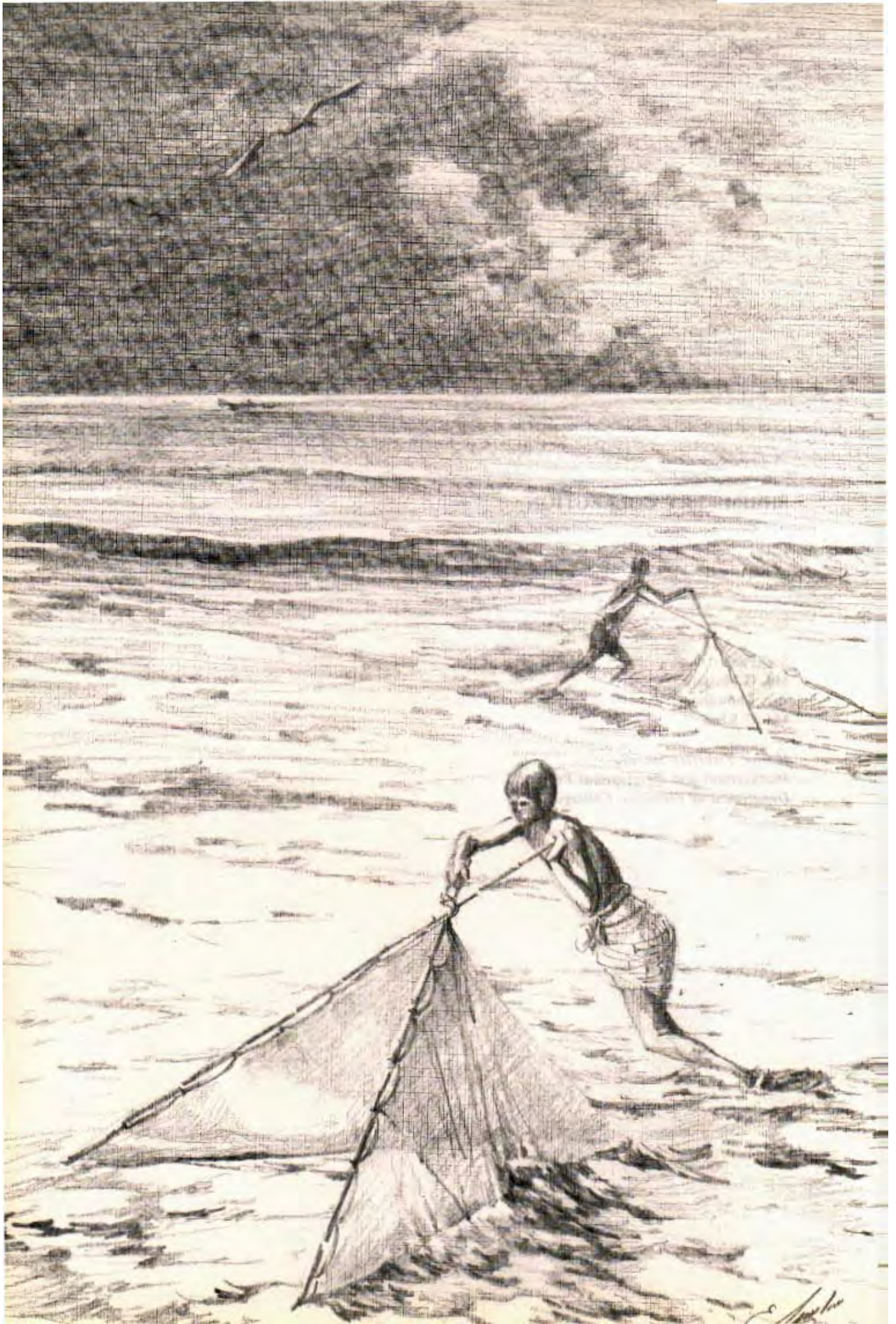


## **SHRIMP FRY COLLECTION**

by

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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 gagnets, 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 demand 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 do 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. monodon* fry.

Scientists are becoming increasingly concerned about a possible threat to the sustenance of the shrimp stock posed by fry-collection, but, 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

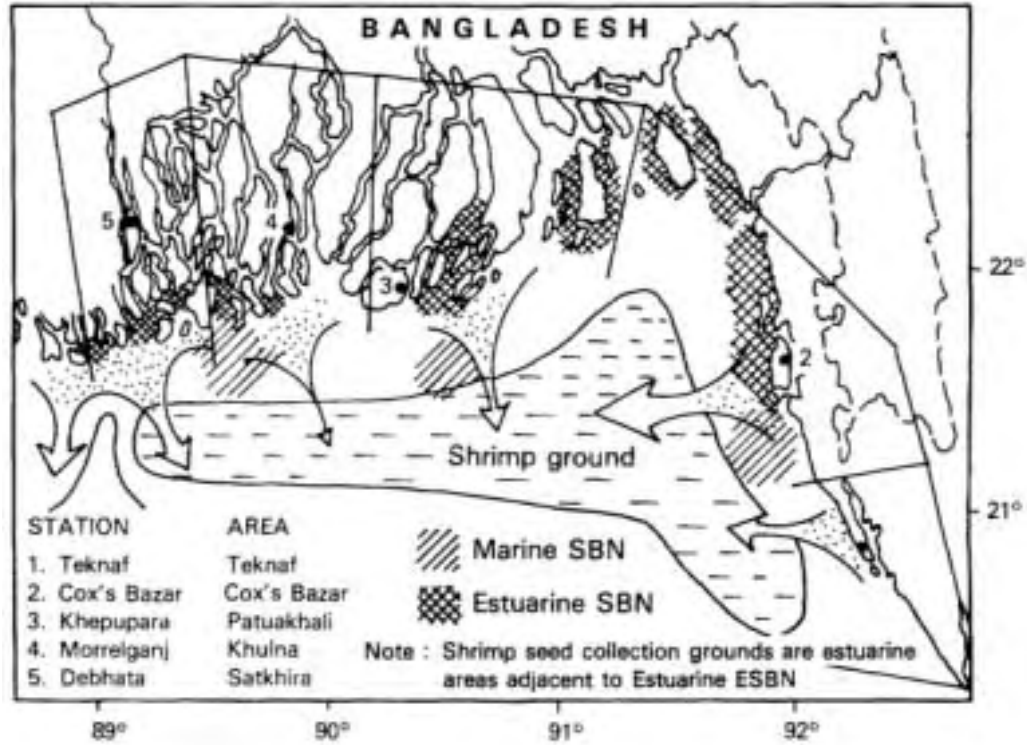
The sampling stations along the coastal belt of Bangladesh were selected on the basis of a preliminary investigation, which provided information on the availability of *P. monodon* fry and the level of its commercial exploitation. The selected commercial shrimp fry-collecting stations were Teknaf, Cox's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

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	Area
Teknaf	Teknaf
Cox's Bazar	Cox's Bazar
Khepupara	Patuakhali
Morreiganj	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 pushnet (PN) is the most common in the Teknaf and Cox's Bazar area, while the fixed hagnet (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<sup>2</sup>. 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.

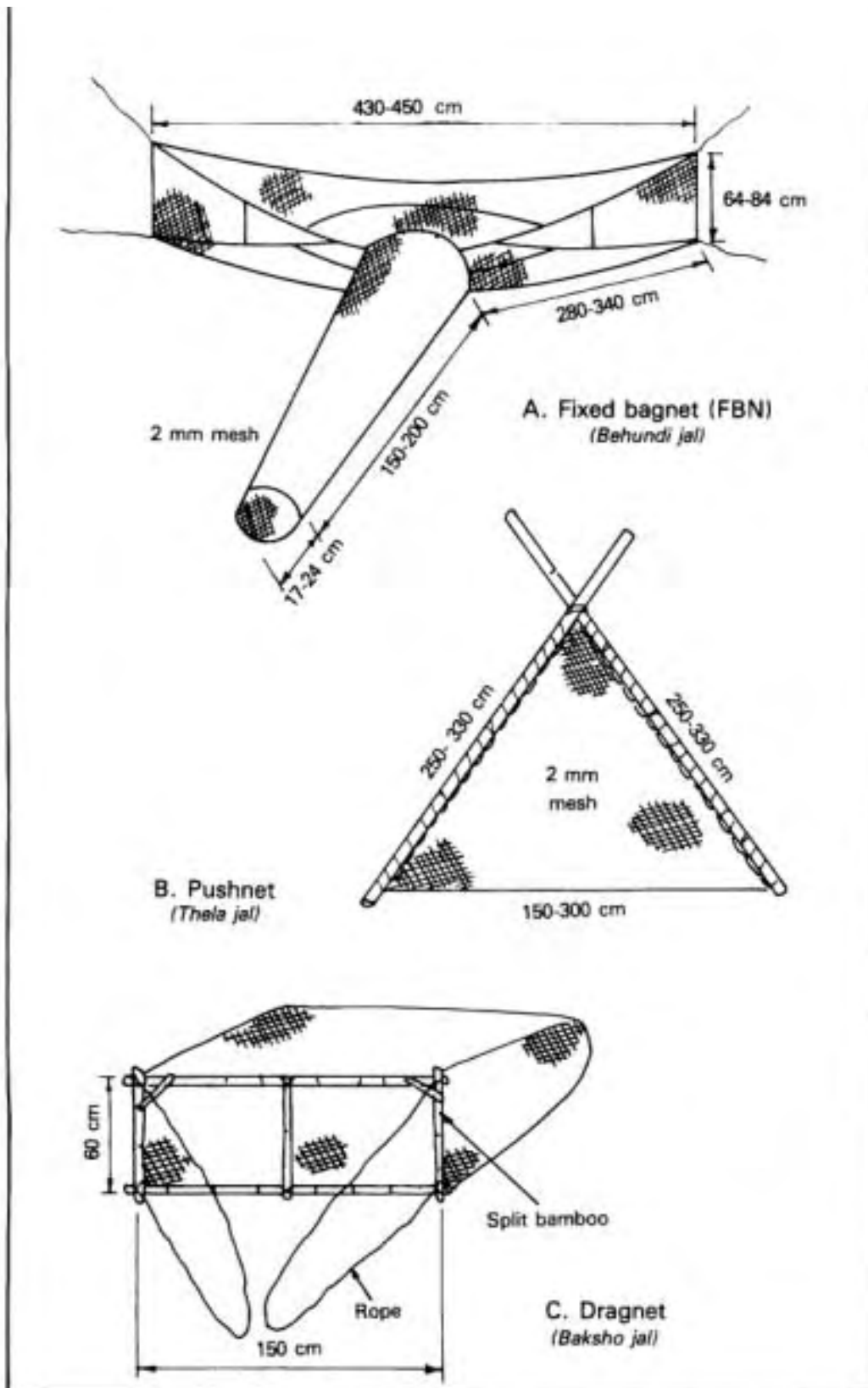
## 2.3 Sampling procedures

The shrimp fry-collection was studied from November 1989 to October 1990. Sampling was conducted fortnightly, 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 from the commercial catches.

US \$ 1 = Tk 32 appx(1990)

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



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, but 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

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 1.

**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

### 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 Bazar		Patuakhali		Khulna		Satkhira	
	PN	FBN	PN	FBN	PN	FBN	DRAG	ERN	PN	FBN
1. <i>P. monodon</i>	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 penaeid 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 (*Stolephorus* sp.) in Khulna and Croaker (*Sciaenidae*) in Satkhira. The FBN had higher proportions of Anchovy larvae in Cox's Bazar, Patuakhali and Khulna.

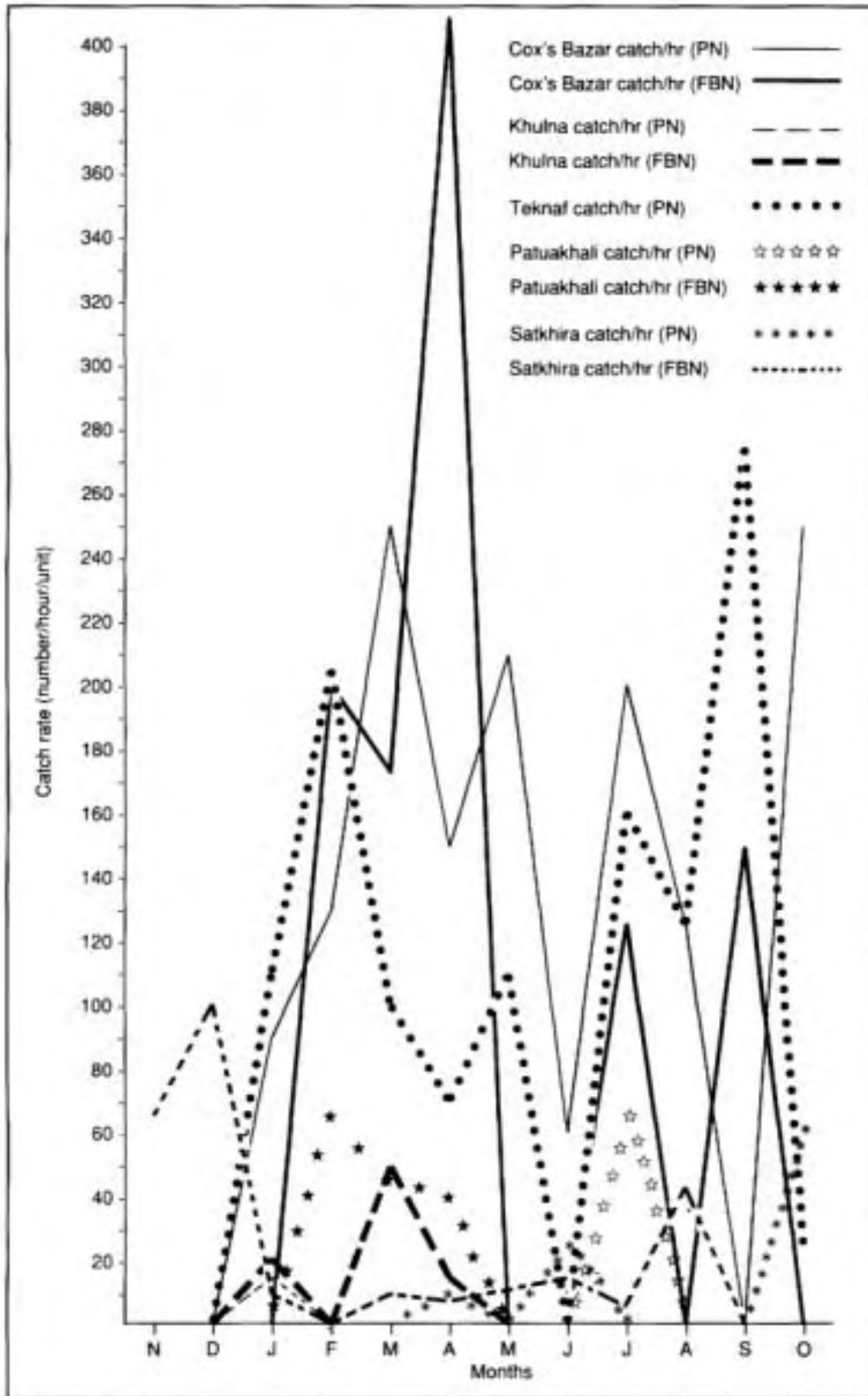
### 3.3 Catch rates

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‰) were distinctly higher than those for Patuakhali, Khulna (2.0‰) and Satkhira (6.7‰).

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.



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



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

Month	Teknaf		Coxs Bazar		Patuakhali		Khulna		Satkhira	
	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)**

Month	Teknaf		Cox's bazar		Patuakhali		Khulna		Saikhira		Total by gear		Grand Total
	PN	PN	FBN	PN	FBN	DRAG	FBN	PN	FBN	PN	FBN		
November	-	-	-	-	-	-	-	-	-	74	-	74	74
December	-	-	-	-	-	-	-	-	13.9	-	-	13.9	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	-	-	-	-	97.7	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	11.2	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	
(Grand total (by area))	163.0	1345.9	-	143.5	-	24.9	-	356.4	-	2033.7	-	2033.7	
%	8	66	-	7	-	1	-	18	-	100	-	100	

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 <i>P. monodon</i> exported	Pond mortality (%)	Transport mortality (%)	Estimated no of <i>P. monodon</i> fry (million)
1987	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)**

Month	Teknaf		Cox's ha:ar		Patuakhali		Khulna		Satkhira		Total by gear	
	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	-	

### 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)**

Month	Teknaf		Cox's Bazar		Patuakhali		Khulna		Satkhira		Total	
	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 areas 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	15	-	-	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

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

Month	Teknaf		Cox,sBazar		Patuakhali		Khulna		Satkhira	
	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

(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. monodon* 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)

Species/Group name	Pushnet					Fixed hagnet			
	Teknaf	Cox's bazar	Patua-khali	Khulna	Satkhira	Cox's bazar	Patua-khali	Khulna	Satkhira
<i>Penaeus monodon</i> (Tiger Shrimp)	2.3	4.0	0.5	0.2	0.5	1.8	0.3	0.1	0.7
<i>P. indicus</i> (Indian White Shrimp)	7.7	9.6	0.0	0.0	0.0	49.9	0.6	0.0	0.0
<i>Metapenaeus monoceros</i> (Brown Shrimp)	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.4
<i>M. brevicornis</i> (Yellow Shrimp)	0.0	0.0	1.6	0.0	1.5	0.0	0.0	0.0	0.2
<i>Parapenaeopsis stylifera</i> (Kiddi Shrimp)	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.1
<i>P. sculptilis</i> (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
<i>Palaeomon styliferus</i> (Roshana Prawn)	0.0	0.0	0.0	0.2	0.0	0.0	0.3	0.0	0.0
<i>Macrobrachium</i> sp. (Prawn)	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.3	0.3
<i>M. rosenbergii</i> (Giant River Prawn)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Macrobrachium</i> sp. (Other River Prawn)	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
<b>Caridean shrimp (Nonpenaeid shrimp)</b>	0.1	3.1	42.2	11.1	19.6	0.6	6.2	17.4	18.6
<i>Eleutheronema tetradactylum</i> (Threadfin)	0.0	0.0	0.0	0.0	0.0				
<i>E. thoracata</i> (Threadfin)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>A. miops</i>	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>C. dussumieri</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
<i>Cynoglossus</i> sp. (Tonguesole)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
<i>Anguilla</i> (Eel)	0.2	0.3	0.0	0.0	1.4	0.0	0.1	0.0	0.7
<i>G. griseus</i>	0.1	1.7	0.0	0.1	0.0	0.0	0.0	0.3	1.2
<i>Gobiidae</i> (Gobs)	0.0	0.0	0.0	2.3	0.5	1.1	0.0	0.6	2.2
<i>Hemiramphus</i> sp. (Halfbeak)	0.1	0.0	0.0	0.0	0.0	—	—	—	—
<i>Sciaenidae</i> (Croaker)	0.3	0.5	0.9	0.0	8.3	0.0	0.0	0.0	0.5
<i>Lateolabrax calcarifer</i> (Giant Perch)	0.4	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0
<i>Leiognathus</i> sp. (Ponyfish)	0.0	0.7	0.0	0.0	0.0	0.5	0.0	0.0	0.0
<i>Mugilidae</i> (Mullet)	0.1	0.1	0.0	2.0	0.2	0.6	0.0	0.0	0.2
<i>Pomadasys maculatus</i> (Slipmouth)	0.9	1.8	0.0	0.0	0.0	0.8	0.0	0.0	0.0
<i>Setipina</i> sp.	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1
<i>Stolephorus fuscus</i> (Anchovy)	0.0	2.3	0.0	8.2	0.1	4.9	13.9	1.7	0.1
<i>Sardinella</i> sp. (Sardine)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
<i>Sillago sihama</i> (Whiting)	10.4	12.8	0.0	0.0	0.0	1.6	0.0	0.0	0.0
<i>Therapon</i> sp. (Therapon)	0.0	0.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Other finfish larvae	0.1	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
<i>Squilla</i>	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
<b>Plankton + other organisms</b>	<b>77.1</b>	<b>30.6</b>	<b>53.9</b>	<b>73.1</b>	<b>62.6</b>	<b>32.7</b>	<b>78.2</b>	<b>79.1</b>	<b>72.3</b>

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