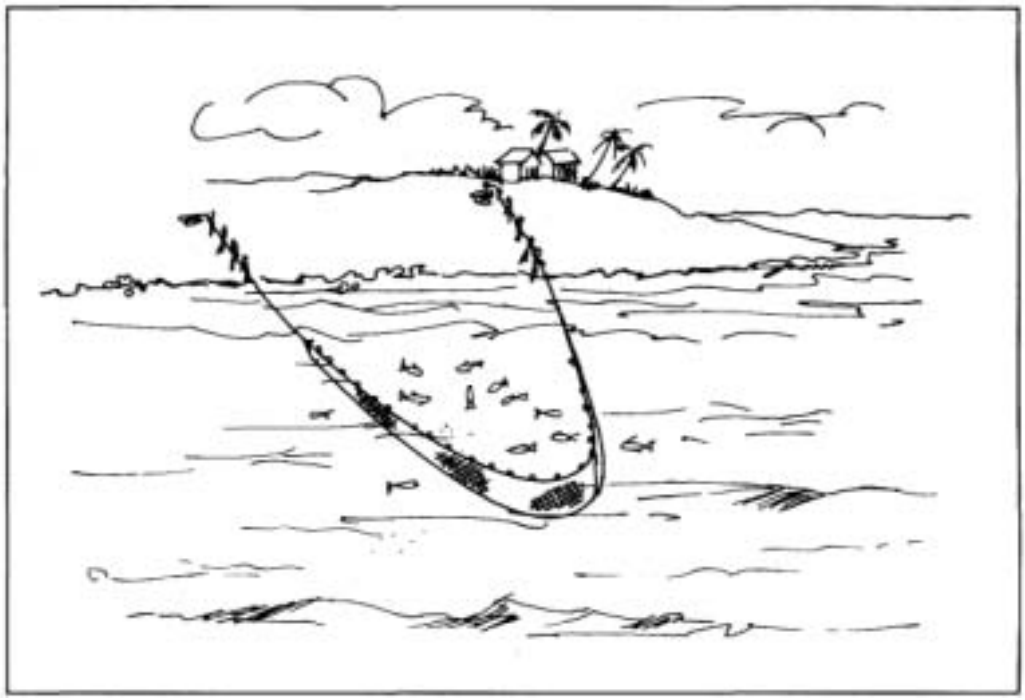
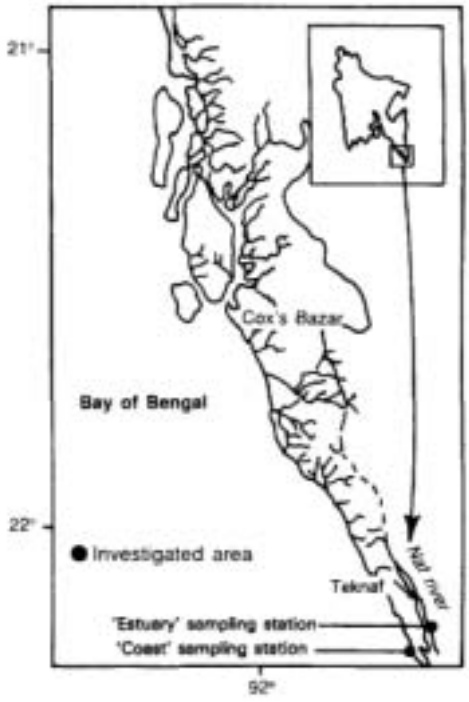
Fig 15. The Bangladesh beach seine - tts operation



A beach seine is operated by 11 - 15 fishermen with one boat. The net extends 600-700 m from the shore to where the depth of water is 8 - 10 m. The net is shot from the boat, to encircle a body of water (Figure 15). It is then brought ashore by the fishermen, who pull the ropes at both ends of the net from the beach. It takes 1-11/2, hours to complete a haul. The fishermen make 3-5 hauls a day, from dawn to afternoon.

Fig 16. Map showing locations of the two sampling stations



13. *METHODOLOGY*

The survey was conducted from March 1988 to February 1989. Two stations were selected, one in the Naf river estuary marked as sampling station 'Estuary' and the other on the Teknaf sea coast and marked as sampling station 'Coast' (see Figure 16). These are in the Cox's Bazar area. The fishing season in the estuary is from March to November, when the sea becomes rough, and on the coast from November to February.

At the 'Estuary' Station, operations of two beach seine nets were sampled on two consecutive days every month, for catch, species composition and size ranges.

At the 'Coast' Station, operations of three or four beach seine nets were sampled for catch, species composition and size range on three or four consecutive days every month. During the spring tide period, when the fishery is active, more nets were sampled on more days.

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As the total catch from the individual hauls were large, subsamples were taken and sorted by species or species group, the weight of which was later raised to the catch of the haul. Collection of length frequency data of major shrimp and finfish species was attempted, but, due to insufficient samples, the data were used mainly to examine size ranges and modal groups.

The shrimp species were identified using Dali (1956), George(l969), Khandakar and Pattra (1971), Shafi and Quddus (1982) and Fischer and Bianchi (1984). The finfish species were identified using Day (1989), Munro (1955), Shafi and Quddus (1982) and Fischer and Bianchi (1984).

Costs and earnings and socioeconomic information were obtained by direct observation and from discussions with the fishermen during sampling visits. The data gathered included information on operational expenditure and income, marketing of catch and prices, income distribution patterns etc.

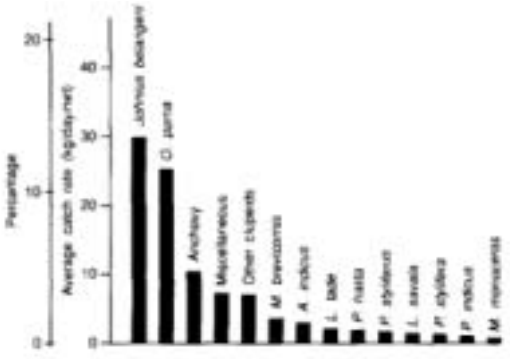
14. *RESULTS*

14.1 *Species composition*

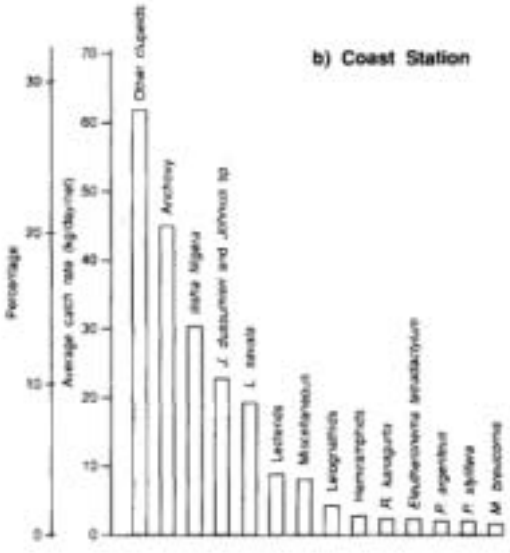
Fourteen species/groups of finfish and shellfish were identified in the estuarine and marine beach seine catches. These included seven species of penaeid shrimp, four species of Caridean shrimp, one or two species each of solenocerid, sergestid and alphid shrimp, species of crab, squilla, mollusc and starfish and 32 species/groups of finfish.

Fig 17. Overall species composition *(%)* and **catch rate (kg/day/net) in the beach seine fishery at the** two **stations**

a) Estuary Station



b) Coast Station



At the Estuary Station, the predominant species/groups were the Croaker *(John/us he/angeril* and *Otolithoides pania).* Anchovy and other clupeids (Figure l7a). These were followed by the Yellow Shrimp *(M. brevicornis)* Sergestid Shrimp *(Acetes indictis),* Grey Mullet *(Liza tade),* Grunt *(Pornadasvs hasta),* Caridean Roshna Prawn *(Pa/aenjon styliferus),* Ribbonfish *(Lepturacanthus savala),* Kiddi Shrimp *(Parapenaeopsis stylifera),* Indian White Shrimp *(P. indicus)* and the Brown or Speckled Shrimp *(M. monoceros).*

At the Coast Station. the Bigeye Shad *(Ilisha filigera)* and other clupeids and anchovy were dominant in the catches, and were followed by the Croakers *(Sciaenids),* Ribbonfish, False Trevally *(Lactarids).* Ponyfish *(Leiognathids),* Halfbeaks *(Hemiramphids),* Indian Mackerel *(Rastrelliger kanagurta),* Threadfin *(Elutheronema tetradactylum),* Silver Pomfret *(Pampus argenteus),* Kiddi Shrimp and the Yellow Shrimp (Figure 17b).

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The Bigeye Shad, other clupeids. anchovy and the Ribbonfish were found in the catches throughout the fishing season at the Coast Station.

14.2 *Catch rates*

The average total catch rate (kg/day/net) for all species combined and for the whole fishing season was 84 in the estuary and 213 on the coast. The catch rate was high from June to October in the estuary and during December-January on the coast (Table 20).

Table 20: Sample catch, effort, catch rates at the two stations

Sampling station! Month	*Total sample (kg)*	*Hauls in sample (No)*	*catch craft (kg) haul/net)*	*Eflout (hauls day (No*	*Catch craft (kg/day) net)*	*A ctive fishing time days month)*	*Monthly production cal h gear (net)* (kg /net)
Estuary Station							
March'88	7	1	7	3	51	20	020
April'88	38	2	19	4	76	20	1520
May'88	20	1	20	4	80	20	1600
June'88	47	2	23.5	4.5	06	20	2120
Sept.'88	27	I	27	4	108	20	2160
Oct.'88	54	2	27	4	108	20	2160
Nov.'88	5	1	15	4	60	16	960
Coast Station							
Nov.'88	96	3	32	3	96	16	1536
Dec.'88	335	3	112	1	447	20	8940
Jan.'89	180	3	60	4	240	20	4800
Feb.'89	92	4	23	3	69	16	1104

The Indian White Shrimp and the Brown Shrimp peaked in April-June. and the Yellow Shrimp, Kiddi Shrimp and the Rainbow Shrimp *(P.sculptilis)* catch rates showed a peak in November (Figures 18a and b, facing page). The Sergestid Shrimp and the Caridean Roshna Prawn had high catch rates in September.

Of the finfish, the Grey Mullet showed peak catch rates in the first quarter of the year (Figure 18b. facing page). Among the Croakers, *J. belangerii* had high catch rates in June and in the second half of the year, while O. *pama* had high catch rates in the first half of the year and in September at both stations. The other Croakers, Bigeye Shad and the Ribbonfish showed peak catch rates in the second half of the year. Anchovy recorded peak catch rates in June and December at the Estuary and Coast Stations respectively (Figure l8b, facing page).

14.3 *Production*

The number of nets that operated at the two stations and the number of days the nets were operated showed monthly variations. Monthly production per net was estimated using the average catch rate (kg/day/net) and the number of fishing days (Table 20). In estimating the total monthly production

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Fig 18a. Monthly catch rate (kg/day/net) for shrimp species or species group

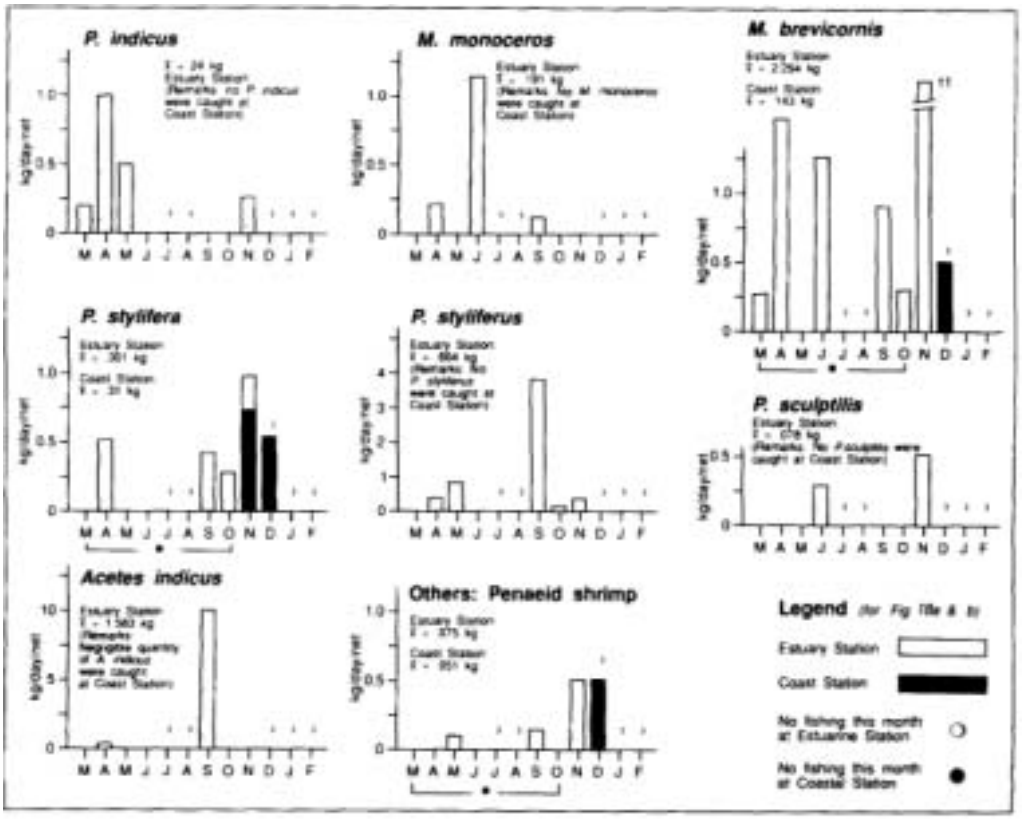
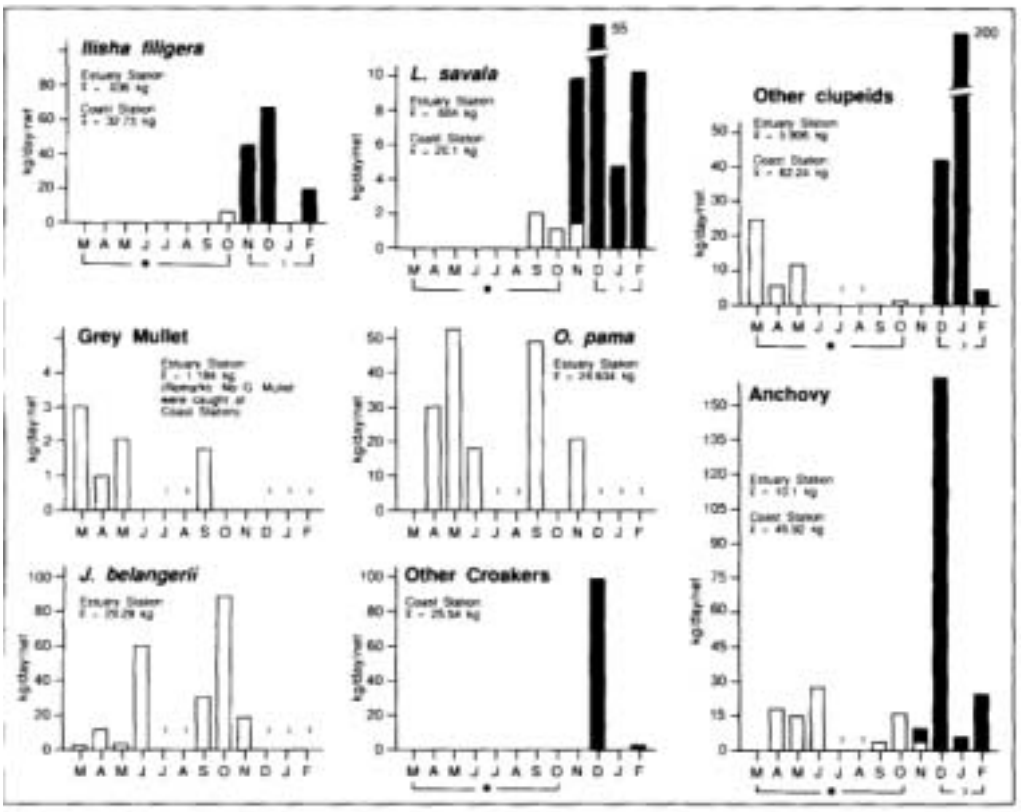


Fig 18b. Monthly catch rate (kg/day/net) for finfish species or species group



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in Cox's Bazar, the ratio of number of nets that operated to the number available at the sampling stations was applied to the total number of nets in Cox's Bazar (see Table 21).

The estimated production was 5010 t. Assuming similar catch rates and production levels in other areas, the total production by the beach seine fishery in 1988/89 was estimated at 8080 t.

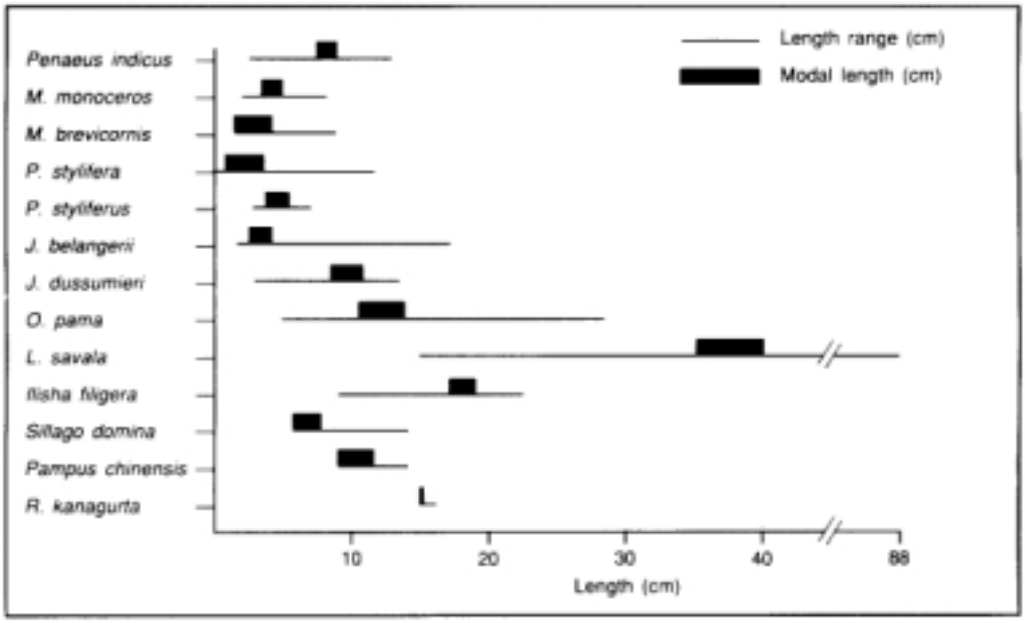
Table 21: Estimation of annual total catch in Cox's Bazar area by beach seine net (1988-89)

	Arerage no. of nets operated per day at station (no)	*Total no. of nets operated per day in Cox's Bazar (no)*	*Monthly catch/net (kg)*	*Monthly catch in Cox's Bazar (t)*
Estuary Station				
Mar. '88	10	138	1020	140.8
Apr. '88	10	138	1520	209.8
May '88	10	138	1600	220.8
Jun. '88	11	152	2120	322.2
Sept. 88	11	152	2160	328.3
Oct. '88	11	152	2160	328.3
Nov. '88	7	97	960	93.1
Total				1643.3
Coast Station				
Nov. '88	12	166	1536	255.0
Dec. '88	16	221	8940	*1975.7*
Jan. '89	15	208	4800	998.4
Feb. 89	9	125	1104	138.0
Total				3367.1
Total catch in Cox's Bazar				5010.4

14.4 *Size of major species*

The size ranges of major shrimp and finfish species caught are illustrated in Figure 19.

Fig 19. Exploited length ranges and predominant length groups of major shrimp and tinfish species in beach seine catches



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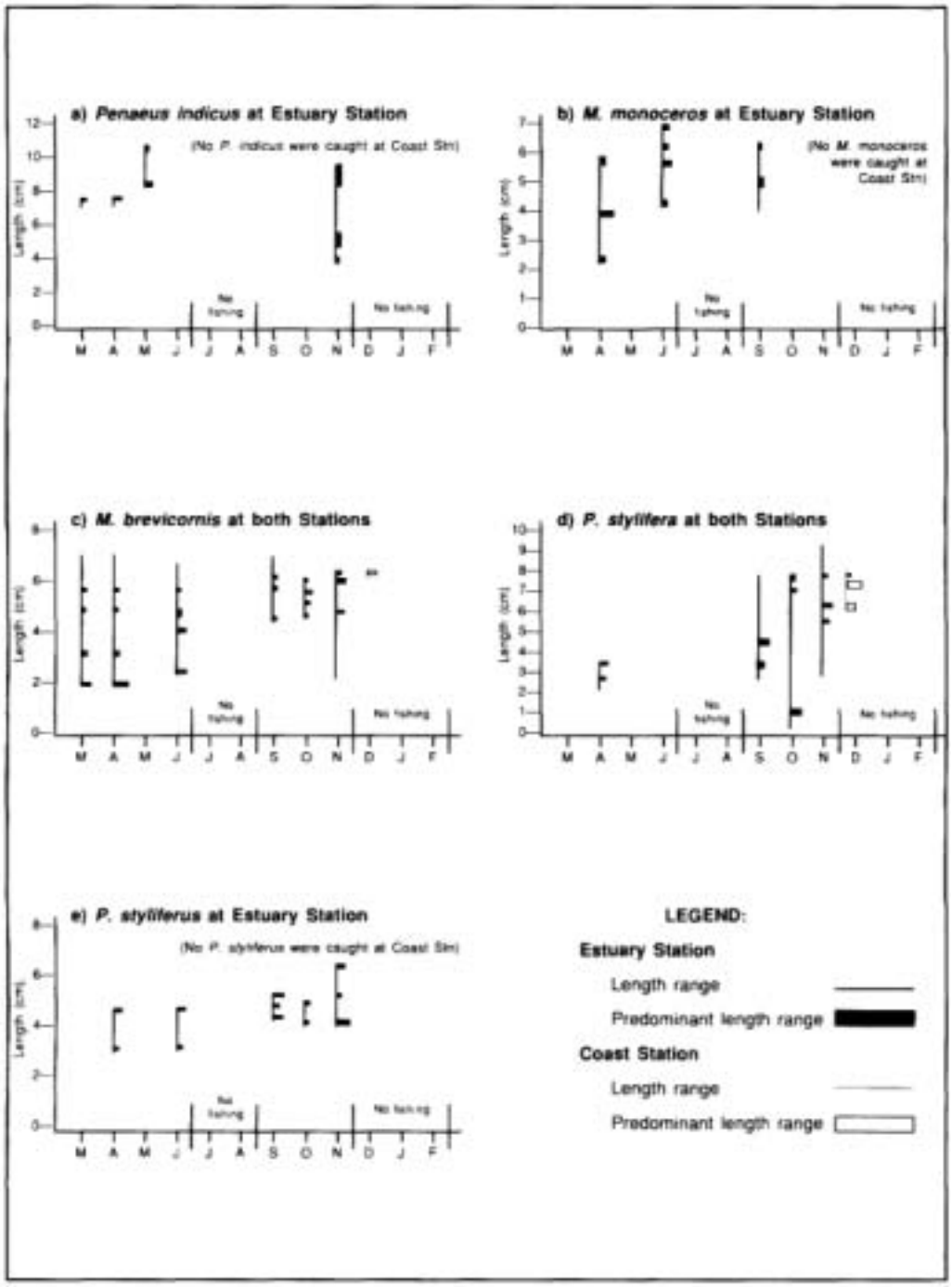
The penaeid shrimps were mostly between 0.4 and 10 cm length. The predominant size ranges of Indian White Shrimp, Brown Shrimp and Yellow Shrimp were highest in April. The size range was lowest in March for Indian White Shrimp and in September for Brown and Yellow Shrimp. (Figures 20a, h and c). The predominant size range of Kiddi Shrimp and Caridean Roshna Prawn was highest in November and lowest in April (Figures 20d and e).

Fig 20 (a, b, c, d, e). Relative proportions of different sizes of shrimp species caught by beach seine in different months



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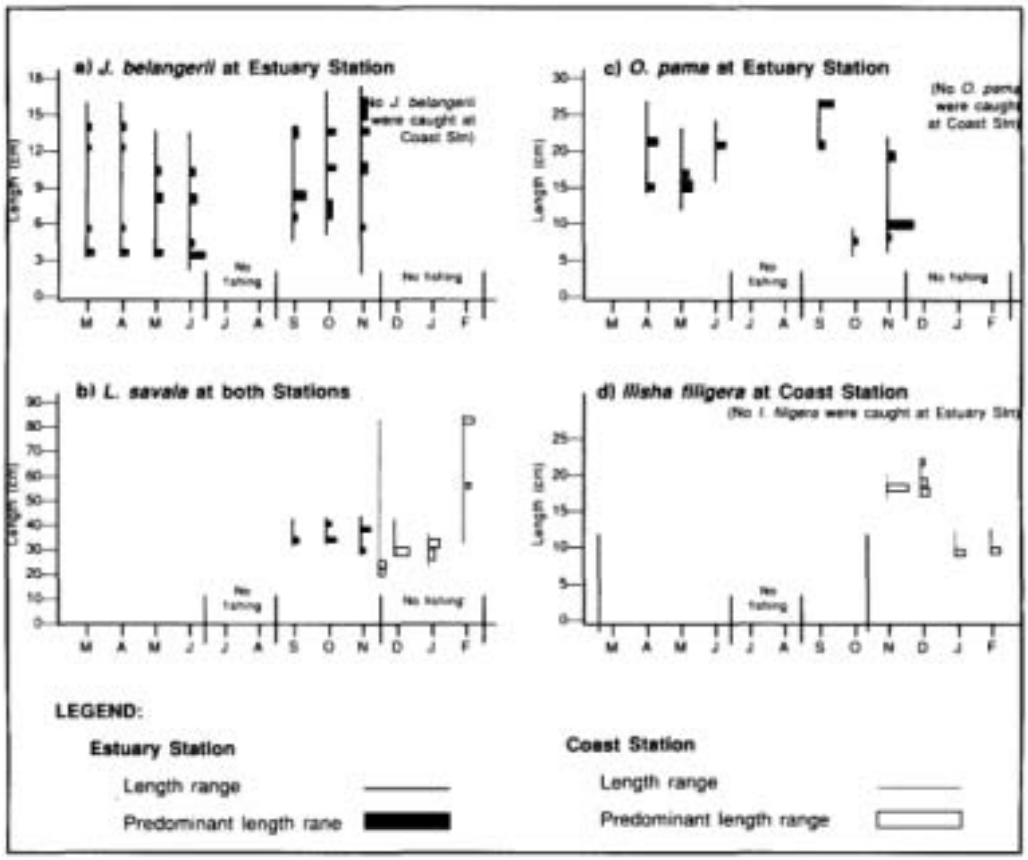
The predominant size ranges of both *O. pama* and Bigeye Shad were highest in November, but lowest in October for *O. pama* and in December for Bigeye Shad (Figures 2Ic andd). The predominant size range of *J. belangerii* and Ribbonfish were highest in June and December and lowest in November and September respectively (Figure 2la and b).

Flg **21 (a, b, c, d). Relative proportions of different sizes of finfish species caught by beach seine in different months**



14.5 *Costs and earnings analysis*

The beach seine owners earn less income in the Naf river estuary in most months than on the Teknaf sea coast fishery. Their maximum gross earning is Tk 21,253 in October, with a net profit of Tk 3,855. Their minimum gross earning is Tk 10,242 in March with a net profit of Tk 185.

Seasonal gross earning per unit was Tk 113,029 over seven active fishing months and the net profit to the owner was Tk 15,083, after reducing the cost of production.

US $ I = Tk 31 appx. (1989-91)

<<

Owners of gear on the Teknaf sea coast, on the other hand, earn a reasonable income from their fishing units during most months of the year. The highest monthly gross earning was Tk. 101,453 per unit, with a profit of Tk 30,589, in December and the lowest monthly gross earning was Tk 12,262, with a net profit of Tk 859, in February.

Gross earning per unit was Tk 171,619 during a season of four active fishing months, while the total profit to the owner during this period was Tk 44,292 after deducting the cost of production.

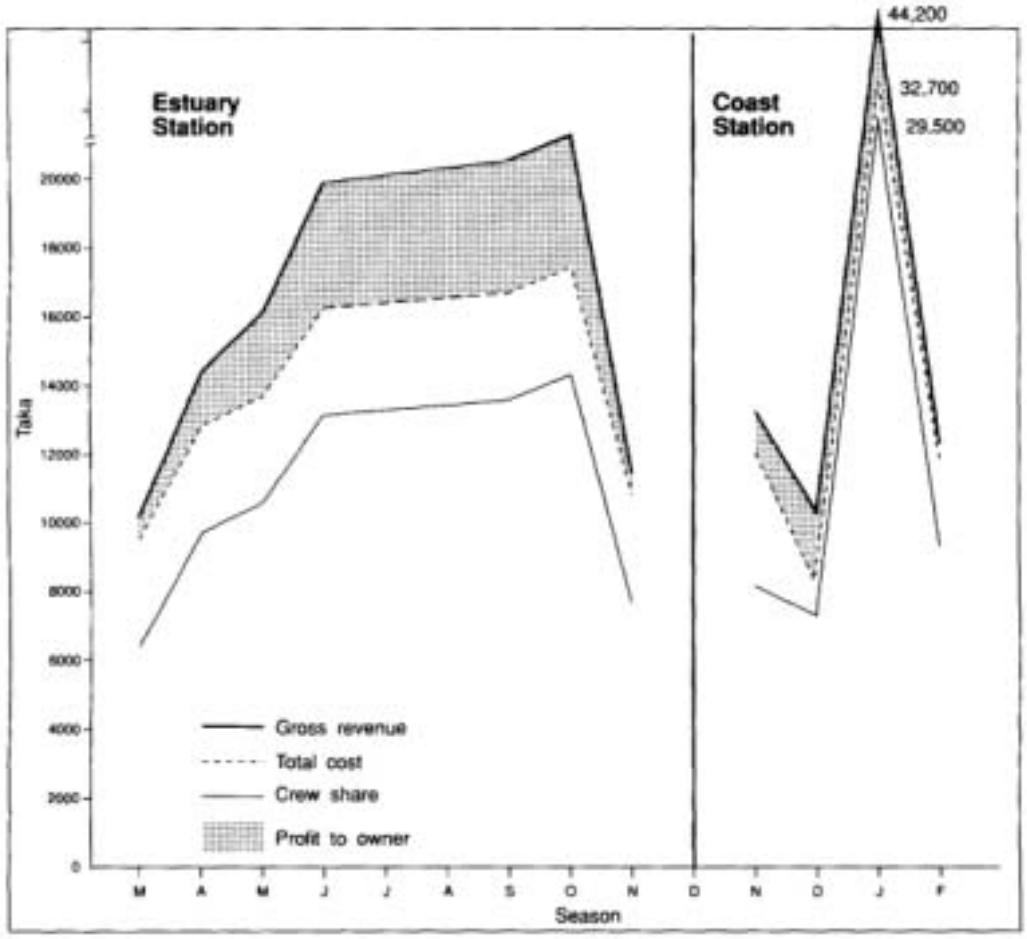
The average monthly gross revenue, profit and average monthly costs for the operations in the estuary are given alongside, along with similar values for the sea coast operation.

item	Estuary (Tk)	Coast (Tk)
Gross revenue	16.150	42.904
* Fixed cost	2,130	2,130
Variable cost	1.100	1.100
Fishermen's share	10.760	28,600
Total cost	**13,990**	**31,830**
Net income	2,155	11,074
Income/fisherman	446	2,200

* Craft value Tk 70.000 and avg. life 7 years. Gear value 1k 100.000 and avg.life *10*years.

Monthly analysis of the costs and earnings of the beach seine operation at the two stations are illustrated in Figure 22.

Fig 22. Monthly costs and earnings analysis for the beach seine fishery in the Estuary Station and the Coast Station



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14.6 *Shares and wages*

Most beach seines and operating boats are owned by *bahardars,* better off people belonging to the fish landing/operating localities. The fishermen get paid on a share basis after incidental expenses, generally small amounts, are deducted.

When net revenue from each haul exceeds Tk 400, one-third of it goes to the owner of the unit and the remaining two-thirds is equally distributed among the fishermen. If the gross revenue is between Tk 200 and 400, a fixed amount of Tk 200 is shared among the fishermen and the rest of the money goes to the owner. When the gross revenue falls below Tk 200, all of it is distributed equally among the fishermen, without anything going to the owner. The beach seine fisherfolk community generally follow this traditional sharing system.

Seasonal income and average income per month to fishermen when operating in the Naf river estuary was 1k 5,795 and Tk 445 respectively and Tk 8,800 and Tk 2,200 respectively when operating on the Teknaf sea coast.

14.7 *Fish and shrimp prices*

The catch is sold on a wholesale basis to middlemen or on a retail basis to traders, at the landing centre. Middlemen sell to retailers who, in turn, sell the fish at the local market.

Prices of mixed species of finfish and shrimp are in the range of 9-20 1k/kg, with some seasonal variations (see Appendix II). Prices of shrimp/finfish species are somewhat higher during December-February, because the quality of the fish/shrimp is better due to the air temperature being low and the spoilage, as a consequence, being less. Prices are lower in March-November when temperatures are high and spoilage likely, due to the lack of well-developed processing, transportation and marketing facilities.

14.8 *Employment*

The number of fisherfolk engaged in beach seine fishing in Cox's Bazar was estimated to be 15,000. In all Bangladesh. the figure was thought to be in the region of 29,000. These estimates are based on the total number of gear units and the average number of persons engaged in operating a unit.

15. ***DISCUSSION***

It was observed during this study that the average catch rates of penaeid, Caridean shrimp and Croaker were higher in the Naf river estuary than off the Teknaf coast. But the average catch rate of Bigeye Shad, other Clupeids, Anchovy and Ribbonfish were higher on the coast (see Figure l8a and b).

The seasonality of the beach seine fishery in the Hugli estuary off the northeast coast of India, as well as the species composition in it described by Dutta *eta!.* (1973), are similar to the findings in this study.

A large proportion of immature shrimp and finfish were found in the beach seine catch during the period of investigation. It is assumed that this may occur in other areas of Bangladesh too. This could result in the reduction in yield per recruit, destruction of juveniles and reduced recruitment of the larger sizes of these species to other fisheries, such as the trawl, longline or trammelnet.

Considering the number of beach seines (558) in the estuarine and marine subsectors of Bangladesh, the catches by this gear need to be taken into consideration when management of penaeid shrimp and other major finfish species is examined.

The present study is more qualitative than quantitative, the' numerical estimation being limited to only one area. Systematic and quantitative estimations in all beach seine fishing areas are necessary for a better assessment of the impact of the beach seine fishery on the shrimp and finfish resources of Bangladesh.

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APPENDIX II

Monthly average price (Tk/kg) of selected species or species group in the beach seine catch at the two stations

Species name	*Station* *	*Mar. '88*	*Apr.*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan. '89*	*Feb.*
Shrimp (mixed)	1	-	-	-	-	-	-	-	-	9	13	13	13
	2	10	10	9	8	-	-	8	8	9	-	-	-
Penaeus indicus	1	-	-	-	-	-	-	-	-	18	20	20	20
	2	20	18	18	18	15	-	-	15	15	18	-	-
Metapenaeus monoceros	1	-	-	-	-	-	-	-	-	18	20	20	20
	2	20	18	18	15	-	-	15	15	18	20	20	20
Croaker	1	-	-	-	-	-	-	-	-	10	13	13	13
	2	13	10	10	10	-	-	10	10	10	-	-	-
Ribbonfish and Sillago	1	-	-	-	-	-	-	-	-	10	13	13	13
(Whiting)	2	10	10	10	10	-	-	10	10	10	-	-	-
Bigeye *ilisha* and	1	-	-	-	-	-	-	-	-	10	13	13	13
Threadfin bream	2	13	10	10	10	-	-	10	10	10	-	-	-
Grey Mullet and Pomfret	1	-	-	-	-	-	-	-	-	15	20	20	20
	2	20	15	15	15	-	-	15	15	15	20	20	20
Other clupeids & engraulids	1	-	-	-	-	-	-	-	-	9	10	10	10
(Anchovy)	2	10	9	9	9	-	-	9	9	9	-	-	-
Mixed finfish	1	-	-	-	-	-	-	-	-	8	10	10	10
	2	8	8	8	8	-	-	8	8	8	-	-	-
Trash fish													
(Tricanthidae	1	-	-	-	-	-	-	-	-	2	2	2	2
Tetraodontidae)	2	2	2	2	2	-	-	2	2	2	-	-	-
Crab and cuttlefish	1	-	-	-	-	-	-	-	-	2	2	2	2
	2	2	2	2	2	-	-	2	2	2	-	-	-

* 1. Coast Station 2. Estuary Station

THE MARINE SET BAGNET FISHERY

by

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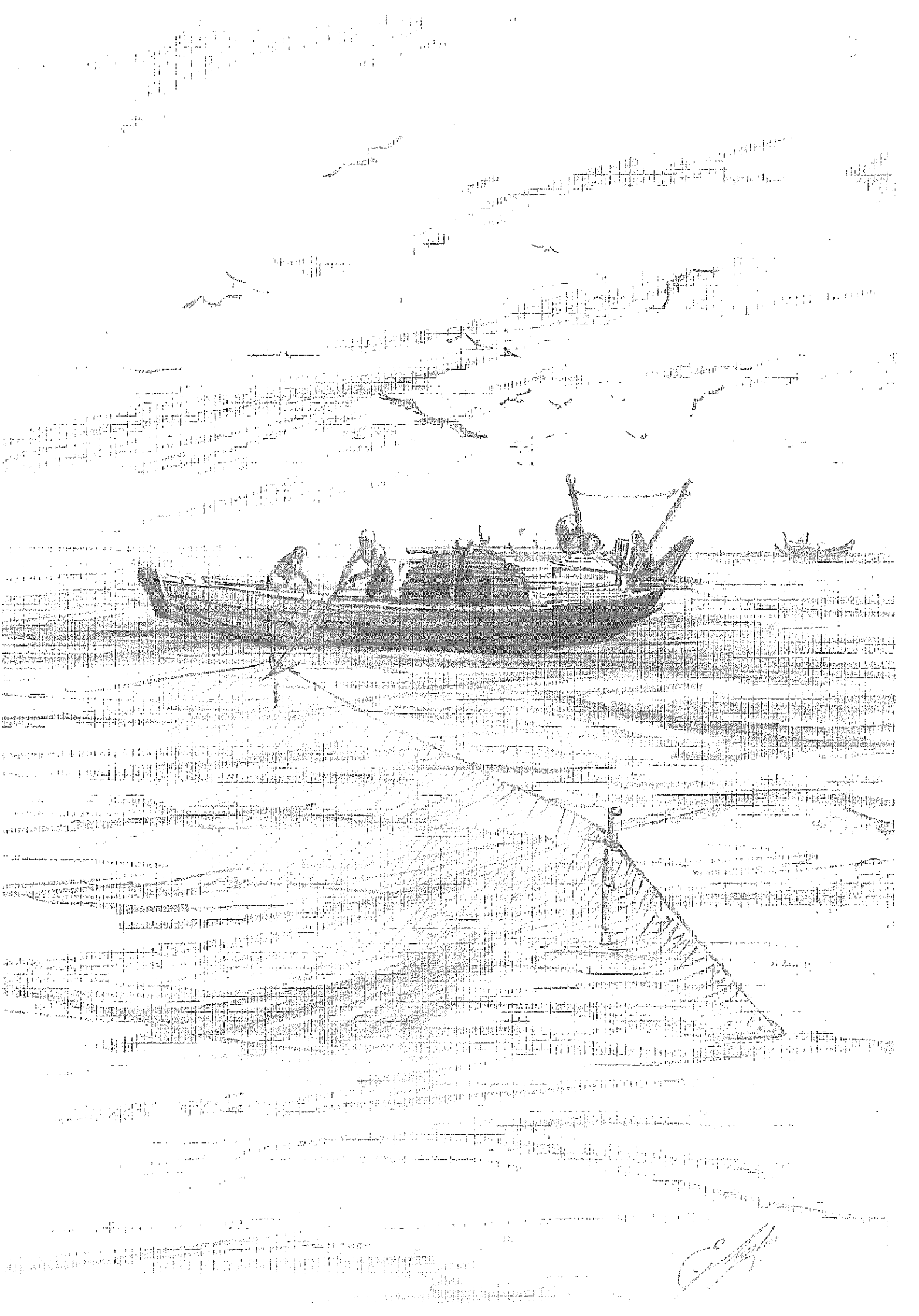


17. *INTRODUCTION*

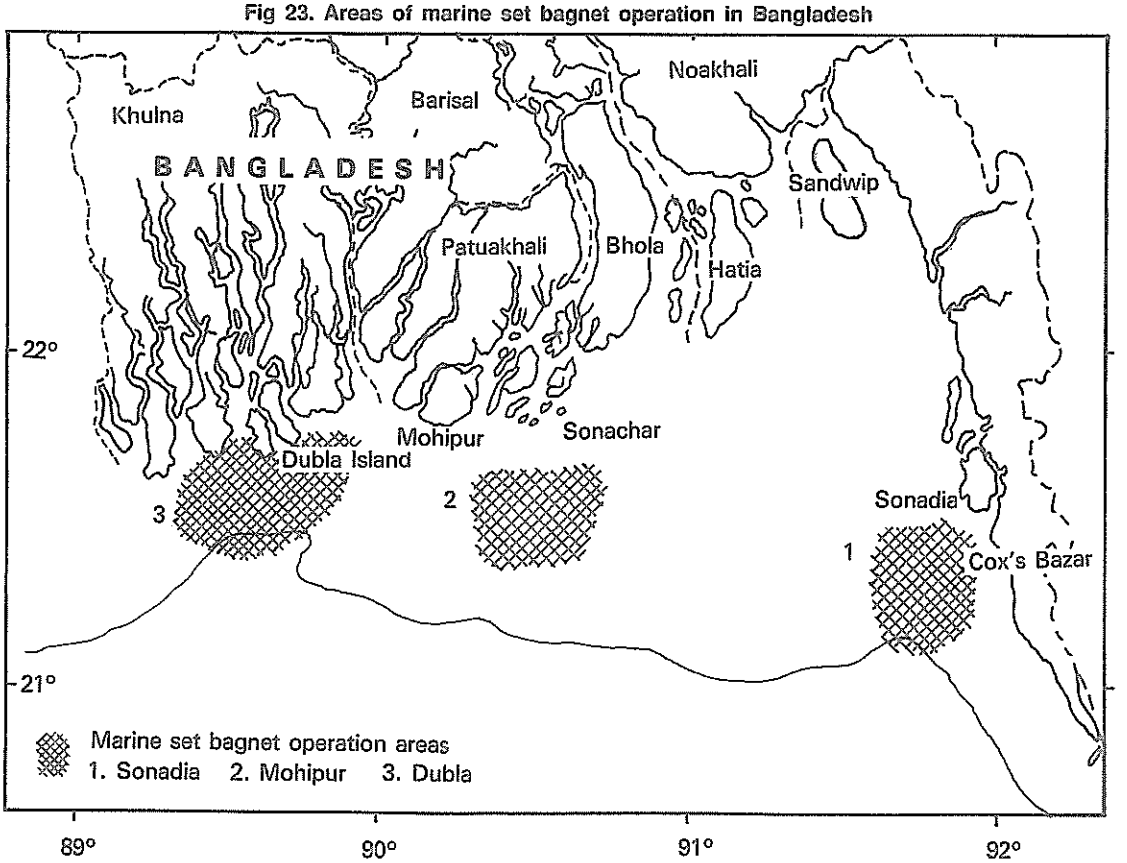
According to existing fisheries statistics (1988-89), the annual marine fish production in Bangladesh is 233,000 t. The small-scale fisheries contribute 96 per cent of this production *i.e* 225,600 t, and 28 per cent of this, 63,000 t, is reported to be from set bagnets (SBN). Marine set bagnets (MSBN) are reported to contribute about 27 per cent of the total SBN production, *i.e.* 17,000t.

In connection with a comprehensive biosocioeconomic study of the estuarine set bagnet fishery, an attempt was also made to assess the level of exploitation by MSBNs. The study particularly aimed to determine the catch rates, production, species composition and size ranges of the predominant species caught. The mean length at first capture and fishing mortality in the MSBN fishery were also examined. The results are included in this paper.

18. *METHODOLOGY*

Data collection was from the three main Marine SBN fishing areas (Figure 23). Mohipur and Dubla are remote areas where communication is irregular and accessibility is not easy, hence extensive sampling was conducted only during the few field visits. In Sonadia, data had been collected throughout the 1983-1986 seasons under another activity of the BOBP, but sampling during the present study was conducted, as in the other two areas, only in 1991. Catch and effort data in Sonadia, had been collected from 1983-86 but size composition and species composition data were collected only in 1985/86.

Fig 23. Areas of marine set bagnet operation in Bangladesh



Monthly species composition was estimated for Sonadia using the data collected during the earlier period, but for the other two areas it was established on the basis of the two surveys conducted in 1991.

Surveys were carried out, in Mohipur and Dubla in January and March 1991 and in Sonadia in January 1991, to estimate the catch, effort, size composition and species composition.

The monthly catch rate (kg/haul) in Sonadia was estimated by averaging the corresponding monthly catches and effort samples for 1983-1986.

19. *FISHING GROUNDS AND SEASON*

The MSBN is operated in a depth range of 10 - 30m in areas where the salinity is 20-30 $^{o}/_{oo}$.

The fishing season is during the winter months, when there is no freshwater run-off. The fishery is suspended during the summer months, mainly because fishermen find it difficult to operate the gear under monsoon weather conditions.

MSBN fishing usually starts after the Southwest Monsoon and continues until the end of the Northeast Monsoon:

— In **Sonadia,** operations start around mid-September and continue up to February;

— In **Mohipur,** fishing starts in October and continues up to mid-March; and

— In **Dubla,** fishing is from October till the end of January.

20. *FISHING GEAR AND CRAFT*

20.1 *The gear*

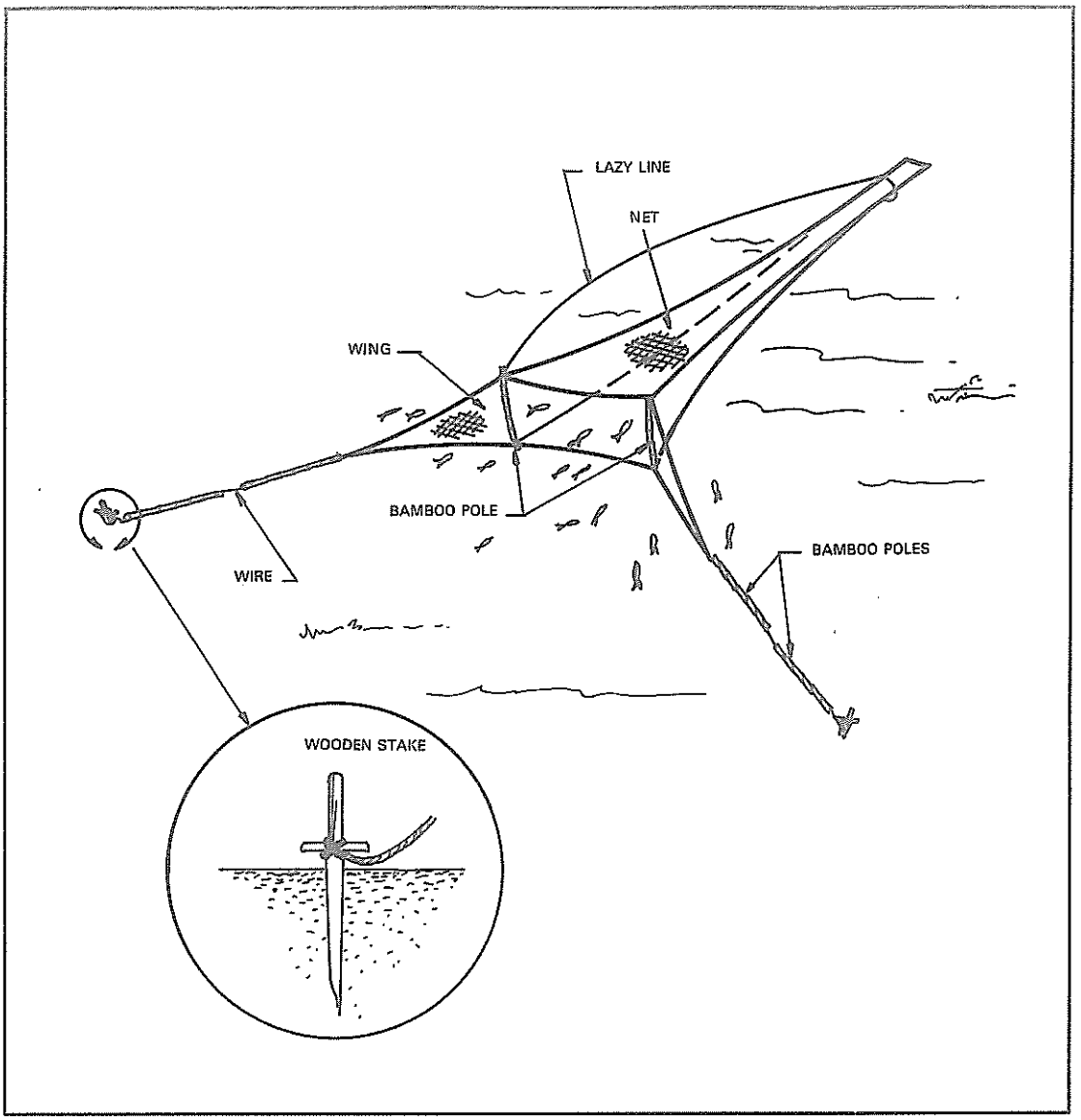
According to a pilot survey of the SBN fisheries of Bangladesh (Kashem and Iqbal, 1985), the number of MSBN in Sonadia was 549, in Mohipur 289 and in Dubla 2248, totaling 3086. According to the fisheries statistics of Bangladesh (DOF 1987/88), the total number of seasonal SBN, *i.e.* MSBN, was 5400. According to the pilot survey of this study in 1991, the total number of MSBN was estimated at 3852 (Table 22) — 65 per cent of them in Dubla, 24 per cent in Mohipur and only 11 per cent in Sonadia.

Table 22: Number and particulars of marine set bagnets used in different areas

Fishing area	*Gear class code*	*No. of gear*	*Width of opening (m)*	*Length of wings (m)*	*Length of net (m)*	*Depth of mouth opening (m)*	*Cod end mesh (mm)*	*Original cost (Tk)*
Sonadia	Glc	415	11 - 15	10 - 16	18.5-35	5 - 8	12-25	25,000-35,000
	Gld	7	15.5 - 20	15.5 - 20	35-40	7 - 8	15-25	30,000-38,000
Mohipur	Glc	930	10.2 - 12.8	10.2 - 11.4	18.3-25	3.2 - 4.6	12	9000-30,000
Dubla	Glc	2125	10 - 15	9 - 16	22-36	3.7 - 6.9	12-18	12,000-30,000
	Gld	375	15 - 23	15.5 - 23	34-36	6 - 6.9	15-18	30,000-35,000
TOTAL		**3852**						

The length of a MSBN varies from 18 to 40m. Its structure and shape and method of operation are similar to that of the estuarine set bagnet. The width of the mouth is given as the distance between poles, assuming that the distance between the poles is proportional to the area of the mouth and, consequently, the volume of water filtered by the gear. A diagram of the set bagnet operated in the marine sector is shown in Figure 24 (facing page).

Fig 24. Traditional set bagnet



The classification of the set bagnets in Bangladesh, as established during the estuarine set bagnet study (Shafiqul *et al.* 1992), is as follows:

Gear class code	*Distance between poles (m)*	*Mouth opening area (m^2)*
G1b*	<6	<15
G1b*	6-10	
18-50		
G1c**	10-15	50-90
G1d**	>15	>90

* (Estuarine, year round)
** (Estuarine and marine, seasonally)

G1c were dominant in all three areas, G1d were totally absent in Mohipur and G1d were less than 2 per cent of MSBN in operation in Sonadia.

20.2 *The craft*

Both motorized and nonmotorized craft are used in the MSBN fishery. The motorized craft are used both for fishing and as carrier boats. Details of different sizes and types of craft used in different areas are given in Table 23.

Table 23: Particulars of craft used in marine set bagnet fisheries in different areas

Area	*Type of craft*	*Length (m)*	*Engine power (hp)*	*Crew/ craft (no)*	*Gear/ craft (no)*	*Avg. life (yrs.)*	*Original cost (Tk x 1000)*
Sonadia	Motorized boat	>12	15-22	08-12	5-8	8-10	300-500
	Motorized countrycraft	>12	15-22	08-10	5-7	8-10	300-400
	SBN craft (nonmotorized)	8-12	-	06-08	3-4	5-6	050-060
Mohipur	Motorized boat	>12	15-22	07-10	5-10	8-10	350-500
	Motorized Countrycraft	>12	15-22	05-08	5-8	8-10	300-400
	SBN craft (nonmotorized)	8-12	-	02-03	2-3	6-8	011-025
Dubla	Motorized boat	>12	15-22	16-20	4-13	8-10	400-550
	Motorized countrycraft	>12	15-22	10-15	4-8	8-10	400-500
	SBN craft (nonmotorized)	8-12	-	06-08	3-8	5-7	040-055

Motorized countrycraft and other motorized boats have engines of 15-22 hp in all three areas. In Sonadia, nonmotorized countrycraft stay in the fishing grounds as long as the nets are in operation, subject to weather conditions, but the motorized craft are mainly used as carrier boats.

In Sonadia, 6-8 units of gear are operated by one motorized boat/countrycraft, while 3 or 4 units of the gear are operated by one nonmotorized boat. In Mohipur, 5-10 units and in Dubla, 4-13 units are operated by a motorized boat/countrycraft. On the other hand, a nonmotorized countrycraft operates 2 or 3 gear in Mohipur and 3-8 in Dubla (Table 23).

The MSBN craft categories are similar in all three areas. However, their costs vary with area, mainly due to differences in availability and quality of the timber used and also due to the purchase of secondhand engines for the motorized craft.

21. *RESULTS*

21.1 *Species composition*

There were 39 species/species groups identified in the MSBN catches, of which five were marine shrimp (penaeids), two freshwater prawn (palaemonids), one sergestid shrimp, one other non-penaeid shrimp (solinoceran) and thirty finfish.

A comparison of the major species/groups in the three areas during January 1991 is given in Table 24 (facing page). The largest share of shrimp/prawn in the catches was recorded in Mohipur (17.8 per cent), followed by Dubla (11.1 per cent). The share of Rainbow Shrimp (*Parapenaeopsis sculptilis*) was approximately half in both areas. Other major species of shrimp/prawn included a sergestid shrimp (*Acetes spp.*) in Mohipur, Yellow Shrimp (*M. brevicornis*) in Mohipur and Dubla, Kiddi Shrimp (*P. stylifera*) in Sonadia and a freshwater prawn (*Macrobrachium rudis*) in Dubla.

The finfish catches were dominated by the same three or four species in all areas, but their relative proportions varied between areas. In Sonadia, the Ribbonfish (*Lepturacanthus savala*) was dominant, followed by the Silver Pomfret (*Pampus argenteus*), Bombay Duck (*Harpodon nehereus*) and

Anchovy (*Setipinna phasa*). Anchovy was the dominant group in Mohipur, followed by Bombay Duck and Ribbonfish. Dubla had Bombay Duck as the predominant species, followed by Ribbonfish and Anchovy. The detailed species composition of all the species is given in Appendix III.

Data available from the BOBP-supported coastal set bagnet fishing trials and investigations (Akerman, 1986) on the monthly variation in the catch rate and percentage composition of main species in MSBN catches in Sonadia are presented in Table 25.

The share of shrimp/prawn in the MSBN catch in Sonadia decreased from November to February. The share of caridean prawn in the catches also dropped from November to February, while the penaeid shrimp (Yellow Shrimp and Rainbow Shrimp) were dominant in February. Among finfish catches, the share of Anchovy and Ribbonfish decreased from November to February, while that of Croaker increased. Bombay Duck contributed to over 50 per cent of the catch in December and January. A comparison of the species composition of MSBN catches in Sonadia between between January 1991 (Table 24) and January 1986 (Table 25) shows a reduced contribution of Anchovy and Bombay Duck and an increased contribution of Ribbonfish and Silver Pomfret in recent catches.

21.2 *Catch rate*

The mean catch rate (kg/haul) estimated for different months in the different areas, the average number of hauls per day, the average number of MSBN gear operating per day and the

Table 24: Major species/groups in the MSBN catches in the three areas during January 1991 (percentage by weight)

	Species/Group	*Sonadia*	*Mohipur*	*Dubla*
a)	**Shrimp/Prawn**			
	Rainbow Shrimp	0.2	8.6	5.9
	Sergestid shrimp	—	4.3	—
	Yellow Shrimp	—	2.9	2.1
	Kiddi Shrimp	2.6	—	—
	Freshwater prawn	—	0.7	—
	M. rudis		*1.1*	*3.1*
	Others	2.0	0.2	
	Subtotal	**4.8**	**17.8**	**11.1**
b)	**Finfish**			
	Anchovy	4.1	28.6	9.1
	Bombay Duck	5.4	25.4	52.3
	Ribbonfish	55.5	5.4	21.0
	Silver Pomfret	7.2		
	Others	23.0	22.8	6.5
	Subtotal	**95.2**	**82.2**	**88.9**

Table 25: Species composition and CPUE (kg/haul) of MSBN at Sonadia during 1985/86

	Month							
	Nov. '85		*Dec. '85*		*Jan. '86*		*Feb. '86*	
Species	*kg/ haul*	*%*	*kg/ haul*	*%*	*kg/ haul*	*%*	*kg/ haul*	*%*
A. Shrimp								
Metapenaeus brevicornis	1.6	1.9	1.2	1.8	0.2	0.5	3.9	8.1
Parapenaeopsis sculptilis	0.1	0.1	0	-	0.2	0.4	1.6	3.3
Other penaeids	-	-	-	-	-	-	0.8	1.7
Subtotal	**1.7**	**2**	**1.2**	**1.8**	**0.4**	**0.9**	**6.3**	**13.1**
Palaemon styliferus	13.8	16.3	2	3.1	0.8	1.8	-	-
Other carideans	10.3	12.2	1.4	2.1	0.6	1.4	-	-
Acetes spp.	0.7	0.8	-	-	-	-	-	-
Subtotal	**24.8**	**29,3**	**3.4**	**5.2**	**1.4**	**3.2**	**-**	**-**
B. Finfish								
Arius spp.	-	-	-	-	0.7	1.6	-	-
Setipinna phasa	36.9	43.7	18.6	28.7	12.4	28.2	4.7	9.7
S. taty	0.2	0.2	-	-	-	-	-	-
Coilia dussumieri	2.7	3.2	0.8	1.2	0	-	2.7	5.6
Thryssa spp.	0.2	0.2	-	-	-	-	-	-
Subtotal	**40.0**	**47.3**	**19.4**	**29.9**	**13.1**	**29.8**	**7.4**	**15.3**
Harpodon nehereus	1.4	1.7	32.5	50.1	22.6	51.5	7.4	15.3
Polynemus spp.	-	-	-	-	0.6	1.4	-	-
Croakers	2.0	2.4	2.8	4.3	4.5	10.3	18.9	39.1
Pampus argenteus	2.0	2.4	-	-	0.1	0.2	-	-
Lepturacanthus savala	10.8	12.8	5.6	8.6	0.3	0.7	1.2	2.5
Others	1.8	2.1	0.4	0.1	0.9	2.0	7.1	14.7
TOTAL	**84.5**	**100.0**	**64.9**	**100.0**	**43.9**	**100.0**	**48.3**	**100.0**

number of active fishing days during each month are given in Table 26. There was no significant difference between the catch rates of MSBN categories G1c and G1d.

Table 26: Catch rate (kg/haul) and total production by marine set bagnets in different areas

Area	*Period*	*Catch rate (kg/haul)*	*Hauls (no/day)*	*Gear in operation (no/day)*	*Fishing effort (days/ month)*	*Monthly production (t)*	*Fishing season (months/ year)*	*Seasonal production (t)*	*Areawise production (t/year)*	*Total MSBN production (t/year)*
Sonadia	Sept.	107.94	4	320	9	1,243				
	Oct.	67.07	4	355	18	1,714				
	Nov.	84.59	4	380	22	2,829				
	Dec.	64.90	4	370	22	2,113				
	Jan	47.93	4	362	20	1,272				
	Feb.	48.37	4	325	9	565	5	9,736	9,736	
Mohipur	Mid-Oct. to mid Jan. (peak)	11.90	4	777	22	814	3	2,442		
	Mid Jan to mid March (lean)	7.80	4	650	18	365	2	730	3,172	
Dubla	Dec. (peak)	47.50	4	2125	22	8,883	1	8,883		
	Jan. to Feb (lean)	16.00	4	1875	18	2,160	2	4,320	13,203	
TOTAL										**26,111**

In Sonadia, where the available monthly catch rates for 1985/86 — have been utilized in the present study, the catch rate peaked in September and declined steadily towards February. In the other two areas, catch rates were not available on a monthly basis, but two mean catch rates were estimated for lean and peak seasons in both areas. For most months, the monthly mean catch rates obtained for Sonadia were very much higher than those obtained for the lean and peak seasons in Mohipur and Dubla.

Notable seasonal variations in the catch rate of major species/groups in Sonadia included decreased catch rates of Caridean Shrimp, Anchovy, Silver Pomfret and Ribbonfish from November to February and increased catch rates of Rainbow Shrimp, Yellow Shrimp and Croakers over the same period. Bombay Duck showed a peak catch rate in December which declined towards February.

21.3 *Production*

The estimated annual production was 9736 t for Sonadia, 3172 t for Mohipur and 13,203 t for Dubla. Peak production was from October to December, October to January and in December for the three areas respectively. Total production for MSBN was estimated to be 26,111 t (Table 26) and production by area is shown in Figure 25.

21.4 *Size ranges of major species*

The size ranges of major penaeid shrimps and finfish caught in the MSBN fishery, based on information collected in 1983-1986, 1987 and 1991 are presented in Figure 26.

The penaeid shrimps were mostly 3-17 cm in length, except for the Tiger Shrimp (*P.monodon*) and Banana Shrimp (*P.merguiensis*), which occurred at size ranges of 12-23 cm and 8-19 cm, with predominant sizes 19-20 cm and 15-16 cm respectively. Length range of Brown or Speckled Shrimp (*Metapenaeus monoceros*) was 6-13 cm, with predominant size 9-13 cm.

Size ranges of finfish were 2-43 cm, except Ribbonfish which occurred in the size range of 14-103 cm (predominant sizes being 20-32 cm and 60-68 cm). The size ranges of Bombay Duck, Silver Pomfret and Croaker were 4-32 cm, 9-35 cm and 2-33 cm respectively, with the predominant sizes 8-14 and 22 cm, 22-24 cm and 5-10 cm.

Fig 25. Total number of hauls per year, the annual production and the gross value of the production of the marine set bagnet fishery (1991, Sonadia 1983-'86, '87, '91)

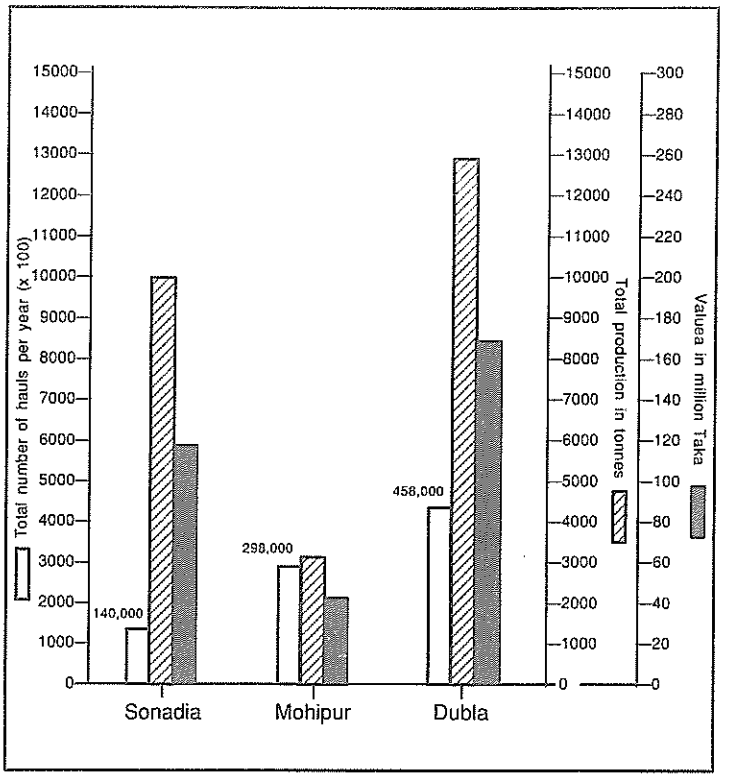
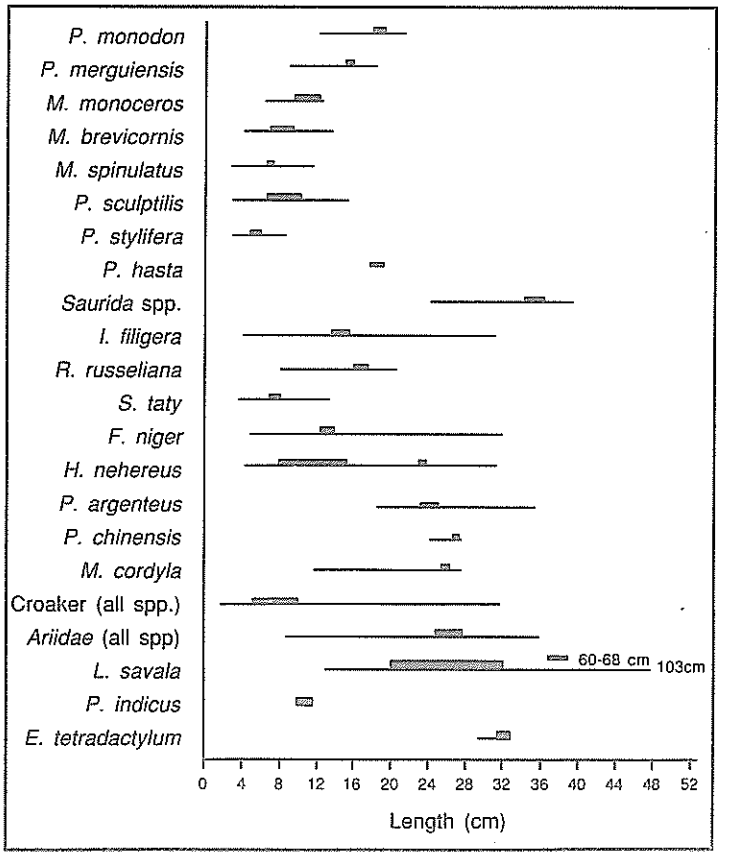


Fig 26. Total length range and predominant length range of major shrimp and finfish in marine set bagnet catches from Sonadia (1983-'86, '87, '91), Mohipur (1991) and Dubla (1991)



22. *ECONOMICS OF THE FISHERY*

22.1 *Prices of shrimp and fish*

Price of Indian White Shrimp *(P. indicus)* was higher in Sonadia than in the other two areas, while Brown Shrimp fetched higher prices in Mohipur. Price of dried fish is not much different in the three areas (Figure 27). Silver Pomfret fetched the highest price in all three **areas.**

Seasonal differences in the value of shrimp and finfish in Sonadia are shown in Table 27.

Flg 27. Price (Tk/kg) of wet shrimp and dry fish from the marine set bagnet fishery in different areas (1991)

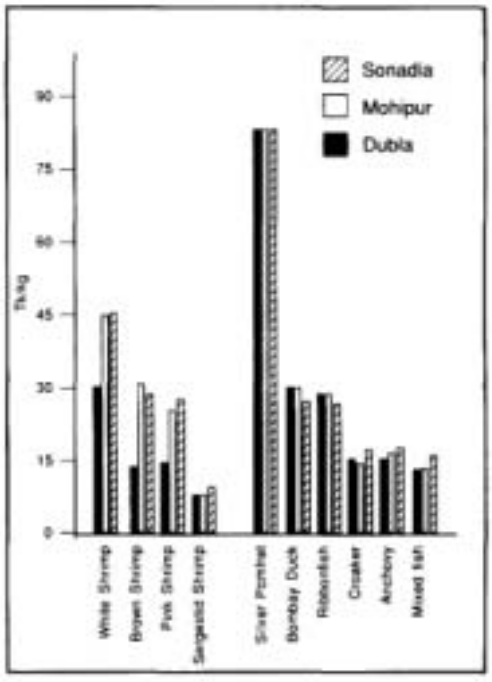


Table 27: Value of dried fish/shrimp and gross earnings at Sonadia (Tk/haul)

		Sep.		*Oct.*		*Nov.*		*Dec.*		*Jan.*		*Feb.*	
Name of spp group	*Price (Tk/kg)*	*Weight* (kg/haul)*	*Value (Tk/haul)*	Weight* (kg/haul)	Value. (Tk/haul)	Weight* (kg/haul)	Value (Tk/haul)	Weight* (kg/haul)	Value (Tk/haul)	Weight* (kg/haul)	Value (Tk/haul)	Weight* (kg/haul)	Value (Tk/haul)
Pomfret	85	—	—	0.95	80.75	1.20	102.00	—	—	0.05	4.25	—	—
Ribbonfjsh	22	1.59	34.98	5.11	112.42	6.47	142.34	3.35	73.70	0.21	4.62	0.71	15.6
Bombay Duck	25	9.97	249.25	0.70	17.50	0.88	22.00	19.48	487.00	13.57	339.25	4.47	111.75
Anchovy	15	9.97	149.55	19.06	285.90	24.01	360.15	11.63	174.45	7.45	111.75	4.47	67.05
Croaker	IS	25.39	380.85	0.91	13.65	1.15	17.25	1.66	24.90	2.72	40.80	11.38	170.70
Mixed shrimp	25	8.39	209.75	12.30	307,50	15.50	387.50	2.81	70,25	1.08	27.00	3.76	94,00
Misc.	7	9.45	66.15	1.18	8.26	1,49	10,43	0.02	0.14	1.28	8.96	4.23	29.61
Total		64.76	1090.53	40.21	825.98	50.70	1041.67	38.95	830.44	26.36	536.63	29.02	488.73
Hauls/day			4		4		4		4		4		4
Fishing days/ month			9		18		22		22		20		9
Gross earning/ month/net			39,259.08		59,470.56		91,666.96		73,078.72		42,930.40		17,594.28

* **Dried** weight *i.e.* 60 per cent of wet weight.
* **All shrimp** prices **at dried** shrimp **rates.**

22.2 *Costs and earnings*

An owner of a MSBN and supporting craft is locally known as a *hahardar*. He organizes the fishing units and may use his own craft and gear or, sometimes, hires craft and other equipment for the fishing season. At Sonadia, remuneration is based on a share system, but in Mohipur and Dubla

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both share and wage systems were observed. One, or a combination, of the two systems is applicable in all three areas. In the share system, the net income is divided into 74 shares and distributed as follows:

A. ***Bahardar's* shares**

Boat (I motorized)	2	shares
Set bagnets (15 units)	30	shares (2 shares per net)
Personal share as shore manager		
Subtotal	33	

B. Crew shares

Majhi (1 no.)	1.5	shares
Majhi (2 nos. for rented boat)	3.0	
Engine driver (2 nos.)	2.5	(1.25 share per driver)
General crew (28 nos.)	28.0	(I share each)
Shore labour (6 nos.)	6.0	(I share each)
Subtotal	**41.0**	
Total	74	

The *bahardar* generally bears all expenses and these expenses are deducted from the gross revenue before the net revenue is shared. A typical operating unit comprises of two motorized craft (one generally rented) and one rented nonmotorized craft. These are used to operate 15 set bagnets. Table 28 (next page) and Figure 28 give details of the gross revenue, and costs. The operational cost includes hire of two craft, craft and gear repair, fuel, food, firewood, utensils, bamboo mats, drying racks, jute piling etc.

The costs, expenditure, profit and crew share for **the entire fishing season** for one net were as **follows:**

		1k
Gross revenue	=	323,999
Total costs	=	61,956
Net revenue	=	262,043
Income to owner (33 shares)	=	116,856
Income from one net to all crew (41 shares)	=	145,186
Income per crew member for keeping 15 units of gear (145,186 x 15) / 41	=	53,117

In Sonadia, the resulting average net income per crew member per month was 1k 8934, with the highest in November (Tk 16,488) and the lowest in February (Tk 1473). Earnings increased until November and then decreased to February.

Fig **28. Costs and earnings analysis and** net Income of *behardar* **and**

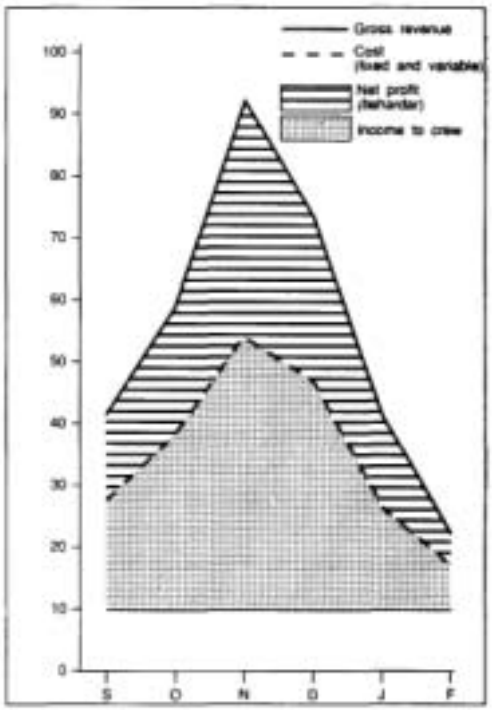

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Table 28: Capital and operational **cost of marine set bagnet unit at Sonadia (share system)**

I. INVESTMENT COST

		Tk
1.	One motorized fish carrier boat	400.000
2.	15 set bagnets (Each Tk.30.000)	450.000
	Total	850,000

Depreciation	*Yearly (6 month* fishing)	*Monthly* (15 *net)*	*Monthly per net*
* Craft (10 years)	20,000*	3,333	222
Gear (5 years)	90.000	15,000	1.000
Operating cost	819,400	136,567	9,104
Total		154,900	10,326

Outs 50% of depreciation accounted for the fishery and the balance 50% attributed to other fisheries conducted during the remaining 6 months.

11. OPERATIONAL COST (including fish drying and shade-making materials)

		Taka
1.	Piling	6.800
2.	Bamboo	35,240
3.	Jute	18,000
4.	Miscellaneous rope.nut,bolt.wire etc	170.610
5.	Utensils	8.750
6.	Food items (including fire wood)	67.777
7.	Diesel. Lub. oil	150,123
8.	Mat	16,800
9.	Boat and net repair	225.900
10	Boat hire charge two boats)	110.000
		819.400

The craft **is** used in other months as a carrier boat. on a rent basis.

It was noted during the survey period that the shrimp catch, especially of exportable varieties was very low, and, hence, the price of shrimp was included under dried shrimp (Table 27). Normally, all the fish are sold after drying. When the fishing season ends, the drying racks, platforms and materials used in the fabrication of temporary shelter were auctioned by the *hahardar*. as these materials had been paid for by him.

As in the estimation of production from the catch per haul, for each area, the average value of a haul was raised for each area and for the season. The estimated total value of the annual production by marine set hagnets was. Tk 117.578,657. TK 35,686.378 and TK 168.353.011 in Sonadia. Mohipur and Dubla respectively (refer Figure 25).

23. *CONCLUSIONS*

The present study indicates that the marine set hagnet fishery contributes about 26.000 t of fish and shrimp. This is higher than the estimate of 17,000 t reported in the statistics of the Department of Fisheries, A total of 3852 units of gear are operated as approximately 250 operational units (each with 15 units of gear). considering that a minimum of 40 people are engaged in each MSBN operational unit — for fishing, processing and marketing of the catch approximately 10,000 people arc estimated to he directly engaged in these activities in the MSBN fishery.

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24. *REFERENCES*

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APPENDIX III

Species **composition of MSBN catches in three areas, during the month of January,** 1991 **(by weight)**

	Species/species group	Sonadia	Mohipur	Dubla
SHRIMP/PRAWN				
I.	***Penaeus indicus***	-	**0.1**	-
2.	***Metapenaeus brevicornis*** (Yellow Shrimp)	.	2.9	2.1
3.	***M. spinulatus***	1.5	0.1	-
4.	***Parapenaeopsis sculptilis*** (Rainbow Shrimp)	0.2	8.6	5.9
5.	***P. stylifero*** (Kiddi **Shrimp)**	2.6	.	-
6.	***Macrobrachium rudis*** (Freshwater Prawn)	.	**0.7**	**3.1**
7.	***Palaemon* spp.**	.	**1.1**	
8.	***Acetes* spp.** (Sergestid Shrimp)	.	4.3	
9.	***Solenocera* spp.**	**0.4**		
	Subtotal	4.8	17.8	11.1
FINFISH				
I.	***Arius* spp.**	**2.5**		
2.	***Hilsa ilisha***	**0.1**		
3.	***Ilisha filigera***	**4.1**		
4.	***Chirocentrus dorab***	**0.1**		
5.	***Raconda russeliana***	.	**3.5**	**2.4**
6.	***Coilia dussumieri***	**2.4**	**2.5**	
7.	***Setipinna phosa*** **(Anchovy)**	**4.1**	**28.6**	**9.1**
8.	***S. taty***	**0.1**	1.4	
9.	***Stolephorus in***	-	2.8	-
10.	***Cynoglossus* sp.**	**0.4**	**0.7**	
11.	***Formio niger***	**0.0**	-	
12.	***Harpadon nehereus*** (Bombay Duck)	**5.4**	**25.4**	**52.3**
13.	***Kirtus indicus***	**0.3**		
14.	***Leiognaihus* spp.**	**1.5**	**2.8**	**1.1**
15.	***Megalaspis cordyla***	**1.5**		
16.	***Polynemus paradiseus***	.	**0.7**	
17	***P. sextarius***	.	**0.2**	
18	***Polynemus* spp.**	.	**0.0**	
19.	***Pomadasvs hasta***	**0.4**	**0.2**	
20.	***Pampus argenleus*** (Silver Pomfret)	**1.2**		
21.	*Croaker*	3.2	1.3	0.8
22.	***Muraenesox talabonoides***	3.2	-	
23.	***Lepturacanthus sarala*** (Ribbonfish)	**55.5**	**5.4**	**21.0**
24.	***Tnichiurus lepiurus***	**0.4**	.	-
25.	Crab	1.0	4.0	1.0
26.	Squilla	0.0		
27.	Sepia	0.6	-	
28.	Loligo	0.4	-	
29.	Jellyfish	0.6	-	
30.	Others	0.2	2.7	1.2
	Subtotal	95.2	82.2	88.9
	TOTAL	100	100	100

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THE TRAMMELNET FISHERY

by

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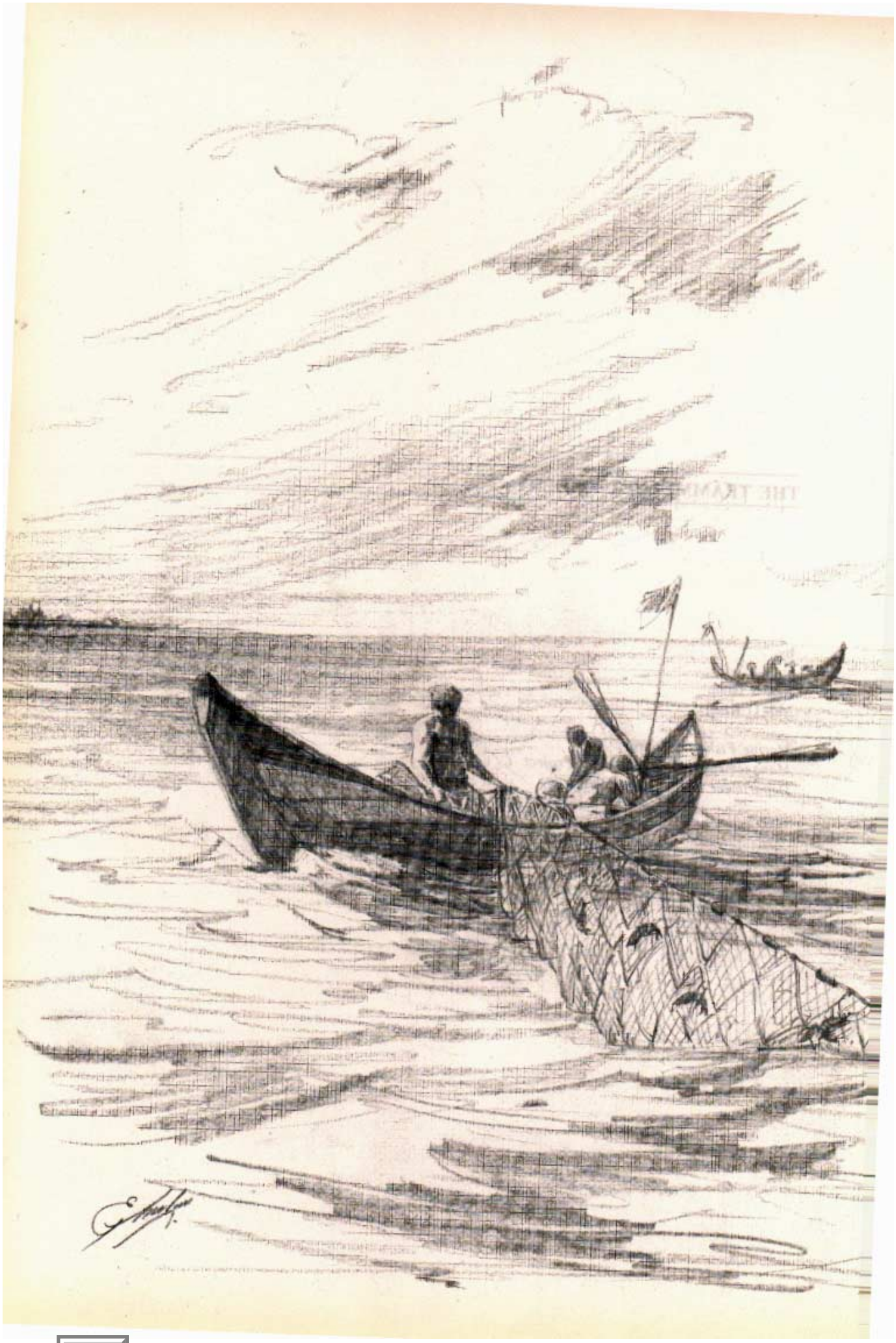

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25. *INTRODUCTION*

The trammelnet, perhaps about 100 years old in the Mediterranean Sea, was introduced in the Bay of Bengal region about a decade ago, spreading from Thailand to Malaysia, Indonesia, Shri Lanka and India in one direction and through Myanmar to the southeast coast of Bangladesh in late 1982. In Shri Lanka, this fishery is well developed and it has now spread to India. A boat development project in Kerala recently urged fishermen to pay greater attention to trammelnets, because of their high earning capacity. Though this net has long been operated in the Mediterranean for flatfish fishing, it is more popularly used for shrimping in the shallow waters of the Bay of Bengal.

Due to the effectiveness of the gear and its operation, as well on account of its profitability, the fishermen of the Teknaf coast of Bangladesh became interested in trammelnetting and began to buy gear from Myanmar fishermen. The fishery, thus, spread upto the Maiskhali Island coast. Reliable information on the number of units in operation, the fishing effort and production etc. of this fishery are not available, except for some preliminary observations by Islam *eta!*. (1987, 1988) and Khan and Rahman (1990). Islam (1991) also carried out a year-long study in 1988-89 on the trammelnet fishery in Bangladesh.

A study of the trammelnet fishery along the southeast coast of Bangladesh was carried out between November 1989 and October 1990. Fishing effort, size and composition of selected species of shrimp and finfish caught, and an estimate of the annual production from this fishery are presented in this paper.

The study was undertaken as a supplementary activity with very limited time allocation. As such, the results are of a preliminary nature.

26. *METHODS*

26.1 *Census*

An enumeration of the number of trammelnets in use and their distribution at landing points between Teknaf and Chittagong was made in February 1991 (Figure 29, see overleaf).

26.2 *Sampling programme*

Biological sampling of the catch by trammelnets was conducted once a month, at the Maiskholipara landing centre at Teknaf, for catch rate, catch composition and length frequencies of the four major shrimp species, and size ranges of other penaeid shrimp, spiny lobster and 13 finfish species. Information regarding economic aspects of the fishery was collected with the help of specially prepared questionnaires used while interviewing the fishermen.

Biological sampling began in November 1989 and continued till October 1990 (except in February 1990), following the lunar calendar and the set bagnet fishery survey schedule. There was no fishing on the scheduled sampling days in April, May and June, due to rough weather conditions. Fishermen also avoided fishing in October, because of low catch rate.

26.3 *Estimation of production*

Annual production was estimated from the data on average catch rate (kg/boat/day), average number of nets operated per day in each month, number of active fishing days in each month and number of active fishing months in a year. This information was collected through questionnaires used while interviewing the fishermen during the catch-sampling visits.

See catch composition. Section 3.5

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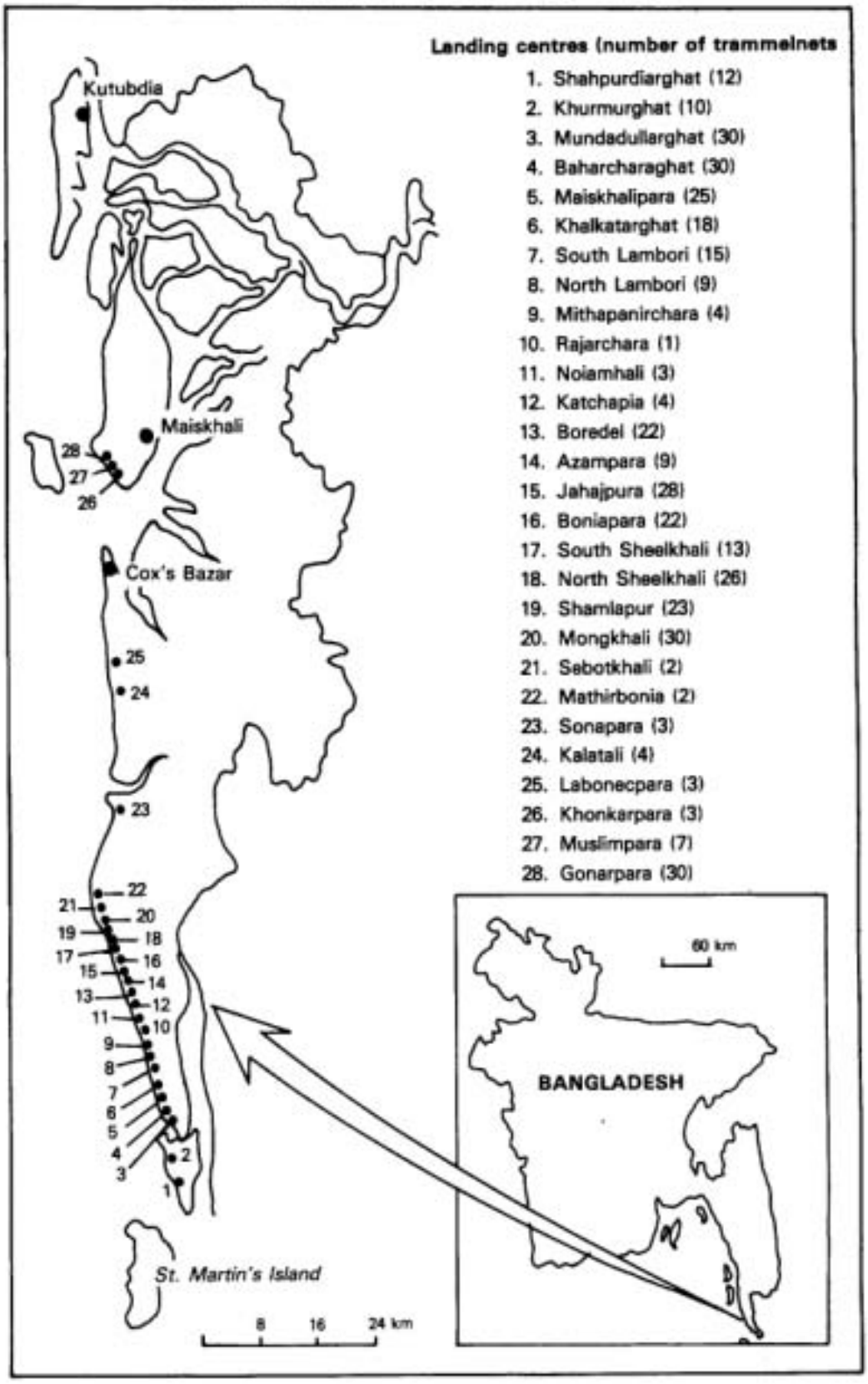
Fig 29. Landing centres of the trammelnet fishery in Bangladesh



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26.4 *Identification of species*

For identification of shrimp and finfish, DalI (1956), Day (1989), Fisher and Bianchi (1984) and George (1969) were consulted.

26.5 Cost and earnings estimation

Information on fixed and variable costs, prices of shrimp and fish caught by trammelnets, the profit-sharing system marketing channels etc. was collected by interviewing the trammelnet fishermen during the monthly catch-sampling field visits. Questionnaires were again used.

27. RESULTS

27.1 *The fishing gear*

The trammelnet has been described in Khan and Rahman (1990). The special feature of this gilinet is that it has three panels attached to the same head and groundropes. The two outer panels have large meshes (150-265 mm) while the inner or middle panel has small meshes (40-45 mm). The height of the outer panels is 1.8 m, while the inner panel has a height of 2.25 m and, therefore, hangs with a considerable slack. When a fish pushes through the inner small-mesh panel, it is easily entangled in a bag formed with the help of the outer panels.

The outer panels are made with twine of size 210 d 6 while the inner panel is of twine of size 210 d 2. The groundrope of the net contains lead sinkers of 5mm diameter, placed at an average interval of 20cm. The floats on the headrope are of 27mm diameter and are placed at an average interval of 65cm.

A complete trammelnet set generally consists of 16 to 25 pieces. The majority of the sets have 18-20 pieces. The length of each piece of net is around 28m and each net costs Tk 1000-1200. Locally made nets cost less. The average life of a trammelnet is 4-5 years, with periodic mending or partial replacement of panels.

27.2 *The fishing craft*

The trammelnet fishermen generally use 8-10 m long open wooden craft of the dinghy type, powered by oars and sail. Each boat normally has one trammelnet set. A crew of five **or six** fishermen row the boat. The prices of the boat vary between 1k 5000 and 1k 8000 and their average life is 8-10 years.

27.3 *Fishing area and operation*

In Bangladesh, the trammelnets are operated in the shallow coastal areas at depths of 8-20 m and about 3-20 km from the fishing base. The area of operation depends on seasonal conditions. The rocky bed of St. Martin's Island is close to most fishing areas of the Teknaf coast and the fishermen try to avoid the rocky bed as it damages their gear.

From the census carried out, it was estimated that 400 trammelnet sets were operating from 28 fishing centres between Teknaf and Maiskhali Island (Figure 29). The fishermen sail out in the early morning and often return in the afternoon. Some fishermen from Maiskhali Island conduct night fishing and return the next morning.

The trammelnets were mainly concentrated in the Teknaf region, where the fishing centres were also close to one another (see Figure 29). Only a few trammelnets were operated in Cox's Bazar and Maiskhali.

27.4 *Fishing effort*

All 400 sets were not operated every day. The fishing pattern depended on tides, climatic conditions and season. The minimum number of boats operated trammelnets during the rainy season and the maximum number in winter when the sea was calm. Thus, the number of fishing days a month depended on both the catch rate and seasonal changes in sea conditions. The soaking time was 3-5 hours/day.

'US $ 1 = 32 Tk appx. (1991-92).

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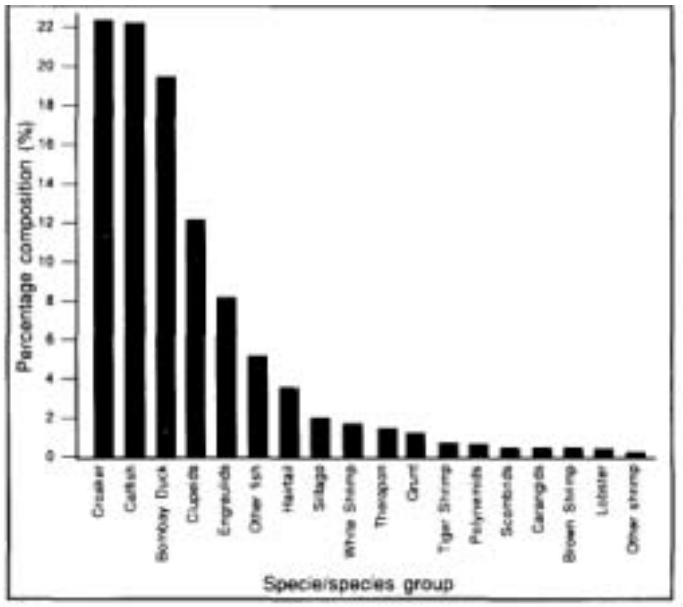
The fishermen operated trammelnets for about 140 days during seven active fishing months and the total trammelnet fishing effort was estimated to be around 34,300 boat-days/year. The maximum fishing effort was during January and the lowest in November.

27.5 *Catch composition*

Seven species of penaeid shrimp, one species of spiny lobster and 29 species/groups of finfish were found in the trammelnet catches during the sampling period. Shrimp, lobster and finfish comprised 2.4 per cent, 0.1 per cent and 97.5 per cent respectively in the annual catch composition, by weight. Demersal fish were more prominent in the catches than pelagic fish in all seasons and contributed to more than 76 per cent of the total catch during the study (Figure 30).

Fig 30. Annual percentage species composition of trammelnet catch



Among the shrimp, the Tiger Shrimp *(P. monodon)*, Indian White Shrimp *(P.indicus)* and Brown Shrimp *(M. monoceros)* were the major species. Tiger Shrimp and Indian White Shrimp contributed 0.4 per cent and 1.6 per cent respectively to the catch during the year.

Croakers (Sciaenidae) and Catfish *(Ariius* spp.) were the predominant species groups, more than 21 per cent each, whereas Bombay Duck *(H. nehereus)* were 19.3 per cent of the catch. Sardine *(Clupeids)* and Anchovy *(Engraulids)* were 10 per cent and 2 per cent respectively. Bigeye Shad *(I. filigera)* and Smoothmouth Herring *(R. russeliana)* were the most predominant species among the clupeids, while Anchovy *(Thryssa* spp.) and Hairfin Anchovy *(Setipinna* spp.) were the major contributors of the Engraulid group. Hairtail or Ribbonfish *(L. savala)* were a bit more than 3.6 per cent, and Whiting *(Sillago)* were around 2 per cent, followed by Grunts *(Pomadsys* spp.). Therapons (Theraponida), Threadfin (Polynemidae), Mackerel (Scombridae) and jack/trevally (Carangids) only occurred very sporadically.

27.6 *Catch rate*

The catch rate varied from a minimum of 19.2 kg/day/boat in November to a maximum of 90.5 kg/day/boat in December. The annual average was 51.14 kg (Figures 31c and d).

The catch rate of penaeid shrimp was maximum in December, 5.6 kg/boat/day, and minimum in April (0.1 kg). Indian White Shrimp was the predominant species, but Tiger Shrimp was noticeable in November (Figure 31a). Among the finfish species, Bombay Duck had a catch rate of 60 kg/day in August, followed by Croakers with 44 kg in December and 16 kg in January. Clupeids (Herrings/Sardines), followed with 15 kg and 14 kg in December and January. Catfish were predominant in March, April and December, with around 10-12 kg. Engraulids (Anchovy) were predominant from August to December (Figure 31b).

27.7 *Production*

The production from the trammelnet fishery for the year November 1989 - October 1990 was estimated at 1754 **t** for 34,288 boat-days (Figure 3 Id). As shrimp made up 2.3 per cent of the total catch, the annual landing of shrimp from this fishery was estimated as 41 **t,** of which Tiger and White Shrimp were an estimated 6 **t** and 27 **t** respectively.

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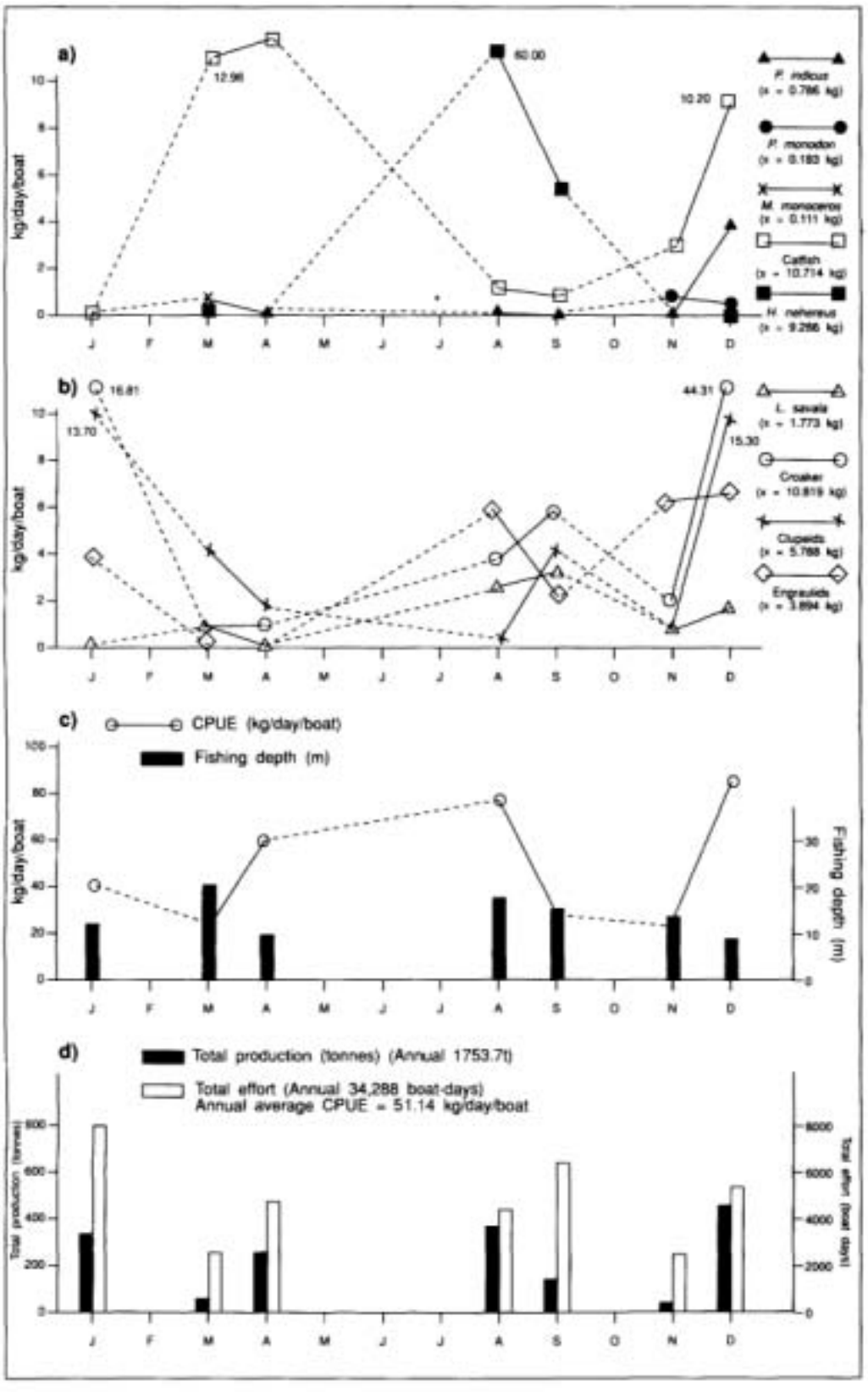
Fig 31. Monthly catch rates of shrimp and linfush species/species groups (a & b), catch rate and fishing depth (c) and total fishing effort and production (d)



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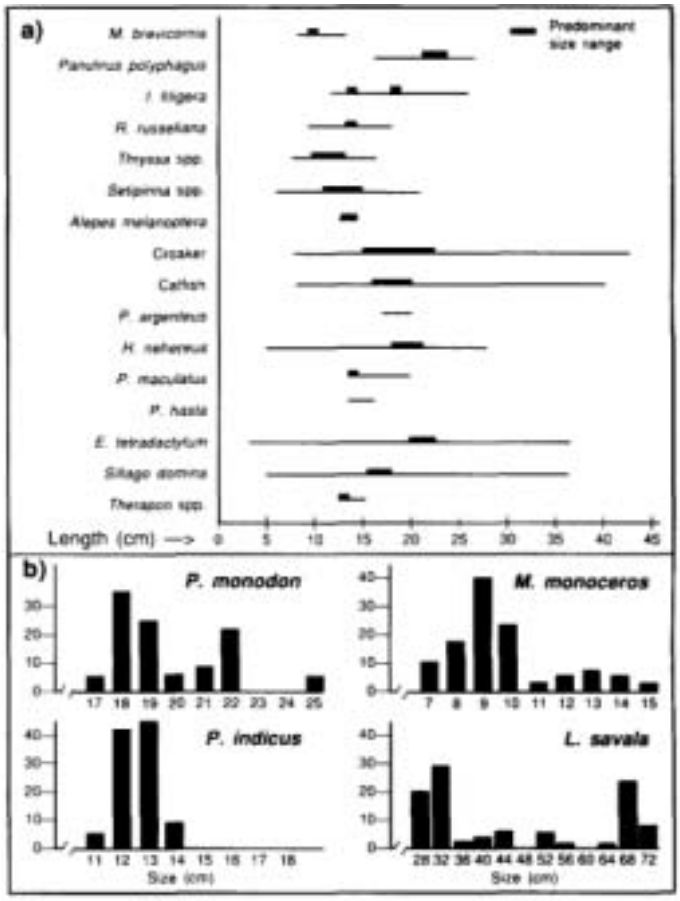
27.8 *Size composition*

Size frequencies of shrimp and size ranges of finfish captured by trammelnet during the study are shown in Figures 32a and b.

Most shrimp and finfish were caught at sizes that were 40 per cent and more of their maximum lengths recorded in the region. Most of the shrimp caught in this fishery were in their preadult and adult stages.

Fig 32. (a) Size ranges and predominant size ranges of major shrimp, lobster and finfish caught In the trammelnet fishery and (b) Size composition of P. *monodon, P. indicus, M. monoceros* and *L. savala*



27.9 *Cost and earnings*

SHARE SYSTEM

Most trammelnets and boats are owned by the better-off people of the fish landing localities. They are locally known as *bahardars.* The fishermen are paid on a share basis, after deducting incidental expenses, which are generally small amounts. If the owner is also a member of the crew, he gets an extra crew share. There were also a few cases of fishermen jointly owning a set or sets of gear and one or more supporting craft.

When the net revenue from the landed catch exceeds Tk 500, 50 per cent of it goes to the owner of the gear and craft and the remainder is divided equally among the fishermen. If the gross income is between Tk 200 and 500, then a fixed amount of Tk 200 is shared among the fishermen and the rest of the money goes to the owner. When gross revenue falls below Tk 200, all of it is distributed equally among the fishermen, without any payment to the owner. This is a traditional sharing system.

MARKETING

Catch is sold on a wholesale or retail basis to the middlemen at the landing centre. Middlemen sell the fish at local markets. Exportable shrimp are sometimes sold at a reasonable price to representatives of a freezing plant from whom the fishermen borrow money for capital and operational costs. Croakers also have a special demand from factories drying them for export.

COST AND EARNINGS ANALYSIS

In most months, the *hahardars* earn a good income from this fishery, with maximum earnings in December and minimum in March. The gross income of a boat per day during the study varied from Tk 128 to Tk 3896, with the average gross revenue per boat per day being 1k 1036. The deductible expenses being very small, the net revenue would be almost equal to the gross revenue.

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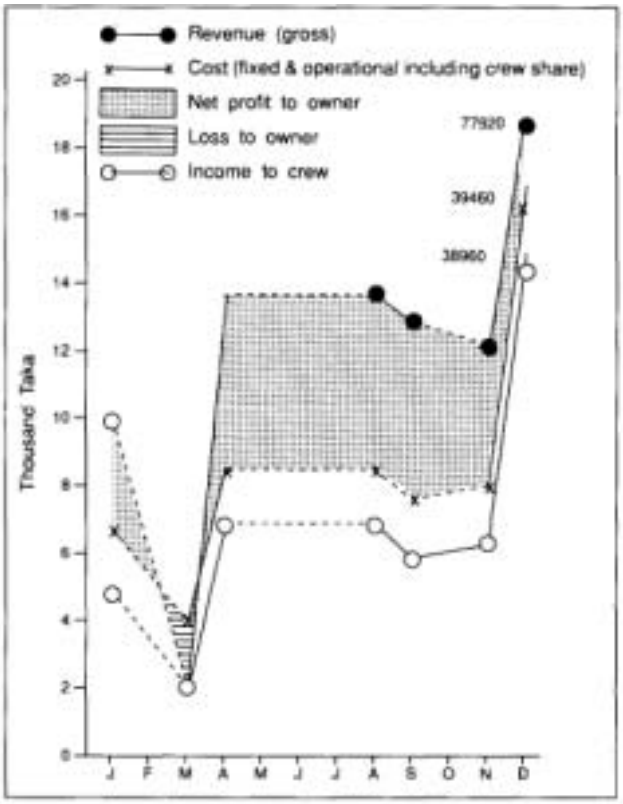
The average annual gross earnings per boat was Tk 143,664 in seven fishing months and the annual income of the owner, after deducting the fixed costs (including depreciation, repair and maintenance cost of craft and gear — about Tk 9000) was Tk 59,437. The operational costs are generally incidentals such as tobacco and minor food items. During the period of the study, the trammelnet fishery was profitable in all months except in March, when there was a loss due to a decline in the catch rates of the more valuable species (Figure 33).

Fig 33. Monthly cost and earnings analysis of trammelnet fishery



28. *DISCUSSION*

The catch composition of the present study is somewhat similar to that of the earlier studies by Islam *et al.* (1987) and Islam (1991). Catch rates of White Shrimp *(P. indicus)*, Croaker, Catfish and Bombay Duck were higher in the earlier studies. Islam *et al.* (1987) observed the catch rate of Banana Shrimp *(P. merguensis)* in the October 1987 trammelnet catch to be 0.4 kg/boat/day (0.3 per cent), with a size range of 14-17 cm and a predominant size class of 14-15 cm. During the 1988/89 survey, the catch rates for this species was 0.03 kg/boat/day (0.1 per cent) in September and 0.7 kg/boat/day (1.6 per cent) in November, with a size range of 10-15 cm and a predominant size class of 13-14 cm. However, during the present study, this species did not occur in the trammelnet catches. It must also be mentioned that Banana Shrimp is one of the major species of penaeid shrimps in Myanmar waters (Price and Htin 1984).

Most shrimp and fish caught exhibited more or less similar size ranges and predominant size classes. They were mostly preadults and mature individuals. The penaeid shrimp caught by this gear were, on an average, fairly large in size and contained much less juveniles and immature individuals. It would appear that the trammelnet is a selective gear.

The number of fishing days and fishing months per year may vary from year to year, because of annual variations in weather and sea conditions. The production estimated during the year of study (1989-90) was 1754 **t** for 34,288 boat days *(i.e.* 51.1 kg/boat/day), whereas Islam (1991) estimated about 618 **t** for 19,720 boats/days/year in 1988/89 (31.3kg/boat/day). These figures indicate that both the effort and the catch per unit effort have increased, as only to be expected in a developing fishery. Khan and Rahman (1990) roughly estimated the annual production by the trammelnet fishery to be in the range of 27,000-36,000 **t,** assuming that 1500-2000 units of the gear are in operation for 270,000 to 360,000 boat days per annum. This over-estimation was based on information supplied by the fishermen during a few visits to the field.

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It was learnt from the fishermen that there had been a rapid increase in the numbers of trammelnets over the last few years, but this rate of increase had somewhat reduced at present. This may be due to nonavailability of the gear, resulting from strong checks at the border between Bangladesh and Myanmar. It was also learnt that some trammelnets are made locally, but these are not popular.

29. *CONCLUSION*

The trammelnet, now operated by country boats, seems to be an efficient and economical gear for inshore capture fisheries.

Most catches are preadult and adults of selected species of shrimp and finfish. Hence this type of artisanal fishery does not seem to be destructive to the shrimp and fish stocks.

If motorized boats are used in this fishery, fishing may be extended to much deeper fishing grounds for better catches and revenue.

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THE BOTTOM TRAWL FISHERY

by

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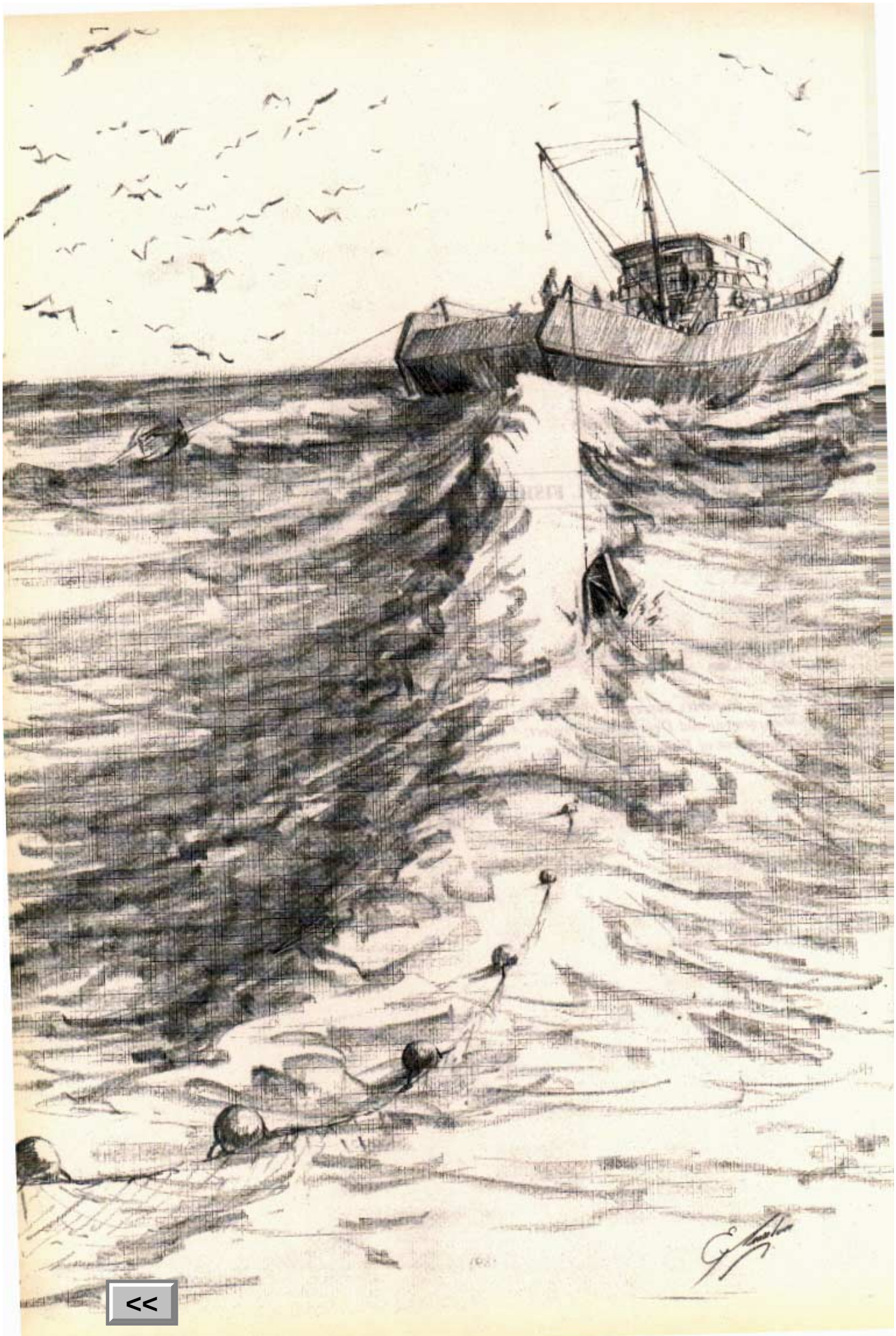

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31. *INTRODUCTION*

Commercial trawling with large vessels (21-41 m length) commenced around 1978/79 in Bangladesh. Initially there were only four trawlers, but there was a rapid increase to about 130 in 1980-81, as a result of a joint venture with Thailand. The fleet size declined after a few years and only about 50 were in operation in the late 1980s. Though all the vessels initially were shrimp trawlers, finfish trawlers increased to 46. as against 27 shrimp trawlers, in 1983-84. But by the late 1980s, there were 31 shrimp trawlers, 10 finfish trawlers and 8 combination trawlers.

Shrimp production increased from 240 tin 1978/79 to 5500 tin 1983-1985. It thereafter declined to around 3,000 t in 1990. Finfish landings increased from 1,300 t in 1978/79 to 7,400 t in 1986/87 and has fluctuated since then. However, *50-65* per cent of the finfish caught as by-catch are being discarded at sea.

The Bangladesh Department of Fisheries (DOF) has been concerned about the impact of the dramatic increase in trawl fishing effort on the resources (White and Khan, 1985a). Various estimates of maximum sustainable yield (MSY) have been made for penaeid shrimp and demersal finfish in Bangladesh waters. For shrimp, it ranged from 9.000t (West 1972) to 2,100 t for poor recruitment years (Penn. 1982). For demersal finfish, it is estimated to be 10,000-14,000 t (Penn, 1982).

The Marine Fisheries Survey and Development Project conducted numerous survey cruises and operated both shrimp and finfish trawis on the DOF's r.v. *Anusandhani* and r.v. *Matsuranga* between 1985 and 1990. These surveys were conducted to assess the stocks which were basic for development and exploitation of the marine resources.

The principal species caught in the trawl fishery are, among the shrimp, the Brown Shrimp *(M. monoceros)* and Tiger Shrimp ***(P.*** *nionodon)* (Mustapha ***et*** *al* .1987). Major contributions to the finfish catches are Silver and Black Pomfret *(Pampas argenteus* and *Forrnio niger),* Grunts *(Poniadasvs* spp.). Indian Salmon *(Polvnenius* spp.), Snapper ***(Lurjanus*** spp.). Goatfish (Mullidae), Croaker (Sciaenidae). Mackerel *(Rasrrelliger* spp.), Lizardfish *(Saurida* spp.) and Hairtails/Ribbon-fish *(Trichiurus* spp.) (Lamboeuf 1987 and Khan et a!. 1989).

This study was undertaken to estimate and/or determine:

- Fishing effort:

  Catch and species composition;

  Biological parameters of important shrimp and finfish species, such as growth, mean length at recruitment, size at first maturity, fishing mortality, etc.

- Cost and revenue in the trawl fishery;

  Ecology of the fishing area; and

  Seasonality in abundance.

32. *MATERIAL AND METHODS*

Data from trawl surveys (1988-1989) conducted by r.v. ***Anusandhani*** and r.v. *Machrranga* were used to establish detailed species and size compositions in the respective trawlnets: by fishing grounds, depth ranges and seasons covered by the commercial shrimp and finfish trawler fleets. Catch data from the commercial fleet in more recent years, compiled for routine production estimates, were used along with the detailed percentage species compositions from the survey data, to estimate catch rate and production of individual species.

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32.1 *The gear*

SHRIMP TRAWL

Two shrimp trawlnets of the same size were operated from outriggers on either side *of* the vessel. Each net had a headrope of 15.2m and a groundrope of 18.6m. The codend mesh was 45mm.

Detailed description of the gear is given in Mustafa *et* al. 1987. The gear was operated at a speed of 3 n miles/hr by a 900 hp trawler of 32.4m overall length. Except for a slight difference in size, the shrimp trawl used was similar in design to the commercial net.

FISH TRAWL

The trawlnet used was an Engel's high opening trawl with a headrope of 57.5m and a groundrope of 18.6 m length. The codend mesh was 32 mm. Detailed description of the gear is given in White, T.F., 1985. The design and dimensions of the finfish trawl used during the survey was similar to the net used by commercial trawlers.

32.2 *Selection of survey cruises*

The trawl survey did not cover all the twelve months in any calendar year. Since there was no evidence of significant differences in the species composition in the trawl catches, the data of 1985 and 1986, with best coverage of areas and seasons, were used in estimating the percentage species composition. The schedule of survey cruises and depth ranges was as follows

Cruise type by gear	*Depth range (metre)*	*Month covered*	
		1985	*1986*
Shrimp trawl	< 30	Nov.	Jan.. Feb.. Mar.. Apr.. Jul.
	30-80	Aug.. Oct.. Nov.. Dec.	Jan., Feb.. Mar.. Apr., Jul.
Fish trawl	< 30	Jul., Sep.. Oct.	Jan.. Feb.. Mar.. Apr.. May.. Jun.
	30.80	Jul.. Aug.. Sep.. Oct.	Jan., Feb., Mar.. Apr.. May.. Jun.

32.3 *Selection of survey stations*

Although the survey with finfish and shrimp trawls covered all possible depth ranges from 10 to 80 m, only those stations falling within the trawling grounds of the commercial trawlers were selected for analysis. This was done to improve the compatibility of the catch and size composition in the commercial and survey trawls. The data from the selected stations were classified into two depth-wise strata — < 30m and 30-80 m. The number of stations from which the data were selected for analysis is recorded alongside

Catch by species, fishing effort and length frequency data collected at these stations were used in the analysis.

Type of trawl	*Strata (depth in m)*	*No.of stations*
Shrimp	< 30	40
	30-80	136
Fish	< 30	49
	30-80	81

32.4 *Data analysis*

The distribution of the stations in the two depth ranges are shown in Figures 34 and 35.

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Fig. **34. Shrimp trawl stations surveyed in the 30m(o) and 30 - 80m (•) depth ranges.**

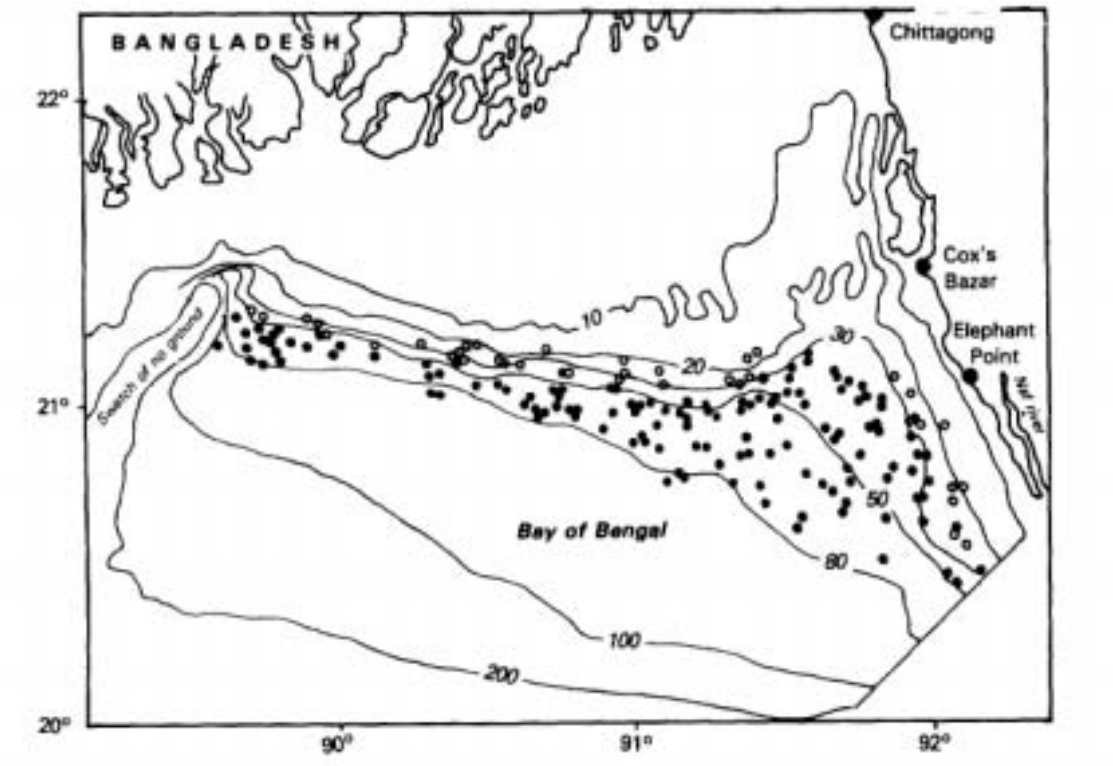
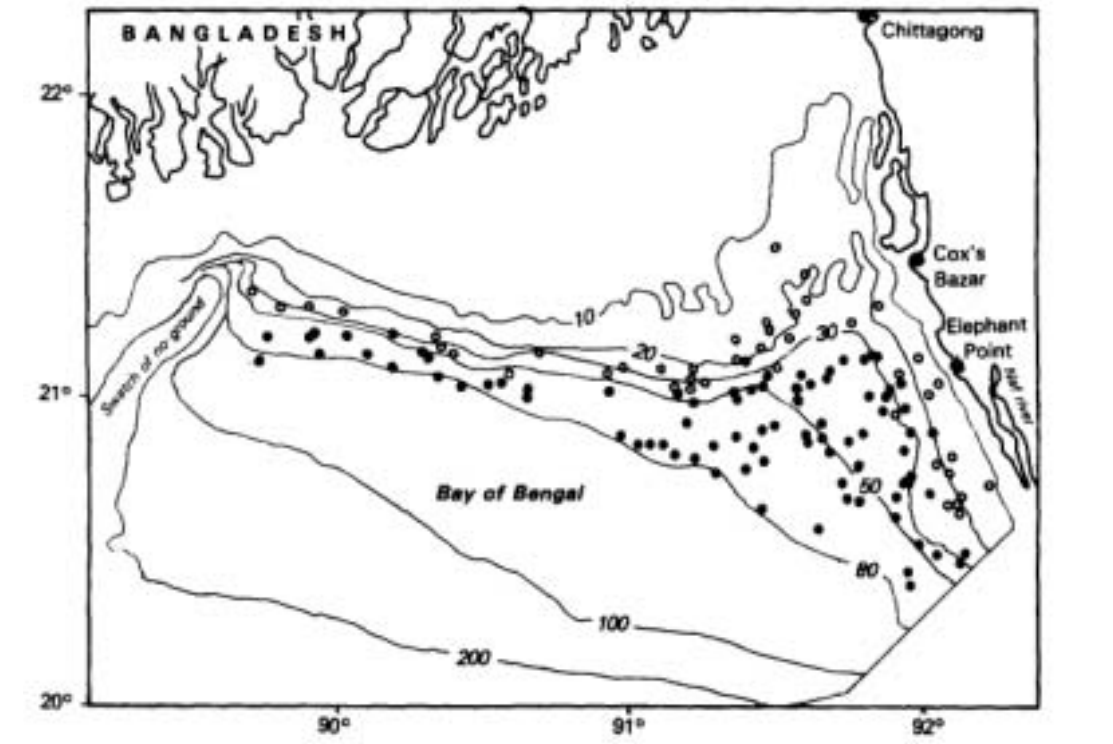


Fig 35. Finfish trawl stations surveyed in the 30m (o) and 30 - 80m (•) depth ranges



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A Hewlett Packard 86B and a Tandon 286SX/20 microcomputer were used to analyze the catch data and to prepare the graphs.

SPECIES COMPOSITION AND PRODUCTION

Species composition and catch rate (kg/hr) were determined for each month and depth stratum. using the survey and commercial catch data. Commercially valuable species were further analyzed to identify the pattern of spatial distribution of fish and shrimp. Monthly species composition of penaeid shrimp in the shrimp trawl surveys, at depths between 30 and 80m, were used as the basis to estimate the catch rate for the various shrimp species in the commercial catches. Annual production of each species, by shrimp trawls, was then obtained by multiplying the estimated catch rate of species (kg/hr) by the total standardized trawling effort (hr) of the shrimp trawl. However. due to tack of survey data for May, June and September the annual species composition was estimated without data for these three months. It was assumed that this would not signit'icantly affect the estimates of production. Schaeffer and Fox models were applied to the commercial catch and effort data for 1982-1990 in order to estimate the MSY.

Commercial catch data of shrimp were available by species for Tiger. White and Brown Shrimp and 'other' categories, while the finfish were separated into 'discarded' and 'retained'. This categorization was useful in checking the estimate production of penaeid shrimp and for taking the discarded by-catch into consideration for composition and overall catch rate.

BIOLOGICAL PARAMETERS

Length-frequency data of selected, commercially valuable species were analyzed using ICLARM'S IBM version of 'complete ELEFAN version 1.11' to estimate growth parameters, mortality rate, selection pattern, recruitment pattern and yield per recruil. Length-weight relationships were also established for ten species, using the LFSA package (Length Frequency Based Stock Assessment) (Sparre, 1987).

Catch rates of penaeid shrimp and finfish, by depth range, were estimated in terms of kg/hr for shrimp trawl and kg/30 min for finfish trawl. Distribution patterns were also studied for a few of the penaeid shrimp and finfish. Total production by the shrimp trawl for the year 1989-90 and the MSY was also estimated using commercial catch and effort data for the period 1981 to 1991. A similar attempt was made for the finfish catch also.

33. *RESULTS*

33.1 *Species composition*

IN THE SHRIMP TRAWL CATCH

The shrimp trawl catch included eleven species of shrimp and spiny lobsters, 15 species of commercially valuable finfish species/groups, 38 species/groups of species classified as by-catch, 28 species classified as trash fish and about eight other commercially important species/groups which were sometimes discarded.

Major species of penaeid shrimp were Brown Shrimp, Tiger Shrimp, Indian White Shrimp and Banana Shrimp. Noteworthy commercially high-valued finfish were Tigertooth Croaker. Blotched Croaker, Bombay Duck, Lizardfish, Goatfish and Ilisha Shad.

Ponyfish, small sizes of Lizardfish, Goatfish, Croakers, Tripodfish, Pufferfish, Squilla, Swimming Crab and small molluscs and Flatfish were considered trash fish. Cuttlefish, squid, octopus, shark and ray are also discarded by some.

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The number of species or groups of species of the five categories mentioned above and their percentage by weight in the total shrimp trawl catch by depth range was as follows:

Categories	*Shrimp trawl*			
	<30 m depth range		*30 . 80 m depth range*	
	Appx. No, of spectes	*Percentage in the catch*	*Appx. No. of species*	*Percentage in the catch*
Shrimp + lobster	11	1.5	11	4.8
Commercial finfish	15	10.0	IS	12.0
By-catch	3]	56.0	38	48.0
Trash fish	18	20.5	28	26.0
Others	8	12,0	8	9.2
Total	**83**	**100**	**100**	100

There was a noticeable decline in the relative proportion of White Shrimp and an increase in the proportion of Brown and Tiger Shrimp in the 30-80 m depth range compared to those in the depth range below 30 m. Among commercially valuable finfish species, an increase in the relative proportion of Ribbonfish/Hairtail, mackerel and Silver Pomfret were evident in the depth range 30-80 m. Croaker continued to maintain a relatively high proportion both in the <30 m and 30-80 m depth ranges. Among the by-catch species, Threadfin Bream, and Tongue Soles were significantly more in the 30-80 m depth range than in the <30 m depths. More trash fish were present in the catches from the 30-80 m depths than from in the < 30 m depths. The proportion of trash fish also increased with the catch. Ponyfish and Silver Biddies were conspicuous among the trash fish. Occurrence of 'other' species discarded were more or less similar in both depth ranges.

IN THE FINFISH TRAWL CATCH

All shrimp species caught by the shrimp trawl in the 30-80 m depth range were also observed in the finfish trawl catches, but only six of the species were present in the finfish trawl catches made in the <30 m depth. Smaller penaeid shrimp *(Metapenaeus* spp. and *Parapenaeopsis* spp.) were caught in relatively higher proportions at depths < 30m. In the 30-80 m depth range, the Tiger and Brown Shrimp were relatively more. Though most of the penaeid shrimp were also caught in the finfish trawl, their percentages were much less than from the shrimp trawl catches.

Among the commercial finfish catches, croaker occurred occasionally, unlike in the shrimp trawl catches, hut Indian Salmon. grouper. grunt, pomfret and Ribbonfish showed relatively higher proportion even in the shallow waters (<30 m). In the 30-80 m depth, Ribbonfish formed a very significant portion, followed by three species observed in the relatively shallow waters. The by-catch category included species which also increased with the increase in fishing depth. Indian Mackerel and False Trevally in the <30 m depth and Seabream in the 30-80 m depth were significant additions found in the finfish trawl catches.

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Trash fish species showed hardly any difference in the number of species caught in the two depth ranges, but a significantly higher percentage was observed in the <30 m depth range. Approximate numbers of species and their percentages under the five categories and in the two depth ranges were as follows:

Fin/Ish trawl

Categories	*<30 m depth range*		*30 - 80 rn depth range*	
	Appx.No. of species	*Percentage in the catch (hr wt)*	*Appx.No. of species*	*Percentage in the catch (by wt)*
Shrimp + lobster	6	0.6	11	0.5
Commercial finfish	20	9.0	20	17
By-catch	43	48	50	55
Trash fish	24	37	24	24
Others discarded	8	5.4	8	3.5
Total	101	100	**113**	100

33.2 *Catch rate*

OF SHRIMP IN THE SHRIMP TRAWL

In the shrimp grounds of < 30 m depth, the annual mean catch rate was estimated at 5.7 kg/hour. It was 7.5 kg/hr in the 30-80 m depth.

The seasons of peak catch rates for different shrimp varieties in the two depth ranges are summarized below. Monthly variations are shown in Figures 36, 37 and 38 (facing page).

Categories	*< 30m depth range*	*30-80m depth range*
a) All shrimp	Apr., Jul.	Aug.. Dec-Feb. (secondary peak)
b) Brown Shrimp	Apr.. Jul.	Aug-Feb.
c) White Shrimp **(sporadic** occurrences)	Jul.	Jan.. Jul. and Aug.
d) Other penaeids	Aug.	Dec-Jan.

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Fig **36. Catch** rates **(kg/hr) of** penaeid **shrimp in** the **shrimp trawl,** during different months **and** In the < **30m and 30** - 80m **depth ranges**

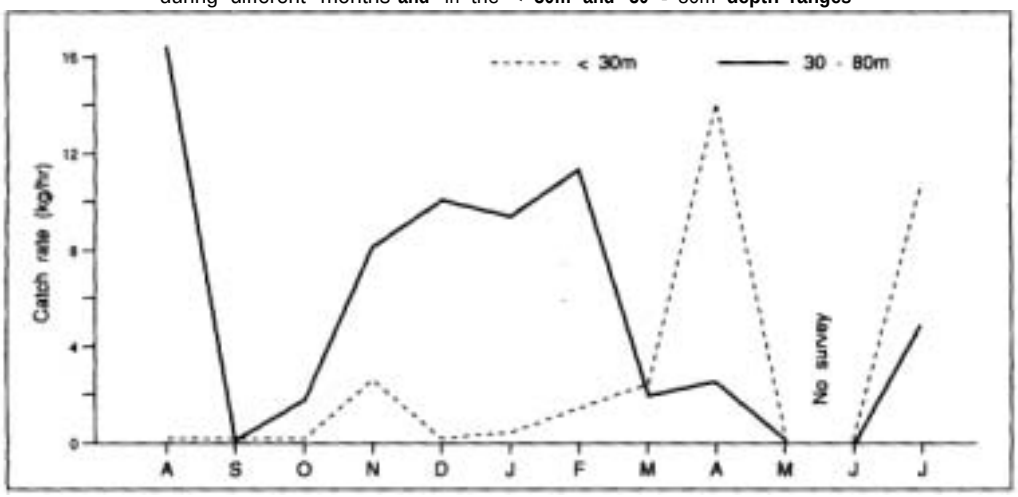


Fig **37. Catch** rates **(kg/hr) of penaeld shrimp in** the **commercial shrimp trawl during** 1988-'89

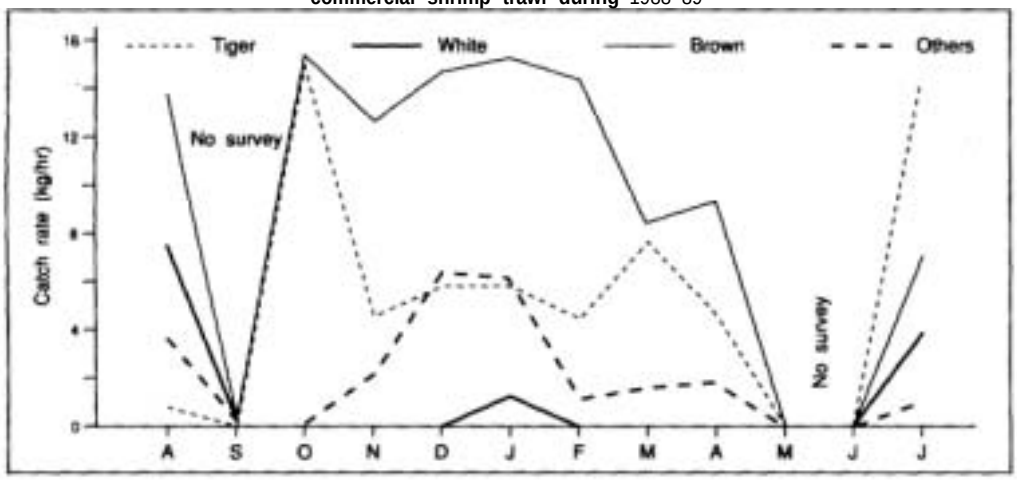
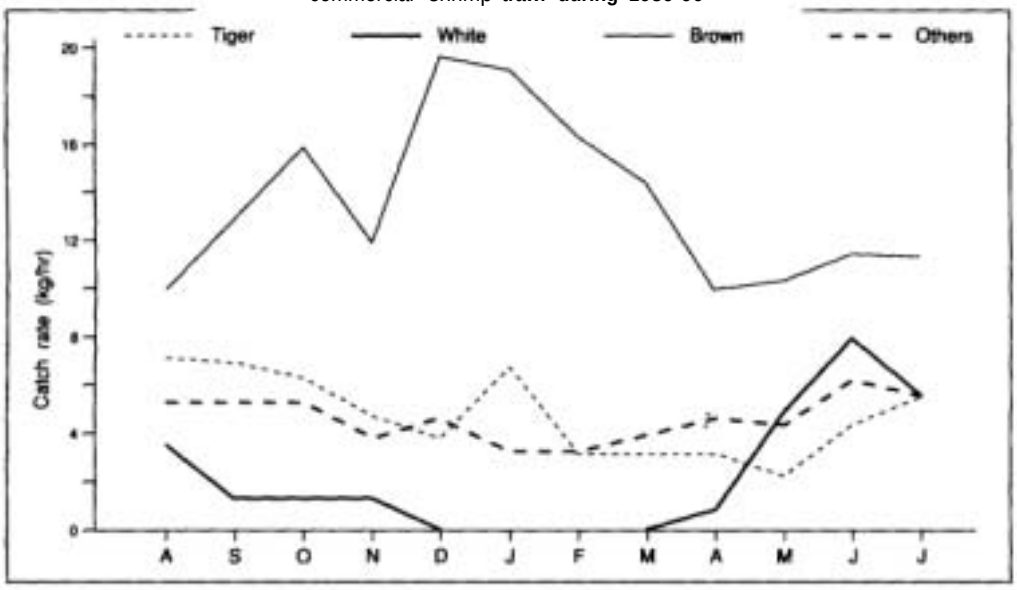


FIg 38. Catch rates (kg/hr) **of penaeid shrimp in the** commercial shrimp **trawl during** 1989-90



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OF FINFISH IN THE SHRIMP TRAWL

The annual mean catch rate of different categories of finfish in the shrimp trawl catches, peak season and main contributors to the peak catch rates are summarized separately, below, for the two depth ranges. Monthly variations in catch rates are shown in Figures 39, 40 and 41 (facing page).

	< 30 m Depth range			*30 - 80 m Depth range*		
Categories	*Annual catch rate kg/hr*	*Peak season and catch rate*	*Major contributors*	*Annual catch rate kg/hr*	*Peak season and catch rate*	*Major contributors*
a) High value finfish	3.3	Jul. (114)	Grunt	2.3	Jul./Aug.(30)	Croaker
b) Low value finfish	188	Apr. (303) Jul. (281)	Croaker Catfish Lizardfish Tongue Sole Small Grunt	67	Feb. (100) Jul. (100)	Threadfin Bream
c) Trash fish	68	Apr. (186)		34	Apr. (80)	
d) Other discards	39			19		

OF SHRIMP IN THE FINFISH TRAWL

Penaeid shrimp catches were extremely low in the finfish trawls operating in < 30 m depth (0.7 kg/30 min) and > 30 m depth (1.3 kg/hr). They recorded nil catches in most months.

OF FISH IN THE FINFISH TRAWL

The mean annual catch rates of different categories of finfish in the finfish trawl catches and the peak months are summarized below:

	< 30 m Depth		*30 - 80 m Depth*	
Categories	*Annual catch rate (kg/hr)*	*Peat season and catch rate*	*Annual catch late (kg/hr)*	*Peak season and catch rate*
a) High value finfish	16.4	Feb. (17) May. (17) Sep. (17)	24.7	Mar. (40) Aug. (25)
b1 Low value by-catch	75	Jul. (232) Mar. (105)	75	Sep. (208)
c Trash fish and other discards	69		48	

Catch rate of finfish showed a decline with increasing depth. The predominant finfish variations in different depth ranges were as follows:

Depth	*10-20m*	*20-50m*	*50-80m*	*50-100m*
kg 30 min haul	*119*	*84*	*53*	*30*
	Croaker	Croaker	Catfish	Threadfin/Bream
	Catfish	Catfish	Goatfish	Mackerel
	Ray	Ponyfish	Threadfin/Bream	Lizardfish
	Grunt	Ribbonfish	Scad	Scad

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Fig 39. Catch rates (kg/hr) of finfish in shrimp trawl catches, during different months and in < 30m and 30 - 80m depth ranges

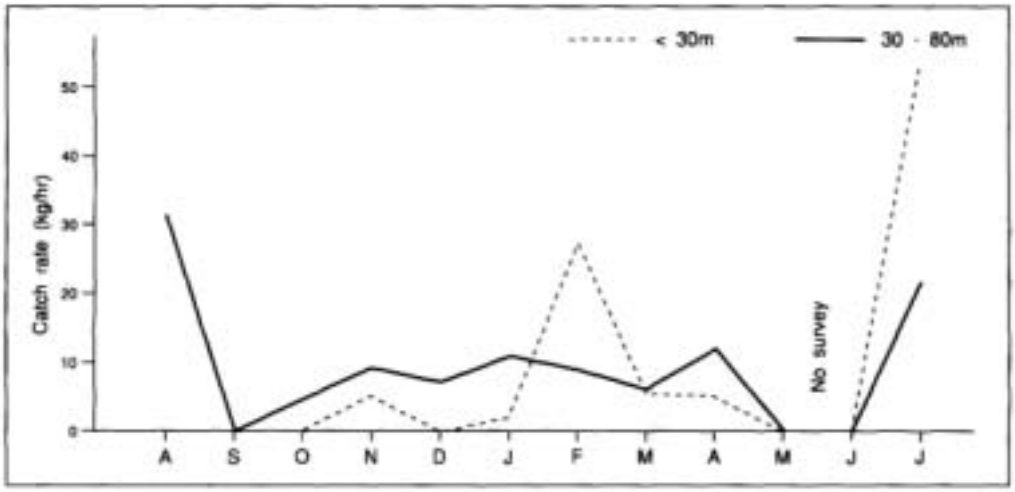


Fig 40. Catch rates (kg/hr) of finfish by-catch in shrimp trawl catches, during different months and in < 30m and 30 - 80m depth ranges

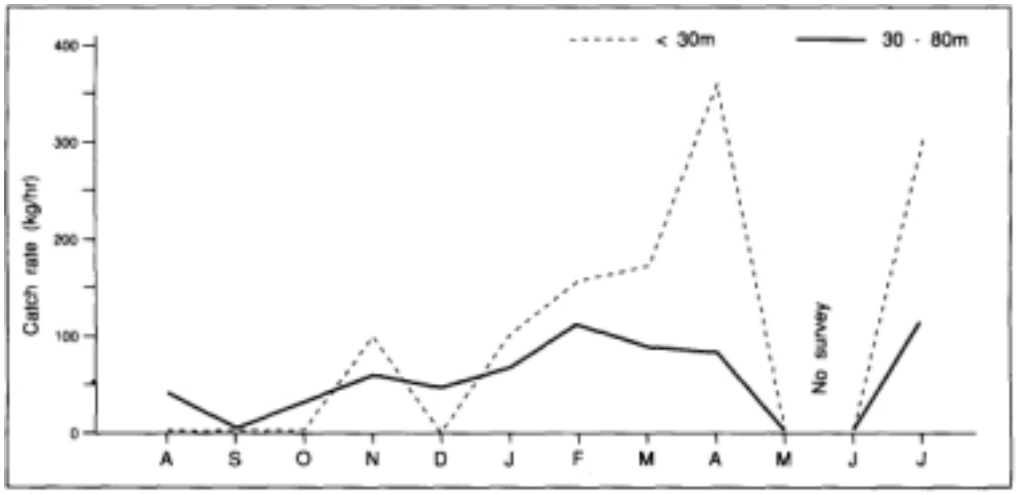
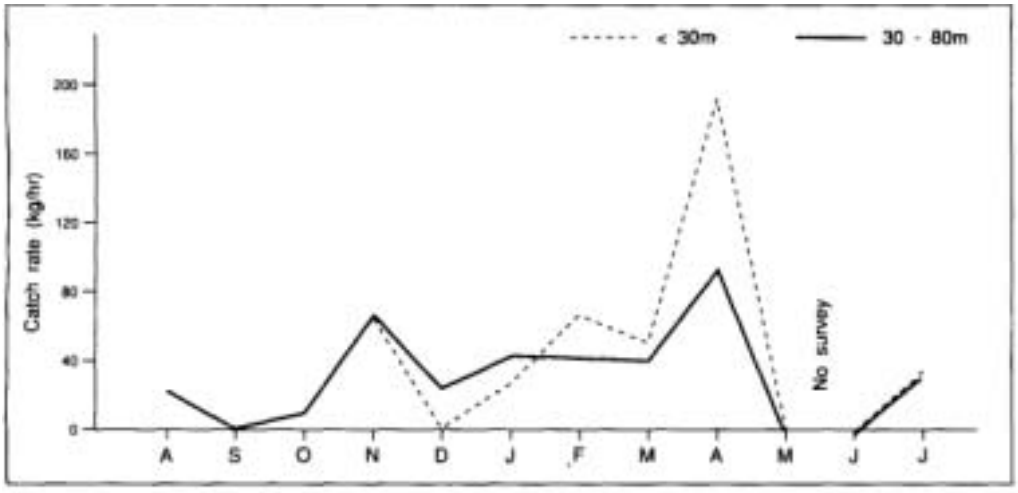


Fig 41. Catch rates (kg/hr) of trash fish in shrimp trawl catches, during different months and in < 30m and 30 - 80m depth ranges



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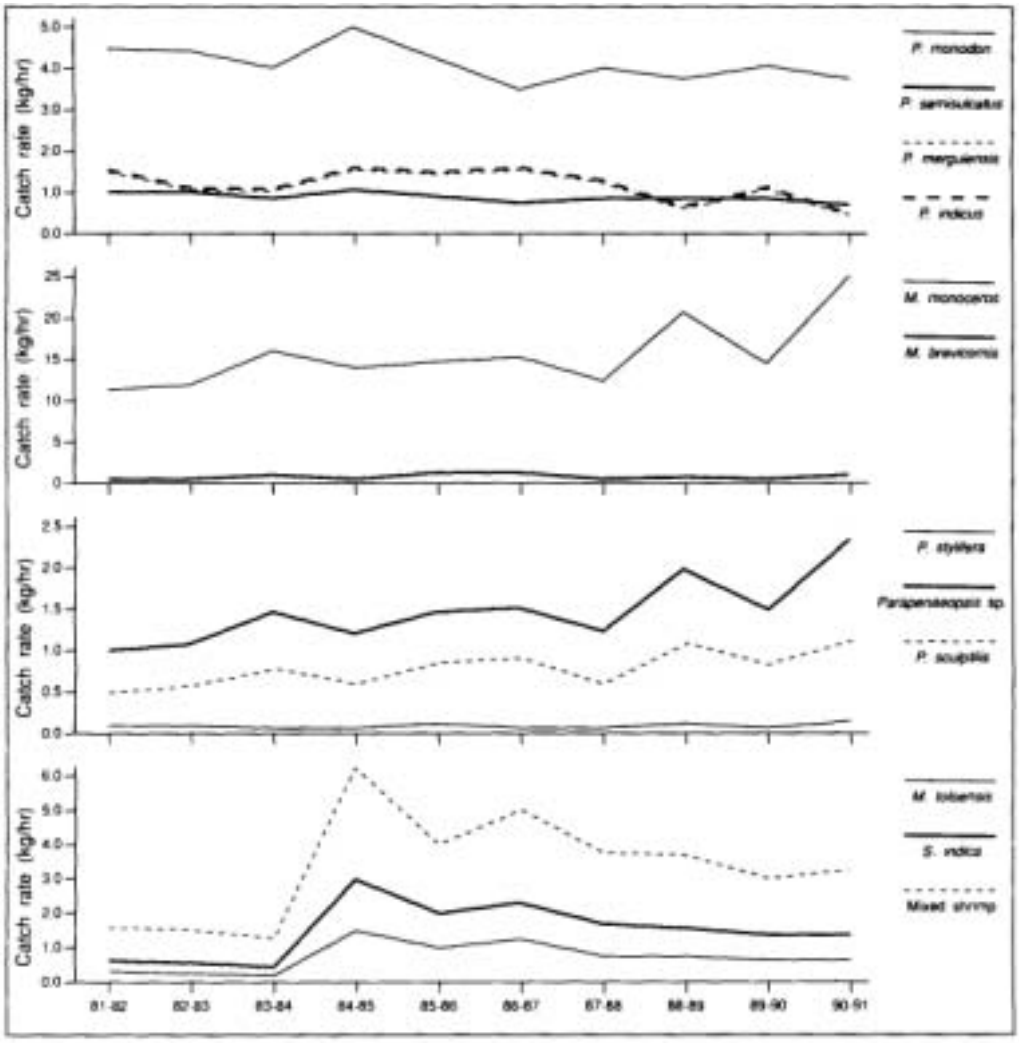
ANNUAL VARIATION IN THE CATCH RATE OF PENAEID SHRIMP

The annual variation in the catch rates of the four commercial categories of penaeid shrimp recorded (Tiger, White, Brown and others) and of all these categories combined, in the shrimp trawl catches for the period 1980/81 to 1990/91, are shown in Figure 42.

Fig 42. Annual variations in the catch rate (kg/hr) tor the four commercial categories of penaeid shrimp, 1981-82 to 1990-'91



The annual catch rate for all penaeid shrimp combined showed year to year fluctuations, but an increasing trend was observed from 1980/81 to 1990/91. Annual average catch rate of Tiger Shrimp showed less annual fluctuations, but a declining trend was evident with an average of 4.5 kg/hr until 1984/85 and 3.7 kg/hr thereafter — approximately a 17 per cent decline between 1980/81 and 1990/91. The White Shrimp and the Banana Shrimp achieved slight increases in annual average catch rate until the mid-'80s (1 .5 kg/hr), but exhibited a noticeable decline (0.7 kg/hr) in later years approximately 50 per cent decline between 1980/81 and 1990/91. The Brown Shrimp had the highest catch rate with wide annual fluctuations and a significantly increasing trend from 1980 (13.5 kg/hr) to 1990/91 (31 kg/hr) — approximately a 130 per cent gain. The small mixed or other shrimp (other *Metapenaeus* spp. and nonpenaeids such as *Solenocera* spp. had a peak in

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1984/85, which declined significantly thereafter but remained higher than the catch rates recorded between 1980/81 and 1983/84. These changes also indicate a significant change in the composition of penaeid shrimp in the trawl catches as shown alongside.

	1980/81 %	*1990/91* %
Tiger	21	10
White	14	4
Brown	58	77
Others	7	9
Total	190	100

It is quite evident that the catch rate of Brown Shrimp has largely influenced this trend in the overall penaeid shrimp catch rate.

The shrimp catch, the standardized fishing effort in the number of fishing days and the catch rates over the last decade are given below.

Year	*Shrimp catch (t)*	*Fishing effort standardized (No. offishing dais)*	*Catch late (kg/fishing day)*	*Revenue in Tk. 1.000.000*
1981-82	1697	3780 *	449	320 *
1982-83	3120	7020	444	580
1983-84	5460 *	9660 *	565	1000*
1984-85	5518 *	8160 *	676	1030 *
1985-86	4034	6440	626	730
1986-87	4488	6930	648	830
1987-88	3523	6580	535	650
1988-89	4893	6940	705	900
1989-90	3134	5540	565	540
1990-91	3430	4500 **	762	650

* Data not used in the production models. as estimated fishing effort was considered unreliable.

** Effort reduced due to loss/damage of trawlers during the cyclone of April 1991.

Source: Marine Fishery Research Development and Management Project, Chittagong.

Annual fishing effort of the trawlers exhibited variations which were difficult to understand or explain.

33.3 *Production*

Using the catch data of the commercially important shrimp and finfish in the trawler landings during 1989/90 and the relevant fishing effort applied by the fleet, the annual production of the commercial categories was estimated. These were further separated into speciets or species groups using the detailed species composition established from the stratified shrimp trawl survey data. Production thus estimated for the shrimp trawl fishery in 1989/90 was 56,217 t of which 2,713t was penaeid shrimp, 6,898 t high-value finfish, 26,568 t low-value .by-catch, 14,526 t trash fish and 5,439 t of other species discarded. Specieswise production under each main category is given in Appendix I.

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33.4 *Population parameters*

GROWTH PARAMETERS OF SOME OF THE MAJOR SPECIES

The length frequency data collected for Tiger Shrimp, Brown Shrimp and Ribbonfish during the survey were analyzed for growth parameters, mortality and recruitment pattern, using ELEFAN vetsion 1.11. (Figure 43 facing page) and the results are presented below.

	ELEFAN METHOD					*WETIFERALL METHOD*		
SPECIES	*L*	*K*	*M*	Z	E	*L*	*L*	*Z/K*
P.monodon Male)	28.8	.2	2.035	7.9	0.74	7.5	30.7	8.036
P.pnonodon (Female)	30.5	.7	2.514	5.8	0.57	15.7	30.8	3.22
M.rnonoceros Male)	8.0	1.4	2.89	6.3	0.54	8.9	15.6	3.92
M.monoceros (Female)	8.6	1.6	2.77	6.3	0.55	9.5	16.8	2.26
L.savala	105	0.85	1.33	2.06	0.65	20.05	—	—

Two recruitments were evident for all three species. The two recruitments were four months apart for the Tiger and Brown Shrimp and five months apart for the Ribbonfish.

PRODUCTION MODELS — MAXIMUM SUSTAINABLE YIELD (MSY)

Surplus production models of Schaeffer (1954) and Fox (1970) were used to estimate maximum sustainable yield (MSY) for the shrimps, based on the catch and effort data for shrimps listed in Section 33.2. These data are from the records of the trawl catch statistics compiled by the Marine Fishery Survey Management and Development Project of the Department of Fisheries. The MSY values obtained for penaeid shrimp were 4145 **t** and 4329 **t** and the effort levels required to achieve this were estimated to be 8500 (158,100 trawling hours) and 11,000 boat-days per year, for. the Schaeffer (a = 0.96357; b = 0.00005599) and Fox models (a= 0.0645 16; b = 0.0000906) respectively (Figure 44. see page 104). These results indicate that the fishing effort of the trawl fishery may have been at or. little above, the optimum effort level in 1983/84 and 1984/85. The correlation between catch rate and effort was slightly better for the Schaeffer model than for the Fox model.

Similar analysis for the finfish catches exhibited extremely poor correlation between catch rates and effort values, probably due to the error in the estimates of discarded by-catch. Hence the results were not considered.

MAXIMUM ECONOMIC YIELD (MEY)

By applyine the average value (Tk/kg) of penaeid shrimp caught to the annual production values (see table in Section 33.2), a Schaeffer-type economic yield model was obtained. The linear regression for the change in the costs of operating the shrimp trawlers was established with the annual changes in their fishing effort. The maximum economic yield level and the corresponding effort level were estimated from these two plottings (Figure 45, see page 105). Maximum Economic Yield appears to he realized when the fishing effort is around 6650 boat-days and the total revenue around 1k 727 million. In fact, in many of the years, 82/83, 85/86, 86/87, 87/88 and 88/89, the fishing effort was more or less at the MEY level, but had fallen below that in the more recent years. The MSY effort level is about 28 per cent greater than the MEY effort level.

It appears that shrimp trawling has generally been swinging between the MSY and MEY, except in the two most recent years.

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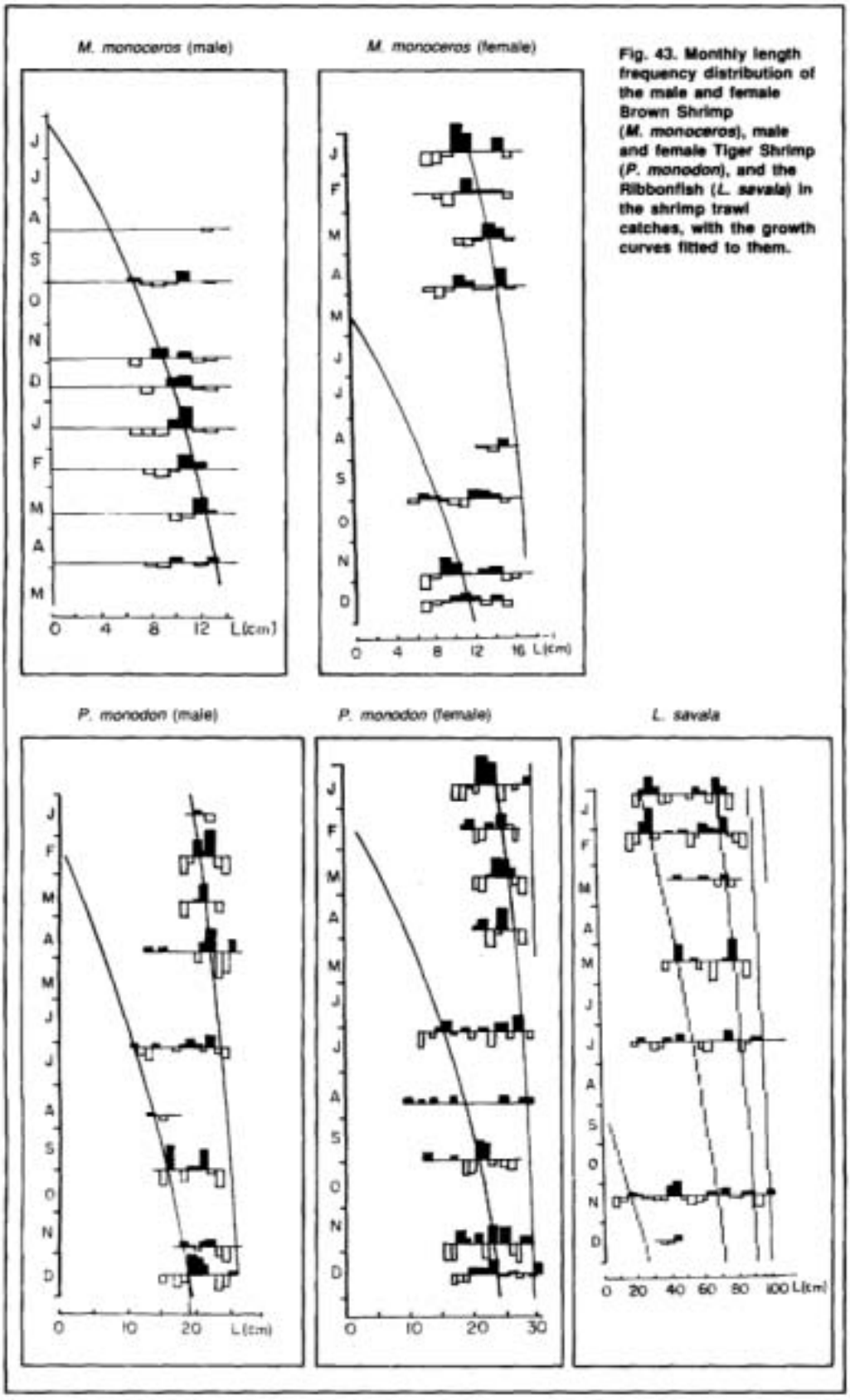

Fig. 43. Monthly length frequency distribution of the male and female Brown Shrimp (*M. monoceros*), male and female Tiger Shrimp (*P. monodon*), and the Ribbonfish (*L. savala*) in the shrimp trawl catches, with the growth curves fitted to them.

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Fig 44. The linear regressions and parabola for the production models fitted accordlng to the Schaeffer **and Fox methods**

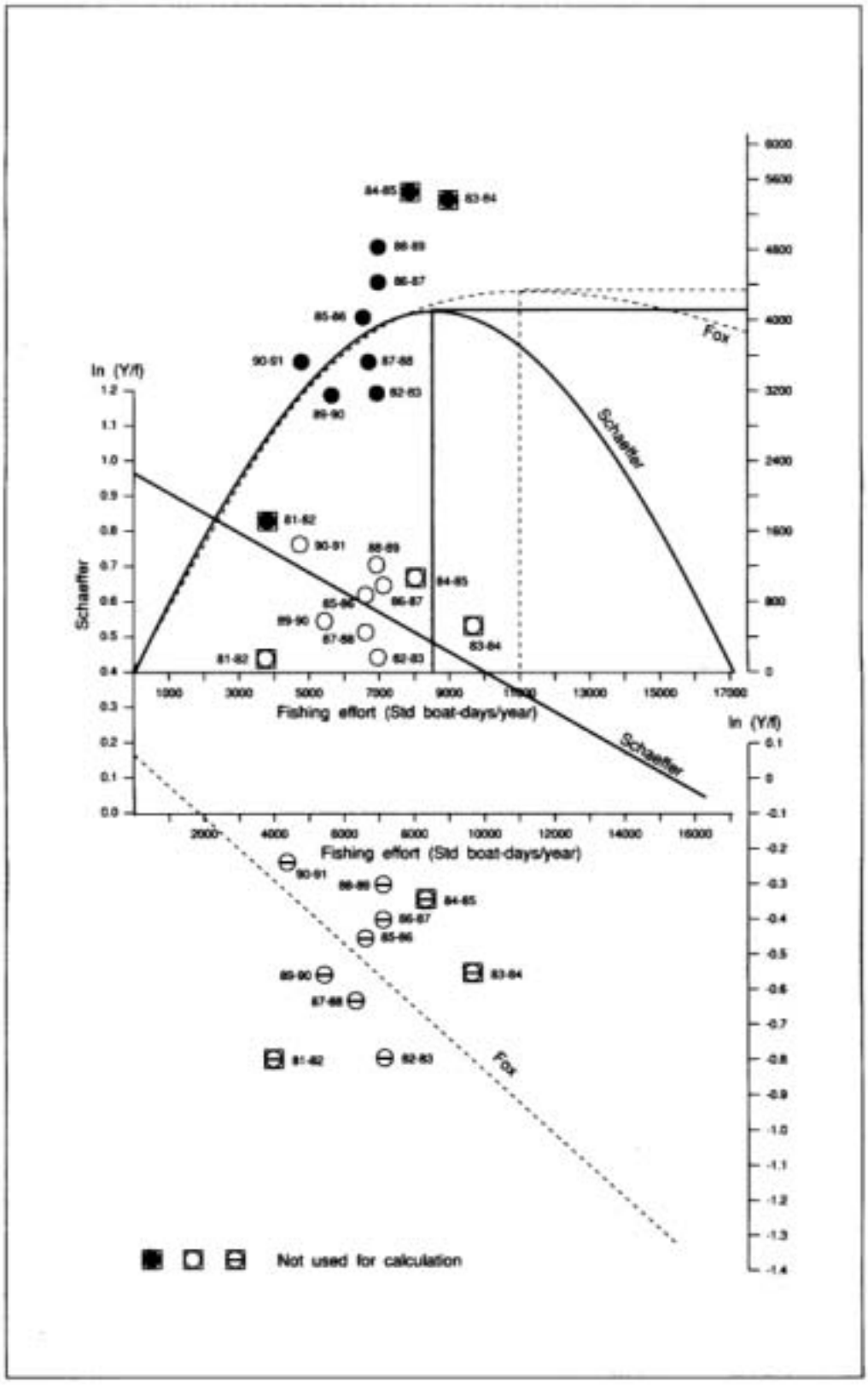

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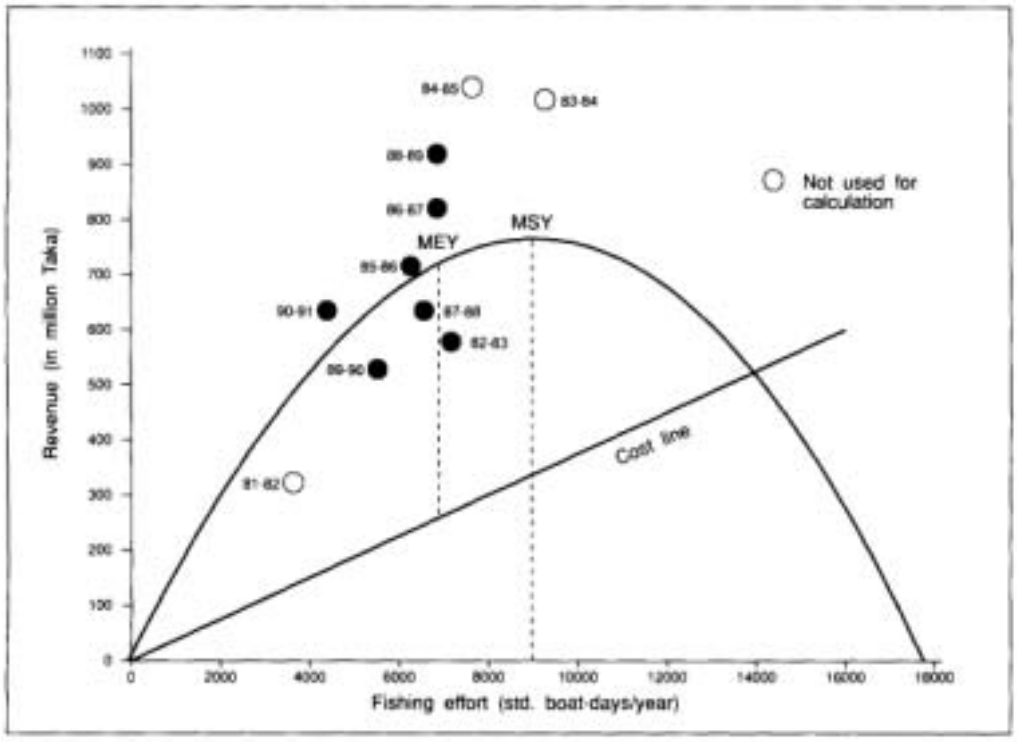
Fig 45. Maximum Economic Yield estimation by applying the cost and revenue values to the Schaeffer's surplus production model



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APPENDIX IV

Estimated production from shrimp trawlers during 1989-90

Shrimp		Total production (t)
Tiger Shrimp	*P. monodon*	452.7
Green Tiger Prawn	*P. semisulcatus*	71.8
Kuruma Shrimp	*P. japonicus*	0.6
Banana Shrimp	*P. merguiensis*	100.6
Brown Shrimp	*P. monoceros*	1567.0
Yellow Shrimp	*M. brevicornis*	43.7
Velvet Shrimp	*M. toloensis*	124.8
	Metapenaeus spp.	77.3
Kiddi Shrimp	*P. stylifera*	8.8
Rainbow Shrimp	*P. sculptilis*	1.7
	Parapenaeopsis spp.	96.9
Coastal Mud Shrimp	*Solenocera indica*	143.5
	Solenocera spp.	8.7
Mixed Shrimp		16.7
Lobster		70.9
Subtotal		2785.7

Commercial finfish		Total production (t)
Indian Threadfin	*P. indicus*	4.0
Silver Grunt	*P. hasta*	700.1
Ribbonfish (Hairtail)	*L. savala*	520.9
Silver Pomfret	*P. argenteus*	139.4
Chinese Silver Pomfret	*P. chinensis*	21.8
Black Pomfret	*P. niger*	13.8
Indian Pink Conger	*C. talabonoides*	11.5
Pink Conger	*Muraenesox* sp.	739.7
John's Snapper	*L. johni*	72.2
Snapper	*Lutjanus* sp.	7.5
Grouper	*Epinephelus* spp.	144.0
Silverpennah Croaker	*P. argentatus*	255.0
Croaker	*Johnius* spp.	2308.9
Belanger's Croaker	*P. belangeri*	34.5
Tigertooth Croaker	*O. argenteus*	1432.3
Blotched Croaker	*O. maculatus*	311.9
Croaker	*Otolithes* sp.	172.5
Spanish Mackerel	*S. commerson*	4.3
King Mackerel	*S. guttatus*	2.0
Talang Queenfish	*S. commersonnianus*	2.3
Subtotal		6898.6

Finfish by-catch		Total production (t)
Blackspot Threadfin	*P. sextarius*	116.1
Paradise Threadfin	*P. paradiseus*	4.9
Largehead Hairtail	*T. lepturus*	25.9
Cock Grunter	*P. maculatum*	947.0
Grunt	*Pomadasys* sp.	17.2
Ilisha Shad	*I. filigera*	1214.5
Hilsha Shad	*Hilsha ilisha*	15.8
Shad	*Ilisha* sp.	347.9
Sardine	*Sardinella* sp.	2.3
Sea Catfish	*Arius* sp.	3146.6
Malabar Blood Snapper	*L. sanguineus*	31.9
Bombay Duck	*H. nehereus*	1035.0
Croaker	*Protonibea* sp.	1143.7
Spotted Croaker	*P. diacanthus*	28.7
Croaker		968.9
Panna Croaker	*Panna microdon*	74.7
Indian Driftfish	*A. indica*	225.7
Indian Mackerel	*R. kanagurta*	330.3
Obtuse Barracuda	*S. obtusata*	40.8
Bigeye Barracuda	*S. forsteri*	120.5
Barracuda	*Sphyraena* spp.	41.7
Cleftbelly Trevally	*A. atropus*	59.8
Scad	*Selar* spp.	2.6
Salema	*S. boops*	42.8
Malabar Travally	*C. malabaricus*	125.0
Torpedo Scad	*M. cordyla*	165.3
Trevally	*Carangoides* sp.	1.4
Indian Threadfish	*Alectis indicus*	4.6
Silver Biddy	*G. filamentosus*	23.0
Wolf Herring	*C. dorab*	7.8
Goatfish	*U. sulphureus*	3860.0
False Trevally	*L. lactarius*	172.8
Japanese Threadfin Bream	*N. japonicus*	7369.5
Threadfin Bream	*Nemipterus* sp.	145.2
Cobia	*R. canadum*	12.9
Lizardfish	*Saurida* spp.	823.1
Greater Lizardfish	*S. tumbil*	2319.3
Bream	*A. spinifer*	18.7
Mullet	*Mugil* sp.	5.7
Tongue Sole	*C. cynoglossus*	1067.2
Indian Halibut	*P. erumei*	461.4
Subtotal		26,568.2

Trash fish		Total production (t)
Blackbanded Trevally	*Seriolina* sp.	13.8
Russelli Scad	*D. russelli*	369.7
Redtail Scad	*D. kurroides*	5.7
Scad	*Decapterus* spp.	27.3
Triggerfish	Balistidae	11.5
Bullseye	*Priacanthus* spp.	138.6
Brushtooth Lizardfish	*S. unodosquamis*	24.4
Elongate Sole	*S. elongate*	403.6
Tenpounder	*E. machnata*	12.1
Longfin Silver Biddy	*P. longimanus*	934.7
Silver Biddy	*Pentaprion* spp.	20.1
Terapon	*Terapon jarbua*	37.1
Red Cornetfish	*F. villosa*	29.9
Ponyfish	*Leiognathus* spp.	932.2
Hairfin Anchovy	*S. taty*	0.9
Anchovy	*Thryssa* sp.	11.5
Goldspotted Grenadier Anchovy	*C. dussumieria*	13.8
Banded Sicklefish	*D. longimana*	97.7
Sicklefish	*Drepane* spp.	0.8
Flounder	Bothidae	152.1
Squirrelfish	Holocentridae	2.3
Cardinalfish	*Apogonidae* sp.	26.7
Pufferfish	Tetraodontidae	119.6
Tripodfish	*Triacanthus* sp.	32.2
Spadefish	*E. orbis*	4.3
Starry Triggerfish	*A. stellaris*	6.9
Trash fish		11,105.4
Subtotal		14,525.9

Other discards	Total production (t)
Cuttlefish	1244.0
Squid	420.6
Crab	1836.8
Octopus	9.2
Other mollusc	170.5
Ray	809.3
Shark	949.0
Sub-total	5439.4
Grand total	56,217.8

THE BOTTOM LONGLINE FISHERY FOR CROAKER (SCIAENIDAE)

by

Md. Q M Huq
Md. G Khan
Z A Chowdhury
Md. N Sarker

Marine Fisheries Survey,
Management and Development Project,
Department of Fisheries, Chittagong

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35. INTRODUCTiON

The traditional fishing gear in the marine fisheries sector of Bangladesh are the set bagnet, gillnet, beach seine, castnet and traps. Trammelnet, bottom longline, and trawl are relatively new introductions. Among these, the bottom longline for croaker has become one of the important fisheries because the catches are for export. It is believed that this fishery began with the encouragement of some overseas buyers in the mid-1970s, in the Cox's Bazar area, but no records are available.

Croakers are taken by several other fishing gear apart from the longline. For instance, they are taken as by-catch in the *hilsa* gillnets and are also present in both the marine and estuarine set bagnet catches. This preliminary study was undertaken to estimate the production of croakers in the bottom longline fishery, the species and size composition of the catch and to make an assessment of the economics of the fishery.

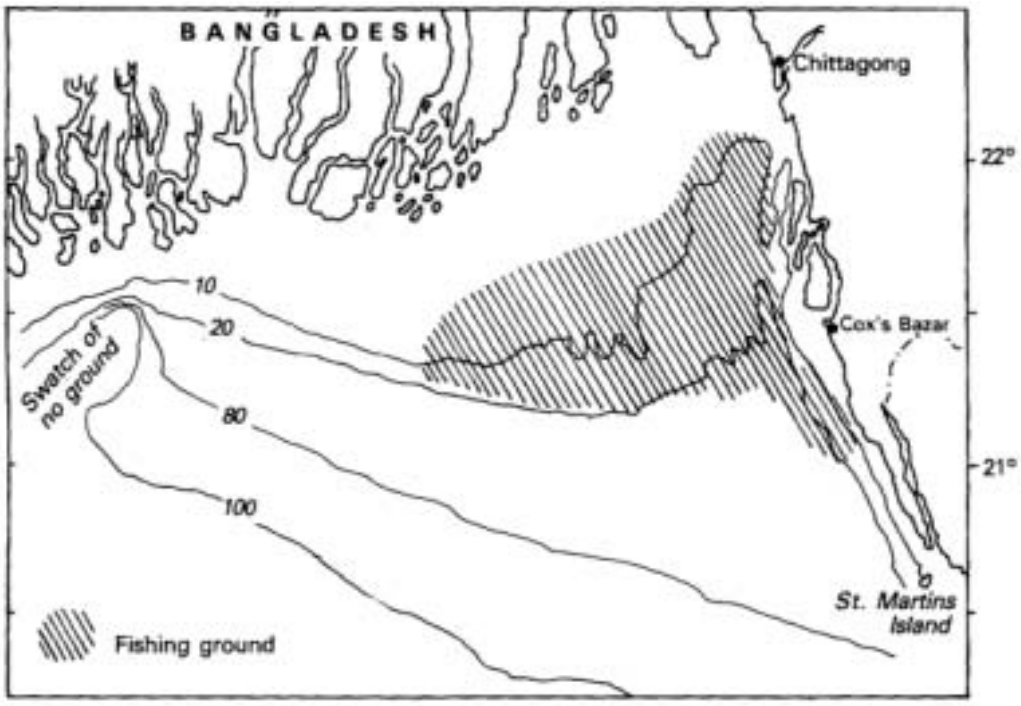
Data were collected during field visits — six days a month in January, February and November 1991. Processing factories in Cox's Bazar were also visited to collect information on processing methods, quantities processed and exported, and their value.

36. *METHODOLOGY*

36.1 *Fishing area*

Longlining for croaker is conducted in areas south of Chittagong, Noakhali and Patuakhali and southwest of Cox's Bazar, roughly within the 10 and 30 m depth contours. The geographic locations of the fishing grounds are shown in Figure 46.

Fig 46. Fishing ground for croaker bottom longlining



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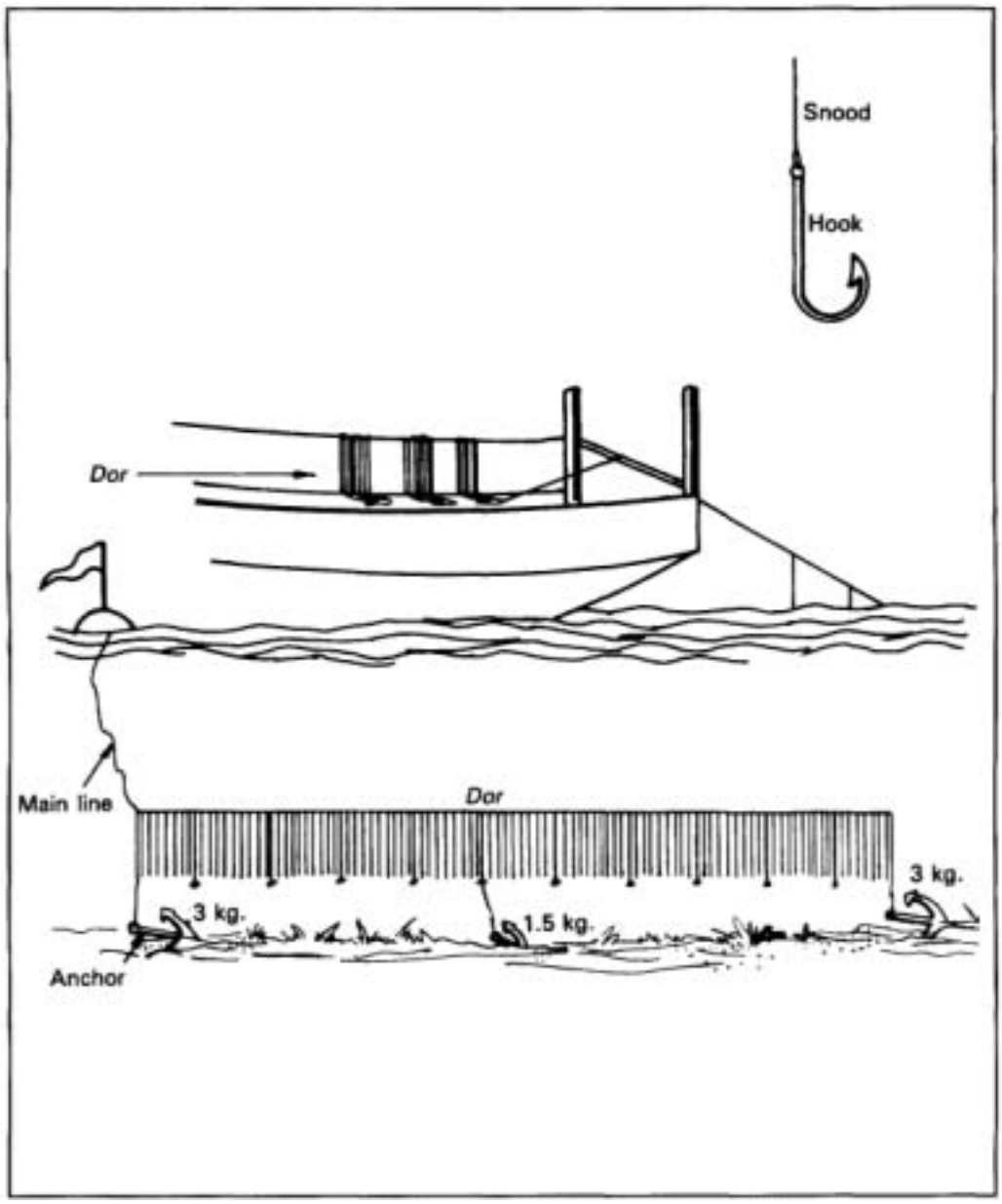
36.2 *Craft, gear and operation*

Motorized craft of 9-12 m length, with 12-36 hp diesel in-board engines are used for longline fishing. The number of fishermen per boat is 8-13.

The average length of the mainline is 3200-4000 m. The distance between two consecutive snoods varies from 1.0 to 1.2 m and the length of the snoods vary from 45 to 55 cm. The size of hook varies from no. 6 to 8 A set of 300 snoods with hooks is called a *dor* (Figure 47).

Fig 47. Design and specifications of a bottom longline



Several such *dors* make up a longline. Each *dor* is weighted down with two 3 kg anchors and a 1.5 kg anchor in between. Between the two 3 kg anchors are also attached 12 iron pieces, each weighing 500 g, to keep the hooks at the bottom. A marker buoy (float) is placed close to the position of each anchor.

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The line is shot at the beginning of high tide or ebb tide and it takes approximately 11/2 hours to complete the setting of the line. It is hauled in two hours after setting and hauling in takes about two hours. The gear is manually operated and four operations are conducted a day.

The bait used are cuttlefish, anchovy, Bigeye Shad, croaker, Ribbonfish and Queenfish. in cut pieces in the case of the larger fish varieties. The hooks are baited while sailing to the fishing ground and are arranged serially on a plank at the bow of the craft (Figure 47). with the coils of lines placed on the deck. Afier hauling in, the hooks without bait are rebaited and the lines readied for the next operation. Fishermen use purchased bait for the first fishing operation: for subsequent operations during the trip, they use a portion of the catch as bait.

36.3 *Fishing season*

The croaker fishing season extends from mid-August to mid-February and fishing is done only during the neap tide period. Day trips are made at the beginning of the fishing season, in August and September, and at the end of the season, from mid-January to mid-February. Fishing trips of four days duration are undertaken during the peak months of October-January. The fishing days average 18 days a month during the lean season and four 4-day trips a month during the peak season.

36.4 *Catch rate and composition*

The average catch per boat per day for a day-trip is 99 kg of croaker (besides 76 kg of other fish). On a 4-day trip, during the peak season, however, the catch rate is 108 kg of croaker.
The targeted species of croaker (Sciaenidae) are:

Scientific name	*Common English name*	*Local name*
Pennahia argentata	Silverpennah Croaker	*Lal poa/poka*
Johnius belangerii	Belanger's Croaker	*Sada poalpoka*
Protonibea diacanthus	Spotted Croaker	*Kala poa/poka*
Otolithoides pamu	Pama Croaker	*Lombu*

During the survey it was found that different species were dominant in the catches at different times of the season. Silverpennah Croaker were dominant in August-November, Belanger's Croaker in December-February and Spotted Croaker towards the end of the season.

Figures 48 a-b show that the size range of Silverpennah Croaker and Belanger's Croaker were predominantly between 30cm and 45cm, with the mode around 36cm. Interviews with fishermen and factory managers revealed that croaker less than 13 cm were not caught in the longlines operated.

Fig 48a. Size group of Silverpennah Croaker *(P. argentata)*

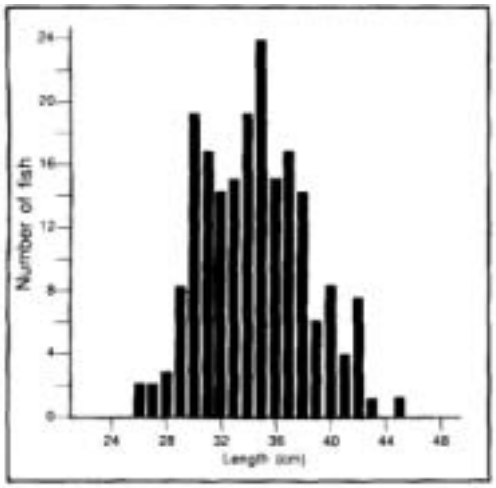
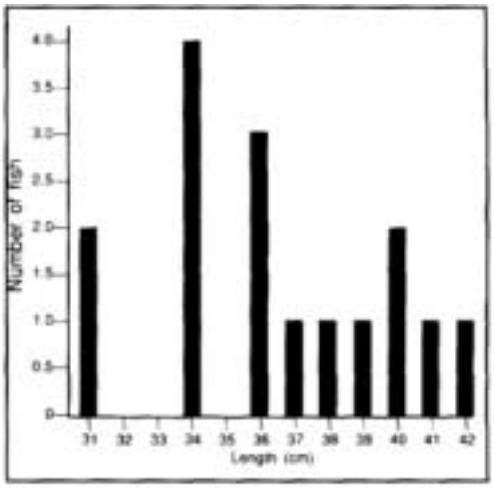


Fig 48b. Size group of Belanger's Croaker *(J. belangerii)*



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Some less valuable species of croaker were also caught in insignificant quantities. Other varieties/ species caught as by-catch included Catfish, skate and ray, Ribbonfish, Threadfin, Tasselfish, Queenfish, grunts etc. The percentage of by-catch varied from 20 per cent during the peak season to 45 per cent during the lean season.

36.5 Annual production

Level of production (range)	*No. of factori-ies*	*Total product. ion (t)*
Less than 50 t	7	142
50-90 t	2	145
Over 100 t	6	740
Total	15	1027

The estimated production of processed croaker, according to data collected from all the processing factories, is given alongside.

Applying the conversion rate used by the factories — that is, dry weight is 36 per cent of the wet weight, and assuming that the entire catch of croaker is for export, the total production of croaker in Bangladesh is estimated to be around 2850 t/year. Out of the total quantity exported. approximately 7 per cent is estimated to come from other fisheries *i.e.* set bagnet. trawl and trammelnet fisheries etc. Hence, the annual production from the longline fishery is around 2650 t.

Considering the total production of 2650 t *(i.e.* 93 per cent of the total exported quantity, with an average catch of 104 kg/boat/day), an effort of 25.480 boat-days would have been applied in this fishery. Taking the average number of fishing days per month to be 18 and the number of months operated as five, the number of boats engaged in this fishery is estimated to be approximately 280.

36.6 *Processing and marketing*

During 4-day fishing trips, the fish is salted on deck, the salt being applied into the visceral cavity. The salt used for on-board processing is one-third the weight of the fish. On-board processing is not carried out during day-trips.

There are, at present. 15 processing factories purchasing croaker for processing and export — twelve in Cox's Bazar, one at Teknaf in the Cox's Bazar District and the other two in Dubla and Mohipur in Patuakhali District.

After purchase, the fish is sorted into 'white', 'red' and 'black' croaker, according to the colour of the skin, and then graded on the basis of their sizes. Those larger than 9" are taken as Grade 1 and those from 7-9" as Grade 2. Fish smaller than 7" are not exported, but sold in the local market.

Most exports are to Hong Kong. After grading. the fish is salted — as in the on-board processing and kept for about 8-20hours inconcrete or wooden tanks, for dehydration. The fish salted by fishermen at sea take less curing time than those salted ashore. After salting, the flesh of the fish becomes very soft. The salted fish is then descaled, washed in water and finally washed in a mix of water and some chemicals of unknown composition that are supplied by the buyers. After sun-drying for 5-7 days. the dried fish are again graded by size and packed into 15 kg packages wrapped in polyethylene for shipment.

The quantities of dried croaker exported, the total value and the value per kg during the last five years are given below

Year	*Exported amount (kg)*	*Value (US $)*	*Price/kg (US $)*
986-87	135,704	612,197	4,51
1987-88	185,516	685,186	3.69
1988-89	845,192	4,508,405	5.33
1989-90	1.152.700	5.321.978	4.33
1990-91	1,087.718	3.882,927	3.57

Source: Quality Control Laboratory. Office of the Dept. of Fisheries. Chittagong.

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37. *ECONOMICS OF THE LONGLINE FISHERY*

A cost and earnings analysis (Table 29) shows that the variable cost of the fishery is on account of the fuel, food, bait, salt, repair/replacement of lost/damaged gear etc. The price of bait is 35-45 Tk/kg. The cost of craft and gear are Tk. 2,500,000 and Tk.4,000 and their average life 15 years and l year, respectively. The estimate of the cost and earnings for a unit during the whole fishing season is presented in Table 30.

Table 29: Cost and earning analysis of the bottom longline fishery for croaker and the average income to owner and crew member per trip. (Values are in Tk*)

Pethtd	Duration of trip (days)	Avg. value of catch (Tk	Avg bait cost (Tk)	Avg. fuel cost per trip (Tk)	Fttod cost per trip (Tk)	Salt cost per trip (Ti)	Add. hooks (Tk)	Net revenue (Tk)	Ciew share (Tk)	Skipper share (Tk)	Boat owner (Tk)
Aug.. Oct. & Feb.	1	4796	700	1700	500	-	500	1396	73	46	587
Nov. - Jan.	4	18,136	700	2000	2000	800	600	2.036	633	266	5068

* US $ l = Tk 32 appx. (1991).

Table 30: Costs and earnings of a bottom longlining unit, for the whole season (values are in Tk)

	Variable cost	Depreciation & maintenance	Salaries/ Shares	Total cost	Total revenue	Profit to owner
Peak season Nov. - Jan. (3 months)	82.350	5775	93,984	182,109	244,836	62,727
Lean season Aug., Oct., Feb (Mid-Aug. to Mid-Feb. 2 months)	122.400	3850	28,798	155.048	172.656	17.608
**Annual	204,750	9625	122,782	337.157	417,492	80.335

** Here 'annual' means one season. *i.e.* the five-month fishing period.

a) Depreciation of fixed cost/month — Tk 1390 + Tk 335=Tk 1725

b) Variable cost/month = Tk 61,200 (for day trips)
= Tk 27,450 (for 4-day trips)***

c) Gross revenue/month = Tk 86,328 (for day trips)
= Tk 81,612 (for 4-day trips)

d) Profit/month = Tk 25,128 (for day trips)
= Tk 54,162 (for4-day trips)

*** Variable costs are less for a month with 4-day trips because there are fewer trips per month, resulting in fuel cost being substantially less for approximately the same number of fishing days.

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After deducting the variable cost from the gross revenue, the balance is shared on the basis of eight shares for the craft owner, two for the head fisherman and one each for the nine crew members.

Major repairs and maintenance of the boat and gear, about 200 Tk/month, are borne by the boat-owner. Therefore, after deducting the depreciation and maintenance cost, the boat-owner gets 8804 Tk/month in the lean season and 20,909 1k/month in the peak season.

The fish is sold to the factory with the swim bladder intact and the fishermen do not get any additional payment for this. The swim bladder of Silverpennah Croaker and Belanger's Croaker is worth 200 Rs/kg (dried) and that of the larger Spotted Croaker 1000 Tk/kg (dried). The factory owners sell these to middlemen linked with the export of this product — 'icing glass'.

37.1 *Socioeconomics*

The fishermen engaged in longlining are traditional small-scale fishermen. These fishermen have diversified from set bagnet and gilinet fisheries because of better income in the longline fishery during the season. From Table 2 it appears that the monthly average income per fisherman is Tk.l309 for the lean season (day trip) and Tk.2848 for the peak season (4-day trip). They engage in set bagnet, gilinet, other types of longline fisheries, agriculture etc., during the rest of the year.

ERRATA

Page i, Line-6, Z A Chowdhury instead of S A Chowdhury.

Page ii, Line-l4, the Marine Fisheries Survey, Management and Development Project, instead of the Management and Development Project.

Page 29, Table-14, SI. No-9, F. ***tetradactylum*** instead of *H. tetradàctylum.*

Page 42, Table-17, SI. No-2, value of K : .44 instead of .*55.*

Page *55*, Line-11, Fiftyone species/groups instead of fourteen species/groups.

Page *65*, Line-4, Md. N Sada instead of Md. U Sada.

Page 91, Line-17, r.v. *Machhranga* instead of r.v. *Mastsuranga.*
Line-21, Mustafa *et al.* instead of Mustapha *et al.*

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PUBLICA TIONS OF THE BA Y OF BENGAL PROGRAMME (BOBP)

The BOBP brings out the following types of publications:

Reports (BOBP/REP/...) which describe and analyze completed activities such as seminars, annual meetings of BOBP's Advisory Committee, and subprojects in member-countries for which BOBP inputs have ended.

Working Papers (BOBP/WP/...) which are progress reports that discuss the findings of ongoing work.

Manuals and Guides (BOBP/MAG/...) which are instructional documents for specific audiences.

Information Documents (BOBP/INF/...) which are bibliographies and descriptive documents on the fisheries of member. countries in the region.

Newsletters (Bay of Bengal News) which are issued quarterly and which contain illustrated articles and features in nontechnical style on BOBP work and related subjects.

Other publications which include books and other miscellaneous reports.

Those marked with an asterisk ***(*)*** are out of stock but photocopies can be supplied.

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NOTE:

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