A Socioeconomic and Bioeconomic Analysis of Coastal Fisheries of Bangladesh

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Khan, S.M. and M.S. Haque. 2003. A socioeconomic and bioeconomic analysis of coastal fisheries of Bangladesh, p. 387 - 438. *In* G. Silvestre, L. Garces, I. Stobutzki, M. Ahmed, R.A. Valmonte-Santos, C. Luna, L. Lachica-Aliño, P. Munro, V. Christensen and D. Pauly (eds.) Assessment, Management and Future Directions of Coastal Fisheries in Asian Countries. WorldFish Center Conference Proceedings 67, 1 120 p.

Abstract

Bangladesh has an exclusive economic zone (EEZ) of 164 000 km^2 and a continental shelf area of 66 440 km^2. Artisanal (small scale) fisheries extend from the coast to 40 m while industrial (commercial scale) fisheries operate beyond 40 m depth. The coastal fisheries of Bangladesh exploit a complex multi-species resource. There are 18 demersal and pelagic species, seven species of larger pelagic and 10 shrimp species that are commercially important among the fishes exploited. In 1996 - 97, total fish production reached 1.3 million t with 75% from capture fisheries (0.9 million t) and 25% from aquaculture (0.4 million t). Artisanal fishing operations dominated the marine fisheries, contributing 82% of the total fish production.

Information on the gross national product (GNP) and domestic product (GDP) showed that the share of agriculture has been declining over the years. The national income accounting procedure in Bangladesh divides the agriculture sector into crops, livestock, forestry and fisheries. Fisheries contribute to economic development of the country in four ways: (a) helping to achieve high growth rates by creating the necessary value-added; (b) providing employment to a large number of people; (c) adding a large volume of valuable foreign exchange; and (d) providing a cheap source of essential food to lower income people. In 1997 - 98, GNP, GDP and value-added contributions at current prices by the fisheries sector amounted to US$35 716 mil, US$34 062 mil and US$1 808 mil, respectively. Of the total export value of US$1 217 mil, 8.5% (US$104 mil) came from fish and fish products. In terms of food consumption, fish ranks third as the most important food item with a mean per capita consumption of 8.36 kg•year^{-1}.

There are three major fishing fleets in Bangladesh namely, the trawlers, the mechanized boats and the non-mechanized boats. In 1972 - 73, there were 10 trawlers and 200 mechanized boats operating in the fishing grounds of Bangladesh. This expanded to 54 trawlers, 3 317 mechanized boats and 14 014 non-mechanized boats in 1996 - 97. Trawlers were divided into 41 shrimp and 13 fish units while mechanized boats included gillnet, set bag net and long-line gear. Non-mechanized boats are also used for gillnet fishing, set bag net fishing, long-line fishing, trammel net fishing and other gear.

The Schaefer and Fox Models were used to estimate the maximum sustainable yield (MSY) for the fisheries of Bangladesh. Results of these bioeconomic models show

that MSY is estimated to be 4 029 t at MSY effort of 9 317 standard fishing days (SFD) using Schaefer's Model. MSY reached 4 136 t at MSY effort of 11 822 SFD using Fox's Model. The current catch of 2 444 t at an effort of 7 491 SFD indicates over-fishing. If this situation continues, the fishery resources will diminish with time. Precautionary measures should be adopted by the Government to minimize if not totally prevent over-exploitation of the fishery resource in the Bay of Bengal. The Government should enact laws and ensure their enforcement. The present number of large trawlers and boat owners should not be allowed to increase. The trawlers and large boat operators should avoid intrusion into near-shore areas and reduce discards/by-catch problems. Artisanal fishers should abandon destructive fishing gear like estuarine set bag net (ESBN), push nets and current jall that kill small fish. Community-based management should be adopted with initiatives coming from the Government, other international and regional agencies and the stakeholders.

Review of the Status of Fishery Resources

The Coastal Water Area

The exclusive economic zone (EEZ) of Bangladesh spans 166 000 km^2 and the shelf area covers 66 440 km^2. The coastal water is very shallow with depths less than 10 m covering 24 000 km^2. Coastal waters are characterized by a prolonged low saline regime due to river discharges. The shelf area down to about 150 m has been found suitable for smooth trawling with very few obstacles. Artisanal fisheries, which previously extended to 20 m depth, now extend to 40 m. An ordinance of the government of Bangladesh (Ministry of Fisheries [MOF] 1997) regulates fishing by traditional fishers up to 40 m depth. Thus, by implication industrial fisheries are those that operate beyond 40 m depth (Habib 1999).

Fishery Resources

Coastal fisheries of Bangladesh exploit a complex, multi-species resource. Eighteen species of demersal and small pelagic, 7 species of larger pelagic and 10 species of shrimps are commercially important exploited resources. Studies undertaken to examine the development potential and status of the resources give different estimates of trawl-able fish stocks varying from 40 000 - 55 000 t to 260 000 - 370 000 t. The current consensus based on a reassessment of these and related studies is a trawlable standing stock of 150 000 - 160 000 t in the coastal waters. Roughly 53% of the standing stock consists of commercially important demersals and 16% consists of commercially important pelagics. Studies on shrimp conducted between 1973 and 1987 give a standing stock of 1 500 - 9 000 t. More recent work suggests a maximum sustainable yield (MSY) figure of 7 000 - 8000 t of penaeid shrimps (Khan et al. 1997). Available information on pelagic resources puts the standing stock at 90 000 - 160 000 t, based on acoustic survey results.

In 1970, coastal fisheries constituted only 10.6% of the total fishery production, but the proportion of coastal fisheries production increased to 28.2% in 1993. In 1996 this proportion, however, declined to 22% (Ministry of Fisheries [MOF] 1997). It is widely acknowledged that increasing pressure on the coastal resources in Bangladesh has caused a decline in marine fish and shellfish in the Bay of Bengal. Artisanal fisheries landings, which contribute about 95% of the total marine landings, are largely composed of post-larvae and juveniles. This has a damaging effect on the stock. Traditional fishing gear is destructive. The trawl fleet is also causing damage as it catches the parent stock during the peak season and also the post-juveniles. An estimated 80% of the catch is not landed by trawlers but discarded at sea. Efforts at limiting trawl operations to deeper (beyond 40 m) areas have been thwarted by court intervention (injunctions). The provision regarding the closed season (Jan. 15 - Feb. 15) is hardly enforced.

The importance of the fisheries sector in the national economy of Bangladesh can be appreciated from Table 1 and Appendix Table 1. In 1996 - 97, the total fish production in Bangladesh was almost 1.3 million t, of which 0.9 million t came from the capture fishery and 0.4 million t from the culture fishery. Table 1 shows that duting a period of 12 years, the capture fishery accounted for 76% of the total fish caught while the remaining 24% was contributed by the culture fishery. The inland fishery supplied 75% of all fish caught in the country, whereas the share of the marine fishery was 25%. Artisanal or small scale fishing dominated the marine fishery, contributing 82% of the total fish caught. The mean values for the decade are smaller

to the corresponding values of 1996 - 97, thus the volume of fish production increased significantly over the decade.

Contribution of the Fisheries Sector to Economic Growth and Welfare

Introduction

Bangladesh is a developing country where much of the total value-added originates in the agriculture sector. But published data on GDP and components of GDP reveal that the share of agriculture in GDP has been declining over the years since independence. The share of the industrial sector has remained more or less constant. Only the services sector has flourished during the last decade. The national income accounting procedure in Bangladesh divides the agriculture sector into four subsectors: crops, livestock, forestry, and fisheries. The fishery is an important sub-sector[1] which contributes to the economic development of Bangladesh in four ways. First, the fisheries sector helps achieve high growth rates by creating the necessary value-added. Second, the fisheries sector provides employment to a large number of people. Third, fish and fish products as an export item fetch a large volume of valuable foreign exchange. Finally, fish and fish products provide a cheap source of essential food nutrients to lower income people. Despite the fisheries sector's strategic importance to economic development, it remains a neglected sector.

Our objective in this section is to evaluate the role of the fisheries sector in the economic development of Bangladesh by examining the performance of the fisheries sector in relation to the performance of other sectors. This can be done separately for each of the four roles of the fisheries sector mentioned earlier. For doing so, we developed some methods of analysis and applied these to the four roles of the fisheries sector. First, we discuss the sources of data and methodology of analysis.

Data and Methodology

Most of the data used in this section are adapted from different issues of the Statistical Yearbook of Bangladesh, Household Expenditure Survey and the Yearbook of Agriculture Statistics of Bangladesh. For additional data, we consulted:

Export From Bangladesh, 1972 - 73 to 1995 - 96. (published by Export Promotion Bureau) and *Fish Catch Statistics of Bangladesh*. (published by Department of Fisheries (DOF).

Most of the variables used in this section are from observations for the period from 1972 to 1998. Values of some variables were not available for the last year and data for marine fisheries and inland fisheries were not recorded separately for the first seven years, 1972 to 1979. Export data for the period 1972 to 1996 were used. National Food Balance data on different kinds of food nutrients were recorded for the period 1982 to 1995. We used both GDP data at constant prices (with 19984 - 85 as the base year) and GDP data at current prices but data on GDP at constant prices, were used for analytical purposes.

Table 1. Volume of fish production (t) in Bangladesh.

	Items	Quantity 1996 - 97 (t)	Mean Quantity 1986 - 97 (t)	Mean Proportion
1.	Capture Fishery	874 604	742 510	75.91
	a. Marine	274 704	243 710	25.10
	i. Large scale	13 564	11 390	1.18
	ii. Small scale	261 140	232 320	23.92
	b. Inland	599 900	498 800	50.82
2.	Culture Fishery	432 135	244 240	24.09
	a. Shrimp Farms	79 020	37 369	3.62
	b. Other Culture	353 115	206 880	20.47
3.	Inland Total	1 032 035	743 040	74.90
4.	Marine Total	274 704	243 710	25.10
5.	TOTAL	1 306 739	986 750	100.00

[1] Very recently, the Government of the People's Republic of Bangladesh decreed the formation of a new Ministry assigning it duties related to fisheries management. Henceforth, we will use the term "fisheries sector" instead of 'fisheries sub-sector'.

In this paper, the services sector has been defined as the sum of the following sub-sectors of GDP: Construction, Power, Gas, Water, Sanitary Services, Transport, Storage, Communication, Trade Services, Housing Services, Public Administration, Defense, Banking, Insurance, Professional and Miscellaneous.

To evaluate the role of the fisheries sector in economic growth and welfare, we used the following methods of analysis: first, we analyzed the relative position of the fisheries sector on the basis of the descriptive statistics (e.g. means) in relation to other sectors. This was done for time series data on both value-added by the sectors and proportions of the sectors in GDP. Second, we calculated annual growth rates of all sectors in GDP using the following formula:

$$\text{Growth Rate of } Y = \frac{(Y_t - Y_{t-1}) * 100}{Y_{t-1}}$$

where

Y_{t-1} = previous value of the variable
Y_t = current value of the variable

Time-series plots of annual growth rates of two or more sectors were drawn in the same figure. Calculated series of growth rates for each variable were marked by wide variations so that making any decision about the growth pattern of the variable in question became extremely difficult.

To overcome the problem of wide fluctuations in the annual growth rates, we applied the econometric technique of non-linear regression to estimate a constant parametric growth rate for each variable. The underlying assumption in estimating such a parametric growth rate is that the variable in question grew exponentially at a constant rate over the sample period. The divergence between annual growth rates and the constant parametric growth rate can be attributed to random disturbances. Such estimated growth rates provide a concrete growth pattern for a variable, as long as the sum of squared differences between annual growth rates and the estimated constant growth rate is sufficiently small and does not exceed predetermined tolerance limits. In the parlance of econometrics, the acceptance of the estimated growth rate is contingent upon having a high R^2 value. The estimate of slope in a linear regression of the logarithm of a variable on a "time" variable is the estimated constant growth rate of the variable in question:

$$\text{Log } \hat{Y} = \hat{\alpha} + \hat{\beta} * \text{time},$$

where a ' ^ ' over a variable or a parameter signifies the estimated value of the variable or parameter in question and $\hat{\beta}$ denotes the estimated growth rate. In econometric estimation, OLS (Ordinary Least Squares) estimates are generally preferred to other estimates. When OLS estimates tend to be biased due to different problems like autocorrelation, heteroscedasticity, etc., we use estimated GLS (Generalized Least Squares). Third, we examined the time-series plots of proportions of each sector in GDP. For better comparison, we drew time series plots of two or more sectors in one figure. Time series plots of proportions illuminate the nature of changes in each sector.

Contribution of the Fisheries Sector to GDP Growth

Estimated annual growth rate in a country is the most widely used criterion of economic development. Each of the sectors and sub-sectors contributes to the growth of a country's GDP. Our goal in this section is to make a comparative evaluation of contributions of different sectors to the GDP growth in Bangladesh.

Descriptive Statistics on Value-added by Sectors

Table 2 presents statistics on GNP, GDP and contributions of different sectors to GDP at both current and constant prices.

Annual Growth Rates of Sectors

More insights into the nature of contributions of different sectors to GDP are given in Table 3. The industry sector attained the second highest annual growth rate of almost 10% in 1997 - 98. The fisheries sector grew at the rate of 9%. Although the mining and quarrying sector had the highest growth rate, the sector was still without much importance accounting for a negligible share of GDP. Both GNP and GDP performed reasonably well during the 1997 - 98 financial year growing at the annual rates of 5.45% and 5.66%, respectively. The agriculture sector had the smallest annual growth rate at 2.94%. Annual growth rates of different sectors during the year 1998 provide a partial view of the growth pattern of GDP; examination of historical annual growth rates over a period of twenty-six years (1973 - 99) may present a better picture.

Table 2. Contribution of the fisheries sector to GDP growth: value-added figures.

Sector	Value in 1997 - 98 (Current Price)		Value in 1997 - 98 (Constant Price)		Mean Value (Constant Price)
	Tk (m)	US$ (m)	Tk (m)	US$ (m)	Tk (m)
GNP	1 623 516	35 716	753 570	29 024	449 660
Per Capita GNP	12 834	282	5 957	229	N/A
GDP	1 548 334	34 062	718 674	27 680	436 650
Per Capita GDP	12 240	269	5 681	219	N/A
Agriculture	443 560	9 758	226 959	8 742	171 710
Industry	148 664	3 270	82 601	3 181	44 730
Mining and Quarrying	492	11	293	11	54
Services	955 618	21 023	408 821	15 746	220 160
Fisheries	82 182	1 808	23 485	905	14 394
Inland Fisheries	71 056	1 563	20 305	782	12 563.5
Marine Fisheries	11 126	245	3 180	123	1 830.5
Agricultural without Fisheries	361 378	7 950	203 474	7 837	157 320

Note: N/A = Not Available.

Table 3. Contribution of the fisheries sector to GDP: percentage shares and growth rates, current for the year 1997- 98.

Sector	Current Share in GDP	Mean Share in GDP	Estimated Growth Rates of Shares	Current Annual Growth Rate	Estimated Constant Growth Rate of Sectors
GNP	–	–	–	5.45	4.45[a]
Per Capita GNP	–	–	–	3.62	2.33[a]
GDP	–	–	–	5.66	4.25[a]
Per Capita GDP	–	–	–	3.82	2.13[a]
Agriculture	31.58	41.11	-1.95[a]	2.94	2.22[a]
Industry	11.49	10.01	1.35[a]	9.55	5.99[a]
Mining and Quarrying	0.04	0.009	12.14[b]	32.00	16.54[a]
Services	56.89	48.86	1.41[a]	6.43	5.59[a]
Fisheries	3.27	3.50	-2.71[a]	8.60	1.95
Inland Fisheries	2.83	3.05	-3.11[b]	8.60	1.55
Marine Fisheries	0.44	0.41	1.76[a]	8.60	6.47[a]
Agricultural without Fisheries	28.31	37.61	-1.92[a]	2.34	2.36[a]
Inland Fisheries in Total Fisheries	N/A	87.26	-0.27	N/A	N/A
Marine Fisheries in Total Fisheries	N/A	12.14	4.50[a]	N/A	N/A

Note: [a] = significant at 1% level; [b] = significant at 5 % level; N/A = Not Available.

Time Series Plots of Annual Growth Rates

Annual growth rates calculated for GNP, GDP, and value-added by all sectors of GDP have been recorded. However, because of its irregular fluctuations, it is difficult to discern any trend and provide analysis based on trends.

Regression Analysis of Constant Growth Rates

Annual growth rates are characterized by widespread fluctuations. It is difficult to discern any systematic pattern from annual growth rates. Constant growth rates estimated with the help of regression analysis can be more helpful in determining the nature of growth patterns of GDP and value-added by the sectors of GDP than the annual growth rates. These growth rates are given in Table 3.

Analysis of Sector Shares

Descriptive Statistics on Proportions

The proportion of each sector in GDP for every year is given in Table 3. The published figures for 1997 - 98 show that the percentage shares of the agriculture, industry, and services sectors in the GDP at constant prices were 31.58%, 11.49% and 56.89%, respectively. The fisheries sector contributed only 3.27% of the GDP in 1997 - 98. It is evident from Table 3 that the services sector with a mean share of 48.86% accounted for most of the value-added in the country. As a contributor to GDP growth, the agriculture sector came second with a mean proportion of 41.11%. The industry sector supplied on the average a meager 10% of the total value-added. The mean share of the fisheries sector in the GDP stood at 3.5%, almost 87% of which was provided by inland fisheries. On the average, approximately 0.41% of the total value-added came from marine fisheries during the sample period. The mining and quarrying sector supplied a negligible proportion of the GDP only 0.009%.

Time Series Plots of Proportions

The following five figures show the proportions of the various sectors in the GDP.

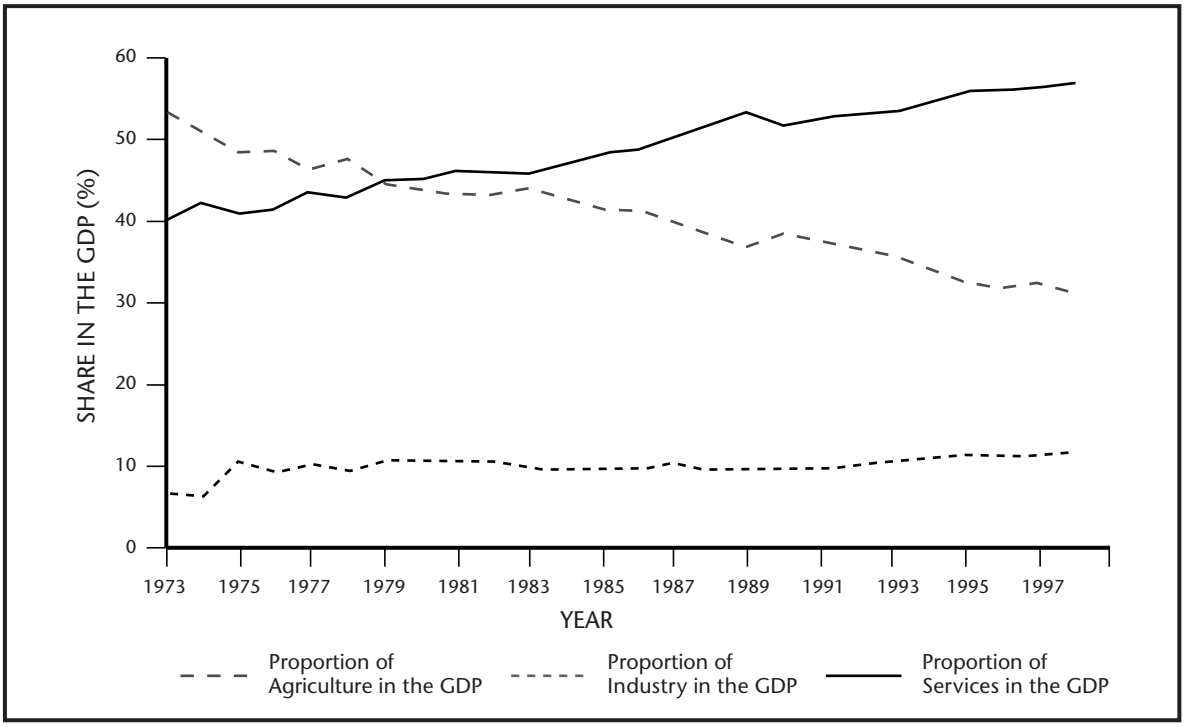

Fig. 1. Proportions of the agriculture, industry and services sectors in the GDP.

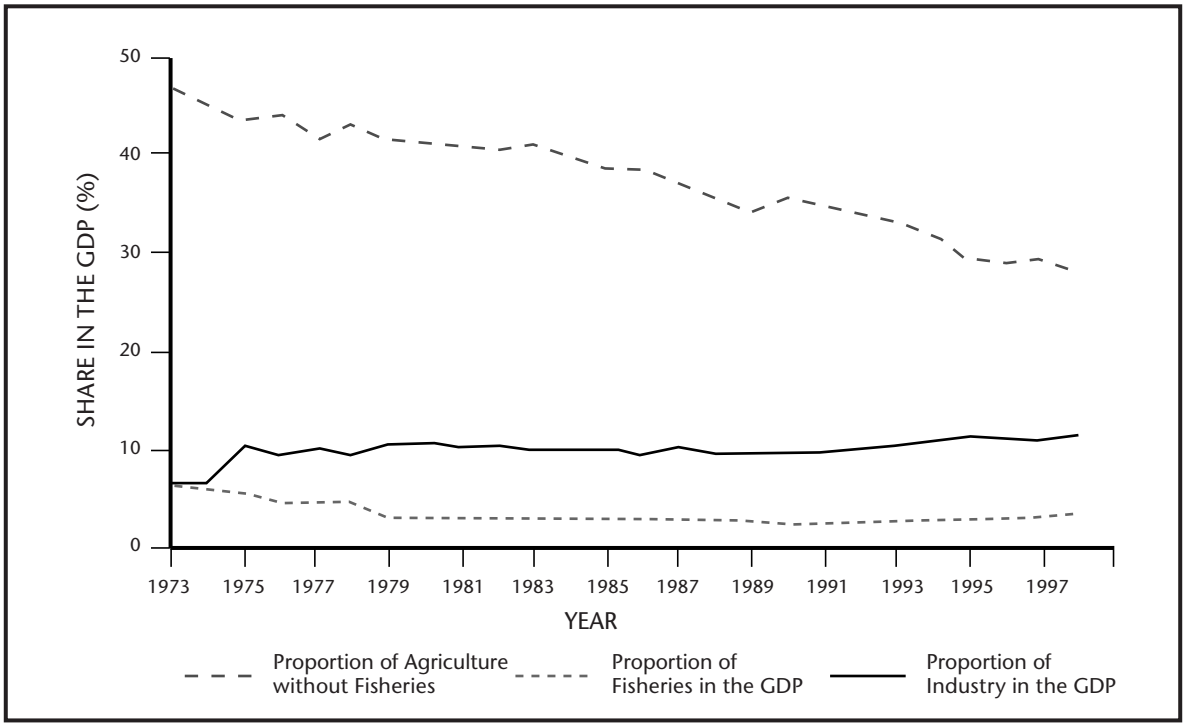

Fig. 2. Proportions of the agriculture sector without fisheries, with fisheries and industry sectors in the GDP.

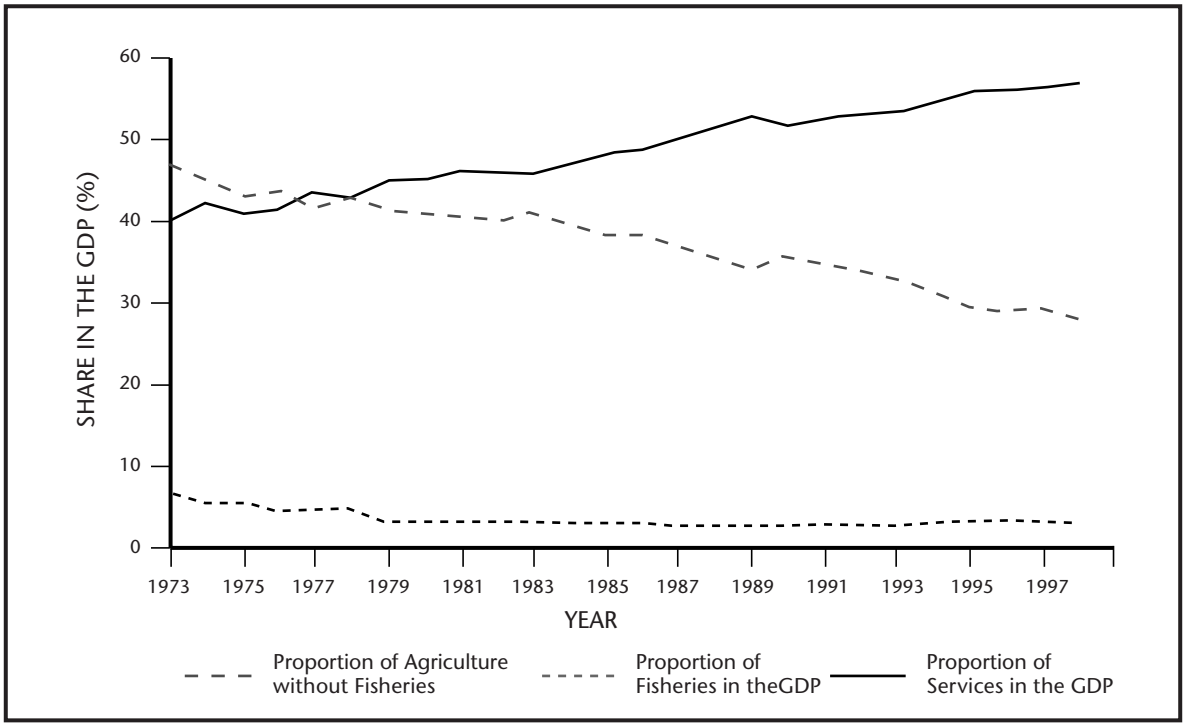

Fig. 3. Proportions of the agriculture without fisheries, with fisheries and services sectors in the GDP.

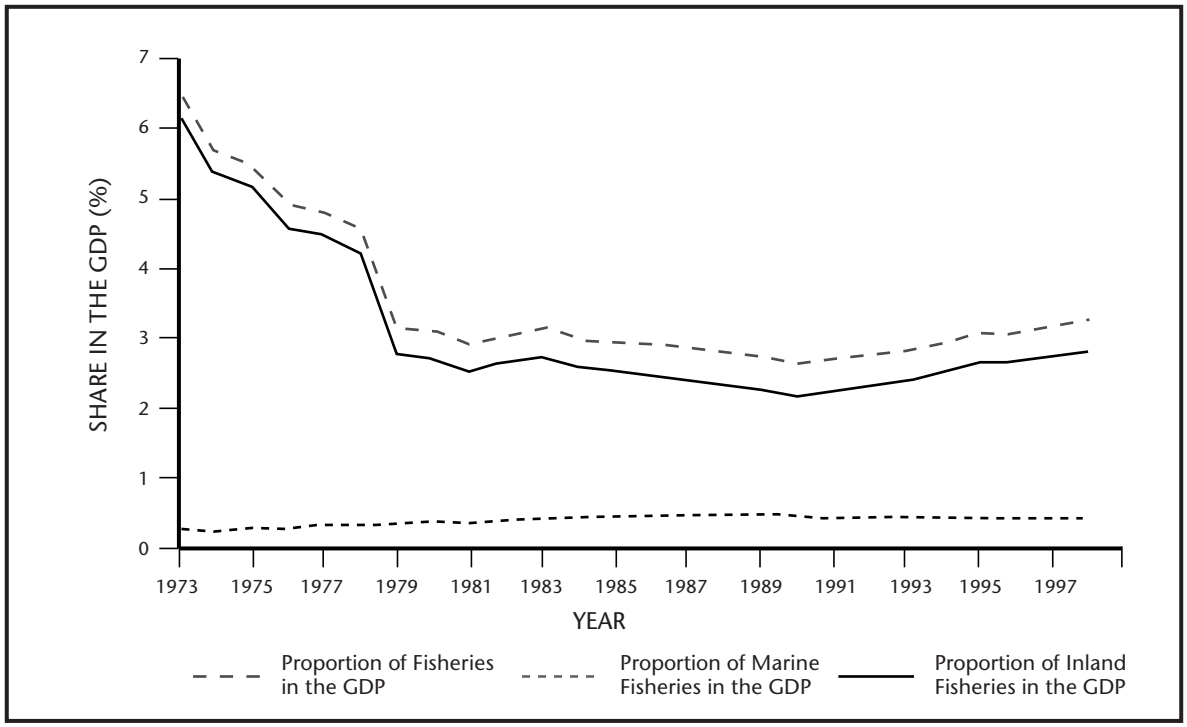

Fig. 4. Proportions of the fisheries, marine fisheries and inland fisheries sectors in the GDP.

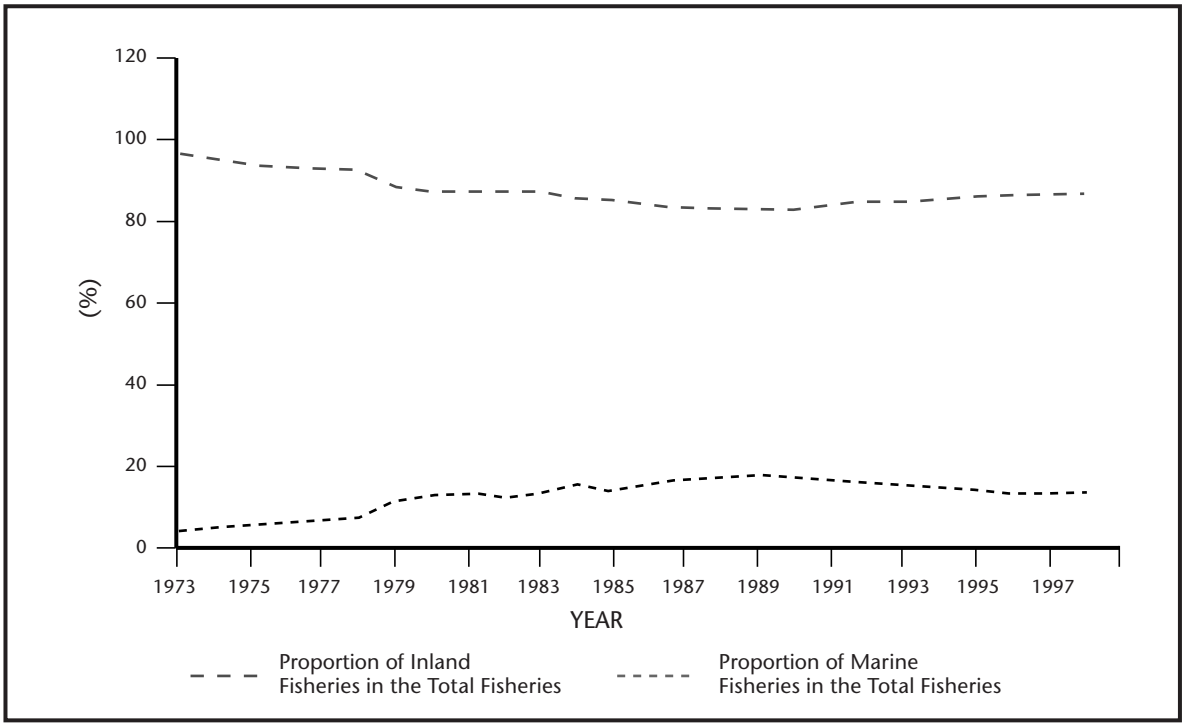

Fig. 5. Proportions of the marine fisheries and inland fisheries in the total fisheries.

Inspection of the time series plots of proportions gives a clear idea of the changing shares of different sectors in the GDP, but it cannot provide the exact measurements of such changes. Regression analysis can be useful for measurements of changes of shares of different sectors over the sample period.

Regression Analysis of Proportions

The estimates of growth rates of proportions were obtained using both the Ordinary Least Squares (OLS) and Generalized Least Squares (GLS) methods. Since most of the OLS regression models had the problem of auto-correlated errors, the analysis of regression results here is based on GLS estimates, which corrects for auto-correlation. Results in Table 3 show negative growth rates for proportions of the agriculture and agriculture without fisheries, with fisheries and inland fisheries sectors, and positive growth rates for the mining and quarrying, industry, marine fisheries and services sectors. In these cases, the estimated coefficients are significantly different from zero at either 5% or 1% levels of significance. In other words, the shares of the agriculture, fisheries and inland fisheries sectors in GDP fell over the sample period.

Mean proportions of the services, agriculture, industry and fisheries sectors in the GDP were 48.86%, 41.11%, 10.01%, and 3.5%, respectively over a period of 26 years. The proportion of the agriculture sector decreased and the proportion of the services sector increased over the sample period. The proportions of the industry and fisheries sectors remained stable. The annual growth rates of the agriculture and agriculture without fisheries sectors fell throughout the sample period, with a few upward fluctuations occasionally occurring. With a few exceptions, the growth rates of the GDP, and of the industry and services sectors were more or less stable. On the average, the growth rates of the services sectors were higher than those of other sectors. The fisheries sector had low growth rates initially, but these growth rates were higher than the growth rates of other sectors at the end of the sample period.

Contribution of the Fishing Industry to Income and Employment

The fisheries sector in Bangladesh provides employment to a large number of people. The artisanal fishers comprise a large section of the total population. Some people are also involved in activities related to fishing such as trading in fresh and dried fish, making fishing gear and crafts, etc.

Data on the total employment level and by sector are available for only a few population census and labor-force survey years. But time series data for the period from 1972 to 1990 on employment levels in the fisheries, marine fisheries and inland fisheries sectors have been recorded elsewhere, and time series observations on nominal wages rate indices by sector are available for the period 1981 - 98.

As in previous sections, descriptive statistics on employment levels have been analyzed. For employment data, two alternative procedures have been applied. Initially, descriptive statistics on employment levels were calculated using the available six observations for all sectors excluding the fisheries sector. For the fisheries sectors, 17 observations were used for calculating the descriptive statistics. Alternatively, interpolated figures were substituted for missing observations to complete the time-series data on employment levels of all sectors of the economy. Data series were interpolated from a trend line estimated for each sector using the available six observations. For each series, we had ultimately 24 observations. The completed time series data were then used in estimating the constant growth rates and calculating descriptive statistics.

Second, we estimated constant growth rates of employment levels with the help of the interpolated data series. Econometric estimates based on six observations are not sufficiently precise, although these estimates are still unbiased.

Third, we calculated real wage rate indices for different sectors of the economy by deflating the nominal wage rate indices by the consumer price index (CPI). Descriptive statistics were not calculated for these real wage rate indices because descriptive statistics on indices are not as interesting as are those on absolute values. Constant growth rates were, however, estimated for these real wage rate indices.

Fourth, we created some pseudo-average productivity of labor series for people employed in different sectors of the economy. To do this for a particular sector, value-added by the sector at constant prices in a particular year was divided by the employment level of the corresponding sector in that year. We then tested for differences in means of average productivity of labor between the sectors.

The seven estimated trend lines using OLS in Table 4 were applied for creating interpolated data series for different sectors:

Table 4. Estimated trend lines of employment levels in Bangladesh.

Sector	Estimated Trend Line	T - Value	Adjusted R^2	d - statistics
Aggregate	TÊ = 10479000 + 12002000 Time	4.77	0.81	1.79
Agriculture	AÊ = 10438000 + 644160 Time	3.24	0.60	1.87
Manufacturing	MÊ = -118020 + 169330 Time	2.99	0.54	1.99
Services	SÊ = -58536 + 396490 Time	6.40	0.89	2.02
Inland Fisheries	IFÊ = 647830 + 1124.4 Time	1.48	0.63	1.42
Marine Fisheries	MFÊ = 341530 + 378.06 Time	0.44	0.92	1.11
Fisheries	FÊ = 898290 + 4471.4 Time	1.65	0.67	1.89

Note: TÊ = Total Employment
AÊ = Employment in the Agriculture Sector
MÊ = Employment in the Manufacturing Sector
SÊ = Employment in the Services Sector
FÊ = Employment in the Fisheries Sector
IFÊ = Employment in the Inland Fisheries Sub-Sector
MFÊ = Employment in the Marine Fisheries Sub-Sector

Analysis of Employment Levels

Descriptive Statistics on Employment Levels

Descriptive statistics[3] on employment levels by sector are given in Table 5. The agriculture sector was the biggest employer, providing approximately 69% of all jobs. The services sector, creating 22% of the total employment, was the second biggest employer in Bangladesh. The industry sector accounted for 9% of the total employment level in the country. The mean share of the fisheries sector in the total employment level was approximately 3%. The inland fisheries sub-sector provided approximately 2% and the marine fisheries sub-sector approximately 1% of the total jobs in the country. Table 5 shows that out of a total population of 124.3 million in the country in the 1996 - 97 financial year, 54.6 million people were employed. The agriculture sector provided employment to a maximum of 34.5 million people. The services sector was the second biggest employer with 16 million employees. The numbers of employees were 6.976 million in the industry sector, 1.548 million in the fisheries sector, 0.769 million in the inland fisheries sub-sector, and 0.508 million in the marine fisheries sub-sector in the same year. Total employment in the country averaged almost 37.3 million over a period of 24 years. Average employment levels were 24.8 million in the agriculture sector, 3.64 million in the industry sector, 8.797 million in the services sector and 1.073 million in the fisheries sector. The inland fisheries and marine fisheries sub-sectors employed on the average 6.93 lakh and 3.63 lakh (1 lakh = 100,000) people, respectively.

Regression Analysis of Employment Levels

Estimated constant growth rates of employment levels are shown in Table 5. The regression estimates reveal stagnant levels of employment in the fisheries sector and in its two sub-sectors. The estimated growth rates in these sectors are not significantly different from zero at both the 5% and 1% levels of significance. The total employment level and the employment levels in the agriculture, industry and services sectors increased over a period of 24 years. The total employment level grew at the rate of 3.42% per annum. The sector growth rates of employment levels were 2.75% for the agriculture, 5.08% for the industry and 4.85% for the services sector. These growth rates are statistically significant at a 1% level and the adjusted R^2 values of the corresponding models are very high, ranging between 75%and 92%.

Regression Analysis of Real Wage Rate Indices

Constant growth rates of real wage rate indices were estimated using regression models. The estimated growth rates were statistically significant in four out of five cases. Since the real wage rate index for the services could not be obtained, we used the real wage rate index for construction as a proxy for it. With the exception of the real wage index for construction, real wage rate indices for the economy as a whole and for other sectors of the GDP registered positive growth rates. In other words, the real income of the labor force engaged in these sectors increased during the sample period. The real wage

[3] The analysis of descriptive statistics here is based on size observations.

Table 5. Contribution of the fisheries sector to income and employment.

Sector	Employment Level in 1996 - 97 ('000)	Mean Employment Levels ('000)	Mean Shares of Employment Levels	Growth Rates of Employment Levels	Mean Average Productivity of Labor (APL) (Tk)	Growth Rates of APL	Growth Rates of Real Wage Rate Indices
GDP (Total)	54 597	37 283	–	3.42[a]	10 732.78	0.50	2.25[a]
Agriculture	34 530	24 824	69.17	2.75[a]	6 690.36	-0.69	2.52[a]
Industry	6 976	3 640.2	8.78	5.08[a]	11 511.85	-0.18	2.32[a]
Services	15 959	8 796.5	22.0	4.85[a]	22 177.27	0.45	1.25
Fisheries	15 483	1 072.6	3.22	0.74	13 497.40	4.50[a]	2.28[a]
Inland Fish	768.63	692.7	2.12	0.22	16 637.49	4.46[a]	–
Marine Fish	507.8	362.3	1.06	2.17	5 106.20	5.71[a]	–

Note: [a] = significant at 1% level; [b] = significant at 5 % level. 1 US$ = Tk 42.95 (average 1996 - 97; source: oanda.com)

rate index for construction workers remained constant during the long period of seventeen years (1973 - 90). The real wage rate index for the industrial workers grew at the rate of 2.32% per annum. The general real wage rate index in the country attained a growth rate of 2.25% per annum. The rate of growth of the real wage rate in the agriculture sector was 2.52%. The real wage rate of workers in the fisheries sector increased at the lowest rate of 2.28% per annum.

Analysis of Average Productivity of Labor

Descriptive Statistics on the Average Productivity of Labor (APL)

The descriptive statistics on the average productivity of labor (APL) are given in Table 5. The mean APL over a period of 24 years (1973 - 97) was 10 732.78 taka for the country as a whole (GDP). The highest average value of APL, 22 177.27 taka, originated in the services sector, followed by the inland fisheries sub-sector with an APL of 16 637.49 taka. The marine fisheries sub-sector attained, on the average, the lowest level of average productivity of labor, 5 106.20 taka. Average productivity of labor over a period of 24 years averaged 6 690.36 taka for the agriculture sector, 11 511.85 taka for the industry sector and 13 497.40 taka for the fisheries sector.

Regression Analysis of Average Productivity of Labor (APL)

Table 5 shows that the rates of growth of APL were 4.5% for the fisheries sector, 4.46% for the inland fisheries and 5.71% for the marine fisheries sub-sector. Average productivity of labor did not increase in the agriculture, industry, and services sectors. Moreover, average productivity of labor in the country as reflected by the APL of the GDP remained stagnant over the sample period. The rate of growth of the APL was higher in the marine fisheries sub-sector than in the inland fisheries sub-sector.

T-tests for Difference of Means of Average Productivity of Labor (APL)

Table 6 shows "t" values for tests of differences of means of the APL. It has "t" values for both tests of paired differences in means, and tests of differences in means of independent samples. The mean APL in the fisheries sector was found to be greater than the mean APL in the country as a whole (GDP). The mean APL of the fisheries sector was found to be significantly greater than the mean APL of the agriculture and industry sectors. The mean APL of the fisheries sector was greater than the mean APL of the marine fisheries sub-sector and less than the mean APL of the inland fisheries sub-sector. The mean APL in the fisheries sector was much less than the mean APL in the services sector. Finally, the differences in the sample means of APL of the inland fisheries and marine fisheries sub-sectors were statistically significant. In fact, the mean APL of the inland fisheries sub-sector was much greater than the mean APL of the marine fisheries sub-sector.

Table 6. t Tests For differences of means of average productivity of labor between sectors.

Sectors	t-Value (Independent Samples)	t-Value (Paired Samples)
GDP - Fisheries	-3.58[a]	-3.75[a]
Agriculture-Fisheries	-8.93[a]	-8.72[a]
Industries - Fisheries	-1.84	-2.27[a]
Services - Fisheries	9.68[a]	12.55[a]
Fisheries - Inland Fisheries	-3.21[a]	-19.50[a]
Fisheries - Marine Fisheries	7.64[a]	14.91[a]
Inland Fisheries - Marine Fisheries	11.07[a]	19.21[a]

Note: [a] = significant at 1% level; [b] = significant at 5 % level.

Section Summary: The mean share of the fisheries sector in the total employment level was approximately 3%. The real wage rate of the workers in the fisheries sector increased at the rate of 2.28% per year.

Contribution of the Fisheries Sector to Foreign Exchange Earnings

In this section, we examine the role of the fisheries sector as a supplier of export commodities. Time series data on the export value of different commodities and groups of commodities are available for the period from 1972 to 1996. We collected secondary data on the export value of the following export items: frozen food: shrimps; frozen food: fish, fresh/chilled fish, dried fish, sealed dehydrated fish, shark fins and fish maws, tortoise and turtles, crabs, snails, turtle meat, eggs and fins, sea shell and aquarium fish.

In addition to the total export value of fish, data on the export value of all primary commodities, all manufactured commodities and the total export value for Bangladesh were also used. Fish export is a fraction of the total primary export. The previous techniques of analysis were applied to the export data used in this section. First, descriptive statistics on both absolute values and shares of different commodities and groups of commodities in the total export value were calculated. Second, econometric estimates of the constant growth rates were obtained using both the OLS and GLS methods.

Descriptive Statistics on Export Values

Table 7 shows the descriptive statistics on export values of different commodities and of groups of commodities for the period from 1972 to 1996. The mean proportion of export value of fish to total export value for Bangladesh was 7.20% over the sample period. The proportion of export value of all manufactured commodities in total export value averaged 71.38% during the same period. The mean percentage share of export value of all primary products in total export value was 28.62%. The average total export value over a period of 24 years (1972 - 96) was Tk39 445 million, out of which Tk 3 400.8 million came from fish exports. The average export earnings of all manufactured commodities and all primary commodities were Tk32 034 million and Tk7 411.3 million, respectively.

Table 7. Contribution of the fisheries sector to foreign exchange earnings.

Item	Mean export value (Tk m)	Mean export value (US$ m)	Growth rates of export values	Mean share in total export value	Growth rates of shares
Total Export	39 445	1 217.5	17.31	–	–
Primary Commodities	7 411.3	261.08	11.93	28.62	-5.48[a]
Manufactured	32 034	956.43	19.19	71.38	1.88
Fish	3 400.8	104.36	25.17	7.20	7.80

Note: [a] significant at 1% level; [b] significant at 5 % level.

Regression Analysis of Constant Growth Rates

Constant growth rates for seven variables, including three proportions, were estimated using both GLS and OLS estimation methods. The estimated growth rates of proportions reveal a falling share of all primary commodities and a rising share of fish and all manufactured commodities in total exports. The export value of all commodities and of fish grew over the sample period (1972 - 96). The export value of fish, however, grew at the highest rate of 25.17% per annum. The second highest growth rate of 19.19% was observed for the export value of all manufactured commodities. The growth rate for the total export value was 17.31%, which is much higher than the lowest growth rate of 11.93% per annum obtained for the export value of all primary commodities.

Section Summary: Although fish and fish products had initially a small share in the total export value, this share increased during the period 1972 - 96. Moreover, exports of fish and fish products grew at their highest rate during the sample period.

Contribution of the Fisheries Sector to Domestic Nutrition

This section highlights the contribution of the fisheries sector to the national consumption pattern. The peculiarity of the fisheries sector lies in its being a cheap source of food. The analysis in this section is undertaken in two perspectives. First, time series data on per capita availability of fish and other consumption items were analyzed with the help of descriptive statistics and econometric estimates of constant growth rates. Time series data are also available on the daily per capita intake of nutrients from different groups of food including fish. The three food nutrients for which data are available are energy, protein, and fats. Data on each food nutrient have been explained with the help of descriptive statistics and regression analysis tables.

Analysis of Per Capita Availability of Consumption Items

Descriptive Statistics on Per Capita Availability

The Statistical Yearbook of Bangladesh publishes data on per capita availability of 24 items, although it does not record data on the per capita availability of fish. Other sources were used for calculating the per capita availability of fish. We selected 14 items of consumption, of which 10 items were from the food group and 4 items were from the non-food group. Data on the per capita availability of consumption items are available for 19 years (1979 - 97).

Table 8 shows the descriptive statistics on the per capita availability (consumption) of food and non-food items. As the staple, food grain is the first item, with a mean per capita availability of 163.12 kg•annum^{-1}. Secondly, the mean per capita consumption of milk and milk products was 10.65 kg •year^{-1}. Fish, the third item, showed a mean per capita consumption of 8.36 kg•year^{-1}. The mean per capita availability of meat was 3.51 kg•annum^{-1}, much less than that of fish. The mean per capita annual availability of pulses, sugar, and edible oil were 3.56 kg, 2.11 kg and 1.41 kg, respectively. The mean per capita availability of eggs was 14 per annum. Among the non-food items, the mean per capita availability of cement, new cloth, paper, and electricity stood at 17.00 kg, 8.58 m, 0.42 kg and 36.94 kWh, respectively. Comparison of the mean values with current values of per capita availability of different consumption items shows declines in per capita availability of three items, viz. food grain, paper and milk and milk products. The per capita availability of other consumption items increased during the survey period.

Table 8. Contribution of the fisheries sector to national food balance: Per capita availability of consumption items.

Item	Unit	Quantity	Mean per capita avail.	Estimated growth rate
Food Grain	kg	162.00	163.12	0.04
Pulses	kg	4.50	3.56	5.14[b]
Sugar	kg	2.23	2.11	3.11[a]
Meat	kg	3.68	3.51	2.34
Eggs	no.	19	14	2.47[a]
Cement	kg	27.71	17.00	6.22[a]
New Cloth	m	11.10	8.58	3.73[a]
Paper	kg	0.39	0.42	0.46
Electricity	kWh	61.05	36.94	8.77[a]
Edible Oil	kg	1.88	1.41	1.99
Milk and Milk products	kg	10.10	10.65	-2.93[a]
Fish	kg	10.18	8.36	2.14[a]
Inland Fish	kg	8.09	6.30	1.32
Marine Fish	kg	2.21	1.90	2.93[a]

Note: [a] = significant at 1% level; [b] = significant at 5% level.

Growth Rates of Per Capita Availability

Estimates of constant growth rates of the per capita availability of different consumption items are also given in Table 8. The positive growth rates for eight items are significantly different from zero. The per capita availability of eggs, cement, new cloth, pulses, sugar, electricity, fish and marine fish grew at the rates of 2.47%, 6.22%, 3.73%, 5.14%, 3.11%, 8.77%, 2.14%, and 2.93% per year, respectively. The per capita availability of milk and milk products in fact declined at the rate of 2.93% per year over a period of 18 years (1979 - 97). Growth rates of the per capita availability were not significantly different from zero for food grains, meat, paper, edible oil, and inland fish. Per capita availability of non-food items like cement, new cloth, paper, electricity, etc., registered quite high positive growth rates.

Analysis of Availability of Nutrients

The quantity of nutrients available in a given quantity of a food item is important. Time series data on daily per capita intake of three types of nutrients from different food items are available. These data were subject to the same techniques of analysis used earlier. First, descriptive statistics on each of the three types of nutrients from different food items were explained. Second, estimates of constant growth rates for each nutrient were made.

Descriptive Statistics on Energy Intake

Table 9 shows descriptive statistics on the daily per capita intake of the three types of nutrients, energy food, protein and fat from different food groups.

Table 9. Contribution of the fisheries sector to national food balance: Current (1995 - 96) and mean (over 18 years) levels of nutrients in different foods.

Food item	Energy food, current, calories·capita^{-1}·day^{-1}	Mean Energy, calories·capita^{-1}·day^{-1}	Protein, current, g·capita^{-1}·day^{-1}	Mean Protein, g·capita^{-1}·day^{-1}	Fats, current, g·capita^{-1}·day^{-1}	Mean Fats, g·capita^{-1}·day^{-1}
Total	2 081	2 032.4	52.7	52.54	49.1	40.49
Vegetable Products	2 000	1 959.3	43.9	44.76	45	36.65
Animal Products	81	73.07	8.8	7.79	4.1	3.82
Cereals	1 662	1 681.5	37.6	38.61	27.4	27.51
Roots & Tubers	37	39.57	1.0	0.99	0.1	0.10
Sugar/Syrup/Honey	66	75.29	0	0	0	0
Pulses	43	38.07	3.1	2.71	0.2	0.16
Treenuts/Oilcrops	2	2.00	0	0	0	0
Vegetables	15	12.86	0.5	0.55	0.2	0.20
Fruits	25	27.64	1.2	1.36	0.2	0.20
Meats and Offals	12	12.29	2.3	2.47	0.2	0.24
Eggs	5	3.57	0.3	0.23	0.4	0.26
Fish	37	35.5	4.9	4.24	1.4	1.74
Milk	19	15.36	0.9	0.71	1.1	1.34
Vegetable Oils and Fats	151	74.79	0	0	16.8	8.32
Animal Oils and Fats	9	6.86	0.1	0.13	1.0	0.67
Spices	11	12.36	0.5	0.51	0.2	0.21

Table 9 shows that 96.4% of the total energy food came from vegetable products. The most important source of energy was cereals, supplying 82.75% of the total energy. In the vegetable products group, on the average, roots and tubers supplied 1.95%; sugar, syrup and honey as one item 3.71%, pulses 1.87%, fruits 1.36%, and vegetable oils and fats 3.66% of the total energy. In the animal products group, the first item was fish, supplying 1.75% of the total energy. The mean percentage shares of milk, meats and offals and eggs were 0.75%, 0.61% and 0.18%, respectively.

Descriptive Statistics on Protein Intake

From Table 9, fish was the second most important source of protein among all food items supplying, on the average, 4.24 g of protein per capita per day. Table 10 shows that fish provides around 8% of the daily protein needs.

Descriptive Statistics on Fats Intake

From Table 9, the mean per capita daily intake of fats was 40.49 g. In the animal products group, the biggest contributor was fish, supplying 1.74 g of fat daily. Table 10 shows that the mean percentage shares of cereals, and vegetable oils and fats in the daily total intake of fats were 68.53% and 19.90%, respectively. In the animal products group, the mean percentage shares were 4.35% for fish, 3.30% for milk, and 1.65% for animal oils and fats.

Regression Analysis of Nutrient Intake

The estimates of constant growth rates of different nutrients were obtained by using both the GLS and OLS methods. Table 10 shows the estimates of constant growth rates of the daily per capita intakes of various nutrient groups such as energy food, protein and fat. Among the animal products group,

Table 10. Contribution of the fisheries sector to national food balance: Shares and growth rates of the contributions of various foods to nutrient supply, shown as percentages.

Food Item	Current Share in Energy	Mean Share in Energy	Current Share in Protein	Mean Share in Protein	Current Share in Fats	Mean Share in Fats	Growth Rate of Energy	Growth Rate of Protein	Growth Rate of Fats
Total	–		–		–		0.09	-0.06	1.37[b]
Vegetable Products	96.11	96.40	83.30	85.17	91.65	90.46	0.10	-0.12	1.63[b]
Animal Products	3.89	3.60	16.70	14.83	8.35	9.54	0.13	0.55	-1.08[b]
Cereals	79.87	82.75	71.35	73.48	55.80	68.53	-0.30	-0.51[b]	0.150
Roots & Tubers	1.78	1.95	1.90	1.89	0.20	0.25	-1.68[a]	-0.68	0
Sugar/Syrup/Honey	3.17	3.71	0	0	0	0	-1.49[a]	0	0
Pulses	2.07	1.87	5.88	5.16	0.41	0.41	8.82[a]	8.69[a]	6.29[a]
Treenuts/Oilcrops	0.10	0.10	0	0	0	0	0	0	0
Vegetables	0.72	0.63	0.95	1.05	0.41	0	1.71[a]	-2.27[b]	0
Fruits	1.20	1.36	2.28	2.59	0.41	0	-1.93[a]	-2.51[a]	0
Meats and Offals	0.58	0.61	4.36	4.71	0.41	0.61	-1.87	-2.17	-3.21[b]
Eggs	0.24	0.18	0.57	0.44	0.82	0.63	3.45[b]	2.5[b]	4.68[b]
Fish	1.78	1.75	9.30	8.07	2.85	4.35	-0.24	1.55[b]	-3.03[b]
Milk	0.91	0.75	1.71	1.36	2.24	3.30	2.22	1.52	1.65
Vegetable Oils and Fats	7.26	3.66	0	0	14.79	19.90	5.63[b]	0	5.67[b]
Animal Oils and Fats	0.43	0.34	0.19	0.24	0.88	1.65	-0.53	-3.66	0.95
Spices	0.53	0.61	0.95	0.96	1.08	0.53	0	0.55	0.46

Note: [a] = significant at 1% level; [b] = significant at 5 % level.

fish was the most important source of energy. Excluding the cereals, fish was also the most important source of protein, and fish was the third most important food item as a supplier of fats.

Conclusions

This section highlight the role of the fisheries sector in economic growth and welfare. To start with the analysis of value-added by sectors, we found that the proportion of the agriculture sector in the GDP decreased from 51% in 1971 to nearly 32% in 1997. The shares of the industry and fisheries sectors were stable at approximately 10% and 3%, respectively. The share of the services sector rose from 42% in 1974 to around 56% in 1997. These results on the sector shares were supported by the results on sector growth rates. The annual growth rates of the fisheries sector, although initially lagging behind the annual growth rates of other sectors, finally caught up with the higher growth rates of the services and industry sectors. It is also evident from the analysis of constant growth rates. The estimated constant growth rate of 1.95% per annum in the fisheries sector lagged far behind the highest growth rate of 5.99% per annum in the industry sector. Analysis of employment and income shows that the agriculture sector is still the biggest employer, providing on the average 69% of all jobs in the country. The services and the industry sector on the average created 22% and 9% of all jobs, respectively. The fisheries sector was responsible for approximately 3% of the total employment level in the country. The real wage rate of the fishers increased at the rate of 2.28% per annum. Although the mean average productivity of labor in the fisheries sector was significantly greater than mean average productivity of labor in the agriculture and industry sectors, the employment level in the fisheries sector did not increase during the sample period. Employment levels in the agriculture, industry and services sectors, however, grew at positive rates. This may be explained by the fact that people are very reluctant to enter the profession of fishing after observing the widespread poverty of fishing folk. Fishers in the marine fisheries sub-sector had the lowest level of average productivity of labor.

Despite its low role in employment creation, the fisheries sector has important potential as a source of foreign exchange. The export value of fish grew at the highest rate of 25.17% per annum between 1972 and 1996. Moreover, the share of fish and fish products in total export value has been increasing over a period of 24 years.

Analysis of food nutrients showed that fish is the largest source of energy from the animal products group. Fish is also the second largest supplier of protein and the third most important source of fats.

Socioeconomic Analysis of the Artisanal or Small Scale Fishery Sector

This section is devoted to an analysis of socioeconomic indicators for artisanal fishers. In some places we appended the national survey results for some socioeconomic variables.

The fishers in Bangladesh play an important role in enhancing economic development by providing the requisite value-added for GDP growth. The fisheries sector employs a large number of people, supplies the essential protein base for the poor section, and earns a significant amount of foreign currency for our national exchequer. We discuss these contributions of the fisheries sector in more detail using secondary data. Our objective in this section is to supplement our previous analysis by micro-analysis of primary data on important but interrelated aspects of a fisher's life. We analyze primary data on different socioeconomic indicators of the standard of living of the fisher. We compare our findings on socioeconomic indicators for fishing units with national findings on similar indicators obtained by the Bureau of Statistics, *Household Expenditure Survey* (HES) 1995 - 96. This comparison provides the scenario of the relative positions of fishers among the different occupations.

Data and Methodology

Our results in this section are based on primary data collected through the questionnaire method. We collected data from four classes of fishers belonging to different income groups with variations in the size of capital investment in 1995 - 96. At the bottom lies the class of artisanal fishers living in coastal areas and fishing in shallow waters. Although they use both non-motorized and motorized boats, these boats are the smallest in terms of horsepower and size. We selected two sites of small scale fishers to survey considering the following criteria for selection:

1. The proximity of the fishing village to the nearest city

2. Accessibility of selected site through different means of transport

3. The heterogeneity of fishing units with regard to fishing gear

The two villages selected as survey areas for small scale fisheries were Peshkar Para in the district of Cox's Bazar and North Salimpur in the district of Chittagong. Peshkar Para is only 2 km to the west of Cox's Bazar town. North Salimpur, situated in Situkunda Thana, is about 10 km to the north of Chittagong City. Fishers in the two villages come from low-income groups, and are representative of the artisanal fishers in Bangladesh. There are sub-categories of fishers in these two villages, depending on the ownership of fishing craft and gear and on the supply of manual labor used in fishing. We selected 50 fishing units from each sample village using the stratified random sampling technique.

Assessment of the Socioeconomic Status of the Fishing Households and Communities in Peshkar Para and North Salimpur

Educational Levels

Information on the educational levels of respondents and their wives is provided in Table 11. In North Salimpur 40% of the respondents had some formal school education, but they had dropped out at different stages. None of them, however, had passed the SSC (Secondary School Certificate) examination. Thirty-two percent of the respondents achieved non-formal education so the proportion of respondents with formal and non-formal education is 72%. Twenty-eight percent of the respondents were completely illiterate. The general level of education was higher in Peshkar Para where 54% of the respondents had formal school education, although none of them had passed the SSC examination. Forty-two percent of the respondents had attained non-formal education so that the percentage of literate people in Peshkar Para stood at 96%. Only 4% were totally illiterate.

Adult literacy in Bangladesh for both sexes is 35% as recorded in the census report of 1991. The Bureau of Statistics, Household Expenditure Survey of 1995 - 96 quotes 52% of all Bangladesh household heads as being illiterate.

The level of educational attainment is low among the wives in Salimpur. Only 62% of the wives had any kind of education, formal or non-formal, and 38% of them were totally illiterate. The level of education is low among the wives in Peshkar Para. Only 60% of them had any kind of education, 40% of them being illiterate. The level of illiteracy was higher among the wives in both sample villages. The illiteracy rate among the adult female population is 63% compared to 47% among males.

Data on education of the children of the fishers are given in Table 12. The children of fishers in North Salimpur go to one primary school, two NGO schools and one secondary school. The children of fisheries in Peshkar Para can be admitted in one primary schools, two secondary schools and two colleges.

Table 11. Education levels in the two villages.

Level of Education (Class)	North Salimpur		Peshkar Para	
	Respondent	Wife	Respondent	Wife
Non-formal	16	8	21	5
One	2	8	0	1
Two	7	0	1	5
Three	2	3	4	2
Four	2	0	8	1
Five	2	2	6	4
Six	0	2	5	1
Seven	0	0	0	1
Eight	4	1	2	1
Nine	1	0	1	1
Illiteraate	14	15	2	15

Table 12. Number of schools.

Category of School	North Salimpur	Peshkar Para
Primary	1	1
NGO School	2	0
Secondary School	1	2
College	0	2

Table 13. Reasons for not sending children to school.

Reason	North Salimpur	Peshkar Para
No economic gain	0	0
Not able to meet expenses	17	9
No prospect for future job	0	0
Environment not suitable	4	0
The child is not interested	4	2
Miscellaneous	0	4
TOTAL	25	15

The schools and colleges are located within short distances of these villages, but we were informed that incentives for sending the children to school are non-existent. In North Salimpur, only two respondents reported that they send their children to school. Table 13 summarizes the reasons for not sending the children to schools. Seventeen families in North Salimpur and 15 families in Peshkar Para do not send their children to school. Most families identify the high expense of education as the main reason. A few families blame the non-academic environments of the fishing villages for this trend. Lack of interest among the children is another common trend in the region.

Structure of Households

Information on the structure of households is provided in the Appendix (Table 3). Households in Peshkar Para have more rooms than households in North Salimpur; the mean number of rooms is 4.08 for Peshkar Para and 3.6 for North Salimpur. The mean area of the main room is almost the same in both villages, 36.3 m^2 in Peshkar Para and 35.97 m^2 in North Salimpur.

Table 14 shows the types of walls, roofs and floors at the two sites. Most houses in the two villages have bamboo walls. There are five houses with brick walls in Peshkar Para and five houses with wooden walls in North Salimpur. Forty-nine households in North Salimpur have earthen floors with the exception of one household having a brick floor.

Almost 50% of all households in the two areas use tin roofs and another 50% use roofs made of thatch and leaves. The national percentage of households using corrugated iron sheets (tin) as roof material was 48% in 1991. Considering brick walls and tin roofs as symbols of economic prosperity, we can conclude that the fishers in Peshkar Para are financially better-off than the fishers in North Salimpur.

Table 14. Structure of houses.

	Wall		Floor		Roof	
	North Salimpur	Peshkar Para	North Salimpur	Peshkar Para	North Salimpur	Peshkar Para
Brick	0	5	1	6	0	0
Wood /Tin/Tally	5	1	0	0	22	25
Earth	0	4	49	43	0	0
Bamboo/Chan/leaf	45	39	0	3	28	23
Straw/Chan	0	1	0	1	0	2

Health and Sanitation

The survey collected data on toilet and drinking water facilities and food availability at the two sample sites.

Drinking Water and Toilet Facilities

Table 15 shows that all families surveyed in Peshkar Para and 46 families in North Salimpur drink tube-well water. There are five sanitary toilets in Peshkar Para and one sanitary toilet in North Salimpur. Forty-four households in North Salimpur and 24 households in Peshkar Para use ring-toilets. The numbers of non-sanitary toilets are one in North Salimpur and 21 in Peshkar Para.

General and Specific Food Availability

Bangladesh is a developing country with a large population to feed. The people of Bangladesh are so poor that most of them find it difficult to eat two meals a day. We gathered data on overall food availability in the survey areas and on availability of some popular food items. Table 16 shows that in our North Salimpur sample 39 families normally face a food deficit and 11 families face an occasional food deficit.

In Peshkar Para 17 families reported normal food deficit, 15 families occasional food deficit and 18 families no food deficit, thus Peshkar Para is better off than North Salimpur in terms of food availability.

More information on food availability is provided in the Appendix (Table 4), which summarizes opinions about the adequacy of some popular food items and gives the frequency of intake of these food items. The quantity of fish eaten by the fishers is considered "normal" or more than normal by all families in North Salimpur and Peshkar Para; these families eat fish almost every day.

Table 15. Drinking water and toilet facilities *(in percentage of households).

Drinking Water				Toilet			
Type	**N. Salimpur**	**P. Para**	**Bangladesh**	**Type**	**N. Salimpur**	**P. Para**	**Bangladesh**
Tube-well	92	100	94	Sanitary	2	10	25
Pond/Well	8	0	2.5	Sanitary (Wheel)	88	48	0
				Kuchchaa	2	42	45
				No. Toilet	8	0	30

Note: * Bangladesh national figures are quoted from Bureau of Statistics, HES 1996 - 97.

Table 16. Overall food availability.

	North Salimpur		Peshker Para	
Nature of Availability	**Frequency**	**Percent**	**Frequency**	**Percent**
Normal food deficit	39	78	17	34
Occasional food deficit	11	22	15	30
No food deficit	0	0	18	36
Surplus food	0	0	0	0

Durable Assets of Households

One indicator of financial solvency of households is the number of durable assets. The current survey gathered data on durable assets in the two villages. Appendix Table 5 shows the distribution of durable assets in North Salimpur. There are 19 families with one radio and one family with two radios in North Salimpur. Members of 52% of the families use wristwatches with the number of wristwatches varying between one and four. Forty-six percent of the households own a wall clock. Forty-six percent households use chairs and 54% own tables. Twenty percent of the families have black and white television sets and 8% have colour television sets. The national figures for owners of radio and television are much lower. Only 18% own a radio/transistor and 4% own a television of any type. Appendix Table 6 provides information on durable assets in Peshkar Para. Seventeen families have radio sets and members of 28 families use wristwatches. There are seven households owning wall clocks, 31 households owning chairs and 27 households owning tables. Eleven families use black and white television sets and one family uses a colour television set. The fishers in the two sample sites have almost identical amounts of durable assets.

Credit Facilities

This section examines the nature of fishers' access to formal and informal sources of credit. Fishing households in North Salimpur are largely dependent on formal sources such as NGOs and banks. Aratdars (local fish buyers) are also a major source of credit in North Salimpur. The average amount of loan ranges between Tk.8 588 from relatives to Tk.23 912 from banks. Informal sources like relatives and aratdars provide the bulk of loans to fishers in Peshkar Para.

Banks provided the most and the largest loans to households in both North Salimpur and Peshkar Para. The overall average amount of loan was Tk.19 872 in North Salimpur while it was Tk.67 332 in Peshkar Para (Table 17).

Assessment of the Linkage of the Small Scale Fishery Sector to Other Sectors of the Economy

This subsection is devoted to the analysis of ownership of different types of household assets in the two sample villages. Possession of wealth by fishing households is an important indicator of overall welfare of the fishers.

Land Ownership

None of the fishers living in North Salimpur own agricultural land, but they do possess a small amount of homestead land. It is amazing, although not unusual, that 13 respondents out of 50 reported no homestead land. These fishers live in rented houses. Each of 10 families has homestead land equal to an area of 2 decimals (247 decimals = 1 ha). Only two families have ponds and two families have fallow land. The mean size of homestead land is 3.87 decimals.

Seven families in Peshkar Para possess agricultural land with the mean size of agricultural land being 144 decimals. All families own homestead land and the average size of homestead land is 9.5 decimals. Four families own a pond and four families own fallow land. The fishers in Peshkar Para have more land property than those in North Salimpur.

Table 17. Average loan of fishing households (Tk). 1 Tk = 0.022 US$ (1997).

Source of Credit	North Salimpur Average Loan	North Salimpur No. of Households	Peshkar Para Average Loan	Peshkar Para No. of Households
NGO	17 250	30	3 000	1
Relatives	8 588	17	57 361	18
Aratdars	23 912	34	53 617	23
Banks	22 829	45	84 819	32
Overall	19 872	–	67 337	–

Table 18. Ownership of land by categories.

Homestead			Pond			Agricultural Land			Fallow Land		
Value (decimal)	NS	PP	Value (decimal)	NS	PP	Value (decimal)	NS	PP	Value (decimal)	NS	PP
0	13	0	0	48	46	0	50	43	0	48	46
1	1	0	2	0	1	8		1	7	1	0
2	10	4	8	1	1	40	0	1	40	0	2
3	8	2	10	0	1	120	0	1	50	1	0
4	9	12	16	1	0	160	0	1	120	0	1
5	4	11	40	0	1	200	0	1	240	0	1
6	3	13	–	–	–	240	0	2	–	–	–
8	1	12	–	–	–	–	–	–	–	–	–
10	0	1	–	–	–	–	–	–	–	–	–
12	0	1	–	–	–	–	–	–	–	–	–
14	0	1	–	–	–	–	–	–	–	–	–
16	1	0	–	–	–	–	–	–	–	–	–
30	0	1	–	–	–	–	–	–	–	–	–
80	0	1	–	–	–	–	–	–	–	–	–
88	0	1	–	–	–	–	–	–	–	–	–
Mean	3.87	9.5		12	15			144		29.5	10

Note: NS = North Salimpur; PP = Peshkar Para. 100 decimal = 1 Acre; 247 decimals = 1 ha.

Livestock and Poultry of Households

Livestock and poultry are always sources of extra income to the rural households. Fishing households in the two sample locations raise different types of livestock to supplement their fishing income. Appendix Table 7 contains important statistics on livestock. Ten families in North Salimpur and seven families in Peshkar Para rear goats. None of the families in North Salimpur has cows and buffaloes whereas in Peshkar Para one family has cows and two families have buffaloes. Peshkar Para has more poultry than North Salimpur; 30 families in North Salimpur raise poultry whereas 57 families do so in Peshkar Para.

Demography, Labor Mobility and Other Transitions

Demography

Household Size

Distribution of households by size is shown in Table 19. This is based on the sample Survey in 1998 and House hold Expenditure Survey in 1995 - 96. Although the traditional joint-family system in Bangladesh is near;y extinct, the survey results from both North Salimpur and Peshkar Para show the fisher's inclination towards this old family system. Table 19 reveals that fishers have bigger families than typical Bangladeshi villagers.

Small families with less than six members are notas frequent here than elsewhere in Bangladesh. In Peshkar Para the percentage of big families with 7 or more members exceeds the national percentages. The mean family size in North Salimpur is 7, which is higher than the national average of 5, as it was in 1995 - 96. The mean family size of Peshkar Para is higher than both the average sizes of North Salimpur and the nation. Families with 8 or more members constitute 40% of all families in Peshkar Para and 14% of all families in the country.

Table 19. Distribution of households by size (percentages).

Size of family	North Salimpur	Peshkar Para	HES National	1995 - 96 Rural
1	0	2	2.2	2.4
2	0	0	5.8	5.7
3	8	0	13.6	13.8
4	6	8	19.0	18.7
5	12	8	20.3	20.3
6	22	14	15.6	15.4
7	12	12	9.6	9.7
8	14	18	6.1	6.2
9	6	10	3.2	3.2
10 and above	20	28	4.7	4.6
Mean	7.02	10	5.26	10.0

Age Profiles of Respondents and Their Wives

The age distribution of the respondents and their wives is presented in Table 8 of the Appendix. Most of the respondents and wives (75%) in both villages came from the age group between 22 years and 46 years. The mean age for the wives was 32.23 years. The respondents' age averaged 38 years.

Occupational Patterns

Table 17 (Appendix) shows the occupational patterns of the respondents. Sixteen fishers give fish trading as their second job and 6 persons engage in other occupations. In Peshkar Para, 48 families are dependent on fishing, 1 family in trading in fish and 1 family in another business. Nine families in Peshkar Para earn additional income from trading in fish. The fishers in Peshkar Para are less likely to find jobs elsewhere. Traditionally occupational mobility has been very limited for fishers in Bangladesh. Lack of education and skills, widespread poverty among the fishers and non-availability of jobs elsewhere inhibit such occupational mobility. The fishers in North Salimpur are less vulnerable to occupational immobility, perhaps because of the close proximity to Chittagong Metropolitan City and the industrial belt of Sitakunda Thana in the northern part of Chittagong district.

Occupational mobility of households

Fishing as a profession is not very lucrative in Bangladesh. This is especially true for artisanal fishers, but socioeconomic factors restrict their exit from this centuries-old occupation.

Changes of employment patterns over generations in North Salimpur are shown in Table 20, and the changes in Peshkar Para are shown in Table 21. Occupational mobility in North Salimpur has been very low over several generations. The minors who did nothing 10 years ago entered the fishing occupation 5 years ago. The picture is a little different in Peshkar Para. More fishers have switched to fish trading over the years. Table 20 shows that the total number of fish traders increased from 12 ten years ago to 22 five years ago.

Table 10 (Appendix) depicts changes in the role of fishing over generations in North Salimpur and shows four classes of fishers. The number of fishers in the group "owners of boats and nets who participate and organize" has increased remarkably over the years. The number of fishers in this group was 18 fifteen years ago and rose to 32 five years ago. There is some evidence of a fall in the number of fishers who own nets and participate in fishing. The number of non-participating owners of boats and nets remained steady at a low level. In Peshkar Para, the numbers of fishers has increased over the generations. This can be seen from Table 11 (Appendix), which shows the changes of roles in fishing in Peshkar Para. Previous changes have been larger than the recent changes. Recent increases in the number of organizing and participating owners of boats and nets is larger than the increase in the number of any other category of fishers. In both cases, most fishers identify monetary gain as the primary cause for changes in roles in fishing.

Table 12 (Appendix) shows the current attitudes of fishers towards fishing. Forty-seven respondents in Peshkar Para are either anxious or not satisfied with their current occupations. The numbers of fishers satisfied with their current occupations are 3 in North Salimpur and 7 in Peshkar Para. Some fishers in Peshkar Para are financially solvent.

Table 22 shows the intentions of fishers to change their occupations. Most fishers are willing to change their occupations for themselves and for their children. In North Salimpur more fishers want new professions for their children than in Peshkar Para.

Table 20. Change of employment patterns in North Salimpur. (1st person - first person employed in the family; 2nd person - second person employed in the family).

Occupation	15 Years Ago		10 Years Ago		5 Years Ago	
	1st Person	2nd Person	1st Person	2nd Person	1st Person	2nd Person
Fishing	4	3	10	7	13	9
Nothing	46	47	39	43	37	41
Student	0	0	1	0	0	0
TOTAL	50	50	50	50	50	50

Table 21. Change of employment patterns in Peshkar Para.

Occupation	15 Years Ago		10 Years Ago		5 Years Ago	
	1st Person	2nd Person	1st Person	2nd Person	1st Person	2nd Person
Fishing	2	2	5	2	4	2
Nothing	43	47	31	38	26	35
Student	4	0	5	4	3	1
Trade in fish	0	1	7	5	14	8
Housewife	0	0	1	1	1	1
Other business	1	0	1	0	2	2
TOTAL	50	50	50	50	50	50

Table 22. Intention to change occupation.

	North Salimpur		Peshkar Para	
	Parents	Children	Parents	Children
1. Want to change present occupation	40	46	49	45
2. Do not want to change present occupation	10	4	1	5

The reasons for intended changes in occupations are given in Table 23. Fishers in both sample sites opt for new occupations for themselves and for their children with a view to freeing themselves from the curse of poverty as well as elevating their social status. Thirty-four fishers in North Salimpur and 23 fishers in Peshkar Para want to change their present occupations for a higher income. Thirty-nine fishers in Peshkar Para and 36 fishers in North Salimpur think that their children can improve their social status by changing occupations.

Conflicts Between the Small Scale Fishery and the Commercial Fishery

Commercial fisheries on the Bangladesh coast appeared in 1974 - 75 when the size of the trawl fleet was only 12. Now it is comprised of 53 trawlers, 41 of which are shrimp trawlers and 12 are fish trawlers. There is, however, an overlap with respect to catch between the two kinds of trawlers, since shrimp trawlers catch some fish and fish trawlers catch some shrimp. The small scale fishery has a

Table 23. Reason for change of occupation. (1st person - first person employed in the family; 2nd person - second person in the employed in the family).

	Parents				Child			
	North Salimpur		Peshkar Para		North Salimpur		Peshkar Para	
Reason for Change	1st Person	2nd Person	1st Person	2nd Person	1st Person	2nd Person	1st Person	2nd Person
Low income	34	1	23	0	9	13	0	0
Low status	5	23	12	0	36	6	39	0
Hard work	2	5	0	0	0	0	0	0
Irregular income	0	0	0	0	1	0	0	0
Other trade	0	0	6	0	0	0	2	0
Dependence on others	0	0	5	0	0	0	8	0

very large fleet of both mechanized and non-mechanized boats. Motorization of boats started in 1972 and the fleet has now grown to 8 000 or more. Alongside these motorized boats a large fleet of non-motorized boats also fish. However, its size has been on the decline since 1974-75 when it was 4 600 in number.

Small scale and commercial fisheries had their separate fishing grounds. The former was fishing in waters less than 40 m deep while the latter was fishing in waters beyond. This arrangement prohibiting trawling within 40 m was instituted by the Marine Fisheries Ordinance of 1983. In the late 1980s and early 1990s, when fishing in the deeper sea came under pressure (the fleet had increased to 64 and foreign trawlers went almost unchallenged), trawlers started to encroach on the near shore fishery. In 1996 the Marine Fisheries Association, a club of trawl owners with origins in the rich urban elite, brought a writ petition to the High Court and managed to obtain a court injunction over the clause of the MFO, 1983, prohibiting trawl fishing in waters less than 40 m deep. The conflict between small scale fishing and industrial fishing has now taken serious shape in the fishing grounds.

Fish trawlers catch a number of species which the small scale fishery also catches. Prominent among them are ribbonfish, Jew fish, croaker, and hilsha. Shrimp trawlers also catch some fish and discard a part which would otherwise have been available to the small scale fishery. Now that both these trawler types are fishing in near-shore waters, they catch all species. They destroy nets set by small scale fishers and sometimes steal these nets. Such incidents have been increasingly reported in recent years. The Coastal Fishermen Coordination Committee, an organization of the fishers in our study site at Chittagong, has reported that 200 such cases took place in the first two months of fishing in the 1999 season. Physical assault on small fishers is also a common feature. All this has implications for the costs of fishing by the small scale fishers and increases their risks.

As a deterrent to the increase of pressure on deep sea fishing, a moratorium has been imposed on increasing the number of trawlers. The association of trawlers (MFA) also favours restricting the trawl fleet, but the investment authorities in Bangladesh are ready to provide finance for new trawlers. The Marine Fisheries Boat Owners' Association is fighting to restrict the fishing grounds as well as the numbers of the trawl fleet. They suggest that a new organization be created to look after the diverse interests of marine fisheries and bring all types of fishing crafts under its control. Instead of the present system of control and support by a variety of institutions such as the Mercantile Marine, Marine Fisheries, Port Authority, Inland Water Ways and a host of others, a central authority should regulate all aspects of coastal fishing.

To mitigate the unhealthy competition between the industrial and small scale fisheries, legal provisions should be made to restrict the former to its separate grounds. Incidence of attacks can be obviated by a strong presence of coast guards. The Navy should be used only to keep the foreign fleet at bay.

Characteristics of the Labor Force in the Commercial Fishery

The commercial fishery, which is composed of the trawlers fishing the high seas, is highly capital-intensive. Fishing laborers who work on large mechanized boats are reported on in this section. The large boat owners are locally known as the "company". They do not participate in fishing. In our Peshkar Para study site, 34 respondents are such large boat owners, and 16 are laborers who work along with other laborers. Many laborers come from far-off areas during the fishing season. The company hires a chief who is known as a *Majhi*, and asks him to organize fishing for the season. Some *majhis* work on a boat of the same company for several seasons. Very large boats require two *majhis*. In such circumstances a second *majhi* is hired under the first. Crew-members are then contacted by the *majhi*. Employment is seasonal.

While on a voyage the laborers receive food on board. They also receive payment at the end of the trip. The company receives a portion of the value of the catch as compensation for the costs incurred, for fuel, equipment, and food for the crew. The rest is divided into two - one half goes to the company and the other to the crew including the *majhis*. This latter half is distributed among *Majhis*. I, *Majhi* II and members of the crew in the proportion 4:2:1. Crew-members receive in advance a portion of their income ("future") which is used to sustain their family when they are away fishing. The mean income per voyage received by crewmembers is Tk.13 487 in our study area.

The laborers go to sea at their own risk, no insurance scheme is there to cover them. The sea is very rough in the fishing season, but no compensation for any loss is ever paid. In case of accident, the laborer loses his life and his family loses their breadwinner.

Institutional Factors in the Fishery Sector

Fishing in the coastal waters of Bangladesh was the exclusive domain of the traditional low caste Hindu community, locally known as *"jaladas"*. The tradition of *"jaladas"* started to break down under continuous pressure from the mid - 1960s when Muslims entered the profession in increasing numbers. The traditional caste fishers as well as the poor Muslim fishers, together now constitute the artisanal fishery community. Some of them own small, non-mechanized (oar/sail) boats and fish with *behundi* (SBN), *khapla* and *fash jal* (gillnet), while others own only the nets, but not any other gear.

The Bangladesh Fisheries Development Corporation (BFDC), set up in 1964 to help develop the fisheries (by providing landing, processing, storage and other facilities), introduced motorization of boats, and distributed 285 outboard engines of 6 hp - 12 hp to poor fishers on a hire purchase basis. These were later replaced by inboard marine diesel engines of 15 - 33 hp in boats 12 - 14 m long. The more affluent among the fishing community adopted mechanized boats and the poor continued with non-mechanized country boats.

The BFDC obtained some trawlers in 1972 and operated five of them until 1985 and leased them out afterwards. In the early 1970s intrusion by Thai trawlers into Bangladeshi waters and exploitation of its fishery took a menacing turn. This led to the introduction of a trawl fleet in the private sector under the aegis of three different schemes:

1. Bangladeshi ownership with assistance of loans from DFIs (development finance institutions);

2. PAYE (pay as you earn) scheme between Bangladeshi entrepreneurs and foreign partners;

3. Joint ventures in which Bangladeshi and foreign partners both invested.

In 1974 - 75 the fishing fleet contained 20 trawlers, which rose to 72 in 1983 - 84. Today, 53 Bangladeshi trawlers (41 shrimp and 12 fish) exploit its offshore fishery resource.

The Directorate of Fisheries (DOF) of the Government of Bangladesh (GOB) issues licenses to trawlers having a loading capacity of 150 tons (t) or above. The vessel license specifies the type of fishing gear used, method of fishing and location of fishing by the vessel. The license holder provides information to DOF on catches and sales in a prescribed form. To receive the license a vessel has to be registered with the Mercantile Marine Department (MMD) of the Ministry of Shipping of GOB. This department also issues a certificate of fitness of the vessel annually. This certificate is a condition for the vessel to receive a fishing license. Thus, DOF exercises control on fishing by the vessel, while MMD is responsible for its registration and safety.

This bifurcation of responsibility-registration and annual inspection by MMD and licensing by DOF has resulted in an unnecessarily lengthy process and boat owners complain about the delay in moving from one office to another in procuring the license. The DOF admits that it lacks facilities for effective monitoring. Fishing by boats without a valid license is not a rarity. A large number remains outside the purview of DOF control.

Conflicts often arise between trawl fishers and artisanal fishers. The latter complain about the intrusion of trawlers into their territory, damage to their nets and destruction of fishing grounds. A court case by the trawl owners has led to the passing of a stay order on the legal provision prohibiting trawl fishing in near-shore waters (within 40 m depth).

The Bangladesh Fishermen Cooperative Society is the association of fishers in both marine and inland fishing sectors. All government assistance to fishers is channeled through this organization. Like cooperatives in other sectors, the representation of fishers and their participation in it is not deemed satisfactory. The boat owners in the marine sector have their national association with their head office at Chittagong. There are owners' associations in different parts of Bangladesh. There is coordination in the working of these associations with the national association, although they exist independently. They have been successful in safeguarding the rights of their members against intrusion by the large trawler owners. It is due to their insistence that the recommendation to halt the growth of the trawler fleet has been effectively implemented.

Effects of Development Interventions, Investment and Other Trends in Coastal Communities

From the latter part of the 1960s the fishery has received increased attention from the government. Cyclones and tidal bores have become a regular phenomenon on the coast of Bangladesh. Small traditional fishing craft are the hardest hit in such calamities. In 1966 - 69, the BFDC introduced motorization of the vessels as described above. The BFDC procured 10 trawlers from the Soviet Union in 1972. This proved lucrative and attracted large private investment in deep-sea fishing. Today the number of motorized boats fishing in 18 m to 40 m depth has surpassed 500 vessels, and trawlers which once numbered 72, are now stable at around 55 in number. With change in craft used, there occurred a revolution in gear used. Nylon nets in place of cotton nets were introduced. The BFDC provided landing facilities, cold storage and some marketing facilities for large scale catches. The above led to drastic changes in coastal fishing. Fishing became capital-intensive and ordinary fishers who could not afford a large investment became hired laborers. Fishers from adjacent and outlying areas join the fishing operation as laborers during the fishing season, which extends to about eight months with mechanized boats and new nets. Fishing expeditions last 8 to 10 days. Fishers who live away from their villages can visit their families at intervals when they come to unload the fish at landing sites for marketing.

As a result of large gains from the new technology, investment in fishing increased very rapidly, which then endangered the resource stock. Government became aware of this and began to limit the fleet. New rules were introduced. One such important rule was the Marine Fishing Ordinance of 1983. The DOF was given unlimited power to check the fishing vessels. But as has already been explained, there are controversies regarding jurisdiction over fishing waters. Again, the authorities involved in the sea are many and their roles overlap, so that proper control of fishing is not possible. DOF is responsible for regulating fishing but its resources are limited.

The small artisanal fishers have suffered most in terms of catch and area of operation. They are compelled to resort to destructive fishing nets and methods in their bid to make their living. In the Chittagong site many fishers were found to use *'current jal'*, a net which catches everything, including juveniles, and therefore is prohibited by law. They are often found to use mesh sizes smaller than the minimum. This is however also found in the case of nets used in mechanized boats. The economic and social problems that the new technology, facilitated by government intervention and new investment, has produced need to be remedied by joint efforts of government, NGOs and the community.

Fleet Operational Dynamics

The State of the Fishing Fleet

Number of Fishing Craft and Gear

The method of gathering and preserving statistics

on fishing craft and gear in Bangladesh is not adequately developed. Lack of information on fishing craft and gear originates from confusion about legal requirements, inadvertence, and negligence of the owners of boats and nets to register their ownerships with government fisheries offices. The existing administrative machinery of the fisheries department of the Government of Bangladesh cannot monitor registration by all fishing craft and gear. Data on the numbers of fishing craft and gear used in small scale fishing are scanty and not reliable.

Some information on fishing craft and gear in Bangladesh is given in Table 24. Bangladesh started with a fleet of 10 trawlers and 200 motorized boats after liberation in 1972. The number of trawlers more than doubled to 21 in a year and then jumped to 26 two years later. The numbers of trawlers changed abruptly in the early 1980s and reached a maximum of 73 in 1984. The number then fell gradually and stabilized at a little more than 50. The current number of trawlers is 54, of which 41 are shrimp trawlers and the remaining are fish trawlers.

The number of motorized boats also experienced three abrupt changes. It increased from 276 in 1974 to 1 000 in 1975, growing more than three times in a year. The number of motorized boats increased again from 1 300 to 2 000 between 1980 and 1981 and from 2 100 to 3 347 between 1983 and 1984. After some fluctuations, it finally settled at the current number of 3 317.

An alternative source has said that 2 500 motorized boats obtained licenses from the DOF, while another 2 500 boats are registered with the Mercantile Marine Department, thus bringing the total to 6 000. Still another source puts the total of mechanized boats at more then 15 000, including the unregistered boats.

Appendix Table 13 shows the number of fishing craft and gear used for different kinds of marine fishing. Two points about Table 13 should be noted. First, some fishing techniques require equal numbers of craft and gear. Second, the number of fishing boats and nets unexpectedly remained fixed in a period of seven years between 1990 and 1997. Appendix Table 14 presents a detailed breakdown of the total fishing craft and gear used in marine fishing.

Table 24. State of the fishing fleet.

Year	Trawlers	Mechanized boats	Non-Mechanized boats	Fishing gear
1972 - 73	10	200	N/A	N/A
1973 - 74	21	276	N/A	N/A
1974 - 75	21	1 000	N/A	N/A
1975 - 76	26	1 000	N/A	N/A
1976 - 77	26	1 050	N/A	N/A
1977 - 78	26	1 100	N/A	N/A
1978 - 79	26	1 200	N/A	N/A
1979 - 80	26	1 300	N/A	N/A
1980 - 81	24	2 000	N/A	N/A
1981 - 82	35	2 050	N/A	N/A
1982 - 83	53	2 100	N/A	N/A
1983 - 84	73	3 347	N/A	N/A
1984 - 85	67	3 300	N/A	N/A
1985 - 86	45	3 137	N/A	N/A
1986 - 87	49	3 317	N/A	N/A
1987 - 88	52	3 317	N/A	N/A
1988 - 89	52	3 317	N/A	N/A
1989 - 90	53	3 317	N/A	23 810
1990 - 91	53	3 317	14 014	23 810
1991 - 92	53	3 317	14 014	23 810
1992 - 93	53	3 317	14 014	23 810
1993 - 94	53	3 317	14 014	23 810
1994 - 95	53	3 317	14 014	23 810
1995 - 96	53	3 317	14 014	23 810
1996 - 97	54	3 317	14 014	23 810

Source: Bureau of Statistics, 1998. N/A = information not available.

Fishing Seasons, Monthly Trips and Other Characteristics of Fishing

Since national data on different characteristics of marine fishing are unavailable, we present here the results from micro surveys.

In North Salimpur, the fishers catch fish in two seasons using mainly two types of nets, viz. *Tong* nets and set bag nets (SBN). The peak season for *Tong* nets consists of four months and the peak season for SBN eight months. The slack season of SBN consists of four months. The seasons of different fishing gear are characterized by varying sizes of catch per unit of effort (CPUE) and normally the catch is large during the peak season. The peak seasons of *Tong* nets and SBN coincide during the first four months of the year and the next four months constitute the peak season for SBN only. The remaining four months comprise the non-peak season for SBN. In the peak season, each trip for the *Tong* net and SBN takes four to five hours. In addition, the fishers go deep sea fishing with SBN in the peak season and this type of long distance trip normally takes seven to eight hours. Each trip with SBN in a slack season takes four to five hours.

The peak and slack seasons last for three and five months respectively, in Peshkar Para. The fishing trips in Peshkar Para are substantially longer and each trip takes two to eight days, depending on the season. In the peak season, each fishing expedition lasts for five to eight days. In the non-peak season, each short-distance trip takes two days and each long-distance trip takes five days. The fishing gear is also different in Peshkar Para. Most fishers in Peshkar Para use floating nets *(Vhaasan Jal)*, pomfret nets *(Failya Jal)* and gillnets *(Lakkha Jal)*. Only a few fishers make use of SBN and purse seine nets. Fishing is in most cases a family business in North Salimpur whereas fishing is a group activity in Peshkar Para. A fishing team there normally consists of more than five persons.

We gathered information on the distance from port, trips per vessel, days or hours per trip, etc., for large motorized boats and trawlers. The average distance from port is 200 km for a trawler and 179 km for a large motorized boat. A trawler on the average makes 11 trips per year, whereas the average number of trips is 21 for a large motorized boat. On the average, a trawler catches fish 200 days a year, whereas a large motorized boat catches fish 239 days a year.

Productivity and Technical Efficiency

Assumptions and Model Specifications

In this section, we attempt to analyze the relationship between input and output in the fisheries sector. Such a relationship can be established by specifying some production functions for the fisheries sector. Regression analysis can then be used to estimate these production functions. A few production models were specified *a priori* as the appropriate models for the fisheries sector and estimated using different econometric techniques. The objectives for estimating the fisheries production models are as follows:

i. To determine the appropriate model for fisheries production on the basis of estimation results.
ii. To examine whether each factor of production is used efficiently.
iii. To calculate the elasticity and share of each factor in total production. The estimated parameters can also be used to calculate elasticity of substitution between any two factors.

Model specification and data

Following Panayotou and Jetanavanich (1987) the fisheries production function can be written as:

$$Q = f(Z,E) \quad (1)$$

Equation (1) says that the catch (Q) depends on the stock of fish (Z) and fishing effort (E). Assuming that the fish stock remains the same for all fishing units during a particular season, equation (1) can be rewritten as:

$$Q = g(E) \quad (2)$$

Where g = parameter of the sustainable yield function.

Fishing effort (E) is, however, a composite index made up of many factors. It can be decomposed into capital stock (fishing craft, fishing gear), service flows (time spent fishing), and managerial ability. Each of these factors can again be represented by one or more characteristics serving as proxy variables. For example, fishing craft may be represented by one or more of the following characteristics: volume, tonnage, horsepower of engine, etc. There may be as many models of fisheries production function as there are combinations of inputs used in fishing.

Two types of models are popular to economists and biologists as the appropriate models for fisheries production functions. Cobb-Douglas and trans-log production functions are widely used.

$$\ln Q_i = a + \sum b_i \ln E_i \quad (3)$$

$$\ln Q_i = a + \sum b_i \ln E_i + [c_{ij} \sum \sum \ln E_i E_j] \quad (4)$$

$$c_{ij} = c_{ij},\ j,i = 1,2 \quad (5)$$

$$\sum c_{ij} = 0 \quad (6)$$

where a, b_i and c_{ij} = parameters to be estimated Equation (3) is the log-linear form of the Cobb-Douglas production function and Equation (4) is the trans-log production function. Equations (5) and (6) are the restrictions that apply to trans-log production function. We estimated these production function models for each of four samples in our study. In Equations (3) and (4), Q stands for the catch of fish in physical units. Similarly E_i stands for fishing efforts measured in physical units. But a fishing unit normally catches different species of fish. It is, therefore, more reasonable to measure catch of fish in monetary terms. Q_i in our survey is measured in nominal values. The Eis can be measured in physical units or in nominal values.

Estimation Results

The estimated fishery production models are presented here (Table 25). For each of four samples, results of two estimated models are given. All factors deemed to represent fishing effort have been included in the first model. These results are shown in Appendix Table 15.

It can be seen from the table that incorporating all seemingly related variables does not produce satisfactory results due to multicollinearity. For example, the independent variables in the model for trawler are area, tonnage and horsepower of the craft, mesh-size of net, and fishing days. The coefficients of these variables are not statistically significant as expected with severe multicollinearity and the fit of the model is not good with adjusted R^2 being as low as 0.24. Some of the variables have signs not consistent with common sense, which is also a symptom of multicollinearity. In the model for Peshkar Para, the coefficient of only one out of seven independent variables is statistically significant. Although the model has a high-adjusted R^2 value, two variables have the wrong signs. Similar results hold for two other models, again due to severe multicollinearity.

To avoid the problems of poor estimation results of the large regression models, we tried several other models for each sample. After a lot of over-fitting, we selected one model for each sample as the best model. The estimation results of the finally selected models are given in Table 25. The selected models fit well to the cross-section data having adjusted R^2 values between 0.54 and 0.89, although R^2 values lose some of their meaning with excessive "data snooping". None of the models have the problem of auto-correlated errors.

Table 25. Estimation results of fisheries production function.

	Model	Method	Tonnage of craft	Area of craft	Weight of all nets	Fishing days	Dep. cost of craft	Dep. cost of gear	Adj R^2	"d" Statistic
Trawler	CD	GLS	–	0.06 (2.40)	–	0.65 (3.10)	–	–	0.73	1.99
Large Motorized Boat	CD	GLS	–	–	–	–	0.25 (5.97)	–	0.89	1.35
Peshkar Para	CD	GLS	0.52 (3.88)	–	0.10 (1.27)	1.21 (3.86)	–	–	0.58	1.57
North Salimpur	CD	GLS	–	–	–	0.35 (2.42)	0.038 (1.05)	0.69 (5.50)	0.73	2.14

Note: CD = Cobb-Douglas; GLS = Generalized Least Squares; Dep. = depreciation.
*** Value in parentheses indicate estimated coefficients.**

In the fishery production function for trawlers, the two independent variables are the area of the craft and fishing days, which both have statistically significant coefficients. The depreciation cost of the craft is the only independent variable in the fishery production function model for a large motorized boat. The coefficient of the variable is statistically significant at the 1% level of significance. In Peshkar Para, the relevant variables of the regression model are the tonnage of the craft, weight of all nets and fishing days. The coefficients of tonnage of the craft and fishing days are statistically significant at the 1% level of significance. The coefficient of weight of all nets is not significantly different from zero. In the fishery production for North Salimpur, the independent variables are fishing days, depreciation cost of craft and the depreciation cost of gear. The coefficients of fishing days and depreciation cost of gear are statistically significant whereas the coefficient of the depreciation cost of craft is not significantly different from zero.

Costs, Earnings and Profitability

Organization of the Study

The questionnaire developed for artisanal fishers contained a section on income and expenditure patterns of fishers. Emphasis was laid on questions about annual income and expenditure from fishing expeditions. These questionnaires were administered to 50 respondents in each of the two sample villages. Separate questionnaires were framed on cost-earnings from owners of large motorized boats and trawlers. Data were collected from 10 owners of trawlers and 12 owners of large motorized boats. Trawl fishing is an example of large scale industrial fishing. Large motorized boats represent medium-scale commercial fishing. The sample from Peshkar Para is an example of commercial artisanal fishing. Lastly, the sample from North Salimpur represents the case of subsistence artisanal fishing. In all, data were collected from four sample areas for four different groups of fishers.

About 320 fishers live in North Salimpur, of whom 200 fishers own boats and nets, participate in fishing and organize the fishing activities. One hundred owners of nets only participate in fishing. There are 20 fishers who do not own boats or nets but work as hired laborers for other fishers. To make our sample representative of all categories of fishers, we stratified our sample of 50 fishers from North Salimpur according to the following scheme:

1. Owners of nets and boats who participate in fishing:	35
2. Owners of nets who participate in fishing:	12
3. Laborers who participate in fishing:	3
Total:	50

Net fishing income was calculated for every fisher in each of the three categories. Mean income levels and other descriptive statistics were calculated for each group.

Unlike in North Salimpur, there are fishers in Peshkar Para who own boats and nets, but who do not participate in fishing activities. The stratified random sample in Peshkar Para comprised the following categories of fishers:

1. Owners of boats and nets who do not participate in fishing:	11
2. Owners of boats and nets who participate in fishing:	11
3. Owners of nets who do not participate in fishing:	1
4. Owners of nets who participate in fishing:	1
5. Laborers who participate in fishing:	26
Total	50

We calculated the net fishing income for each fisher in the five groups.

Profitability analysis in this section is largely based on primary data collected for this purpose. Cost-earnings data were analyzed by calculating and sharing benefits in each of the four sample sites. Net economic profits from fishing activities were estimated for trawl fishing, large motorized boats and North Salimpur. In Peshkar Para, gross income from fishing activities is estimated first by deducting all operating costs from the total revenue. This gross income is then distributed among different groups of fishers according to the agreed-upon formula of sharing. Although we collected data from 122 fishing units in four different samples, we had to delete the observations with negative values for either gross income or net income. Table 26 shows

Table 26. Number of dropped observations.

Sample	Observations with negative values		Total observations dropped
	Gross income	Net income	
North Salimpur	0	7	7
Peshkar Para	3	5	
Large Motorized Boat	0	6	6
Trawler	0	5	5

the number of observations dropped in four samples. Two reasons can be cited for deleting these observations. Technically, the observations with negative values for gross income and net income cannot be analyzed, and secondly negative values create suspicion about the reliability of the data. The negative observations are perhaps due to over-reporting of the costs incurred.

Fishing Assets

We gathered information on present and past ownership of fishing assets in the two survey sites. Appendix Table 16 provides statistics on fishing assets in North Salimpur and Peshkar Para. In our sample of 50 households in North Salimpur, 43 families have at least one boat and 6 of them have two boats each. Seven non-motorized boats are also used in North Salimpur. The 50 fishers surveyed in North Salimpur also own 300 *Tong* nets, 174 SBN, 26 push nets and two other nets. The table also gives information on parents' ownership of fishing assets. We find that the previous generation in North Salimpur owned 7 non-motorized boats, 30 motorized boats, 210 *Tong* nets, and 125 SBN. There is a significant increment in the possession of motorized boats and nets by later generations. Motorized boats increased by 16 units, *Tong* nets increased by 90 units and SBN increased by 49 units. The number of non-motorized boats, however did not increase over the two generations. The fishers in Peshkar Para lag behind their counterparts in North Salimpur in fishing assets. The 50 families surveyed in Peshkar Para owned 12 non-motorized boats, 39 motorized boats, 9 floating nets *(Vhasaan Jaals)*, 34 pomfret nets *(Faillya)*, 29 gillnets *(Lakkha)* and 17 other nets. The number of motorized boats in the possession of the current generation increased to 39 from 7 in the possession of their parents. Similarly, the numbers of different types of nets increased significantly in the current generation over the previous generation. The number of floating nets increased significantly in the current generation over the previous generation. The number of floating nets increased to 9 from 3 and pomfret nets rose to 34 from 16.

Investment Costs

Fishing, like any other economic activity, needs services of many inputs, which can be broadly classified into three categories. Firstly, there are fishing craft and gear, secondly, sailors, engine drivers and helpers (labor input), finally, there must be an organizer who may or may not overlap with other inputs. The entrepreneur has to invest a large amount of money for procuring the capital inputs.

Investment costs were calculated for the total fishing assets, craft and gear for each of four samples. The mean investment costs are shown in Table 27.

The total investment in trawl fishing is much higher compared to investment costs in any other type of fishing (Table 27). The average total investment cost in trawl fishing is Tk. 38 million, whereas the average investment cost in large motorized boats is Tk.1.64 million. The average investment cost is Tk.316 000 in Peshkar Para and Tk.118 000 in North Salimpur. The average investment costs for all large motorized boats, for the village of Peshkar Para and for North Salimpur constitute only 4.3%, 0.83% and 0.31%, respectively, of the average investment cost of trawlers. The variations in investment costs are mainly due to variations in the cost of fishing craft. Table 27 shows depreciation costs, also known as replacement investments. In the case of fishing gear, the depreciation cost equals the total value of fishing equipment divided by its lifetime. In the case of fishing craft, depreciation cost is calculated using the same procedure after deducting 10% of the total value as the scrap-value.

Table 27. Average investment costs for fishing. (in Taka; 1 Tk = 0.022 US$, 1997)

Sample	Investment Cost for Craft	Dep. Cost for Crafts	Investment Cost for Gear	Dep. Cost for Craft	Total Investment Cost	Total Dep. Cost
Trawler	37 768 000	1 432 902	321 580	2 461 123	38 089 580	1 679 025
Large Motorized Boat	1 291 700	156 781	349 170	76 706	1 640 870	233 488
Peshkar Para	207 588	29 078	108 529	21 702	316 118	50 780
North Salimpur	46 170	3 463	719 487	17 271	118 155	20 774

Note: Dep. = depreciation

Cost Structure

The cost structures of various fishing units are given in Table 28 and Table 29. As Table 28 shows, the fuel cost, a major expenditure item, averaged Tk.5.06 million for trawlers, Tk.0.22 million for large motorized boats, Tk.85 000 for Peshkar Para and Tk.35 000 for North Salimpur. The mean annual expenditure on food was Tk.0.5 million for trawlers, Tk.135 000 for large motorized boats, Tk.43 000 for Peshkar Para and Tk.12 000 for North Salimpur. The trawler owners spent on the average, Tk.1.54 million per annum on salary of crews and officers, whereas the total expenditure on hired labor was Tk.41 000 per annum in North Salimpur.

Table 28. Cost structure - absolute values (Tk).

Item	North Salimpur	Peshkar Para	Large Motorized Boat	Trawler
Total revenue from forward selling	196 204	426 933	1 239 300	18 998 000
Fuel cost	35 721	85 380	216 260	5 061 600
Food cost	12 343	43 113	135 220	543 470
Labor cost/salary of crews	40 686	0[a]	0[a]	1 538 200
Maintenance cost		7 844	159 080	942 010
Other variable cost	5 348	17 574	40 000	3 019 600
Total variable cost	85 753	178 467	550 560	8 624 700
Depreciation cost	22 999	41 758	224 210	1 411 400
Interest payments	0	0	31 510	3 146 200
Registration cost & licensee	0	0	11 800	98 770
Total fixed cost	22 999	41 758	267 520	7 136 600
Total cost	108 753	220 227	818 080	15 761 000

Source: Bureau of Statistics 1998.
Note: [a] Remuneration for laborers according to the sharing system.

Table 29. Cost structure - proportions (percentages).

Item	North Salimpur	Peshkar Para	Large Motorized Boat	Trawler
Fuel cost	38.1	38.7	26.0	32.0
Food cost	8.4	19.5	16.5	3.7
Ice cost	0	10.7	18.7	0
Labor cost	27.1	0	0	9.6
Other variable cost	4.8	8.7	4.7	8.3
Total variable cost	77.6	80.8	67.1	53.6
Depreciation cost	27.4	19.2	27.6	20.2
Interest payments	0	0	4	19.7
Office cost	0	0	0	5.6
Registration cost	0	0	1.3	0.9
Total fixed cost	27.4	21.1	32.9	46.4

In Peshkar Para and the case of large motorized boats, income of labor is calculated as a share in the gross net revenue, which is the difference between total revenue from forward selling and operating costs. Trawler owners spent a huge amount of money, Tk.3.02 million on the average, on other components of variable cost. The average other variable cost was Tk.5 000 in North Salimpur, Tk.18 000 in Peshkar Para, and Tk.40 000 for large motorized boats. The total variable cost amounted to Tk.8.63 million for trawlers, Tk.551 000 for large motorized boats, Tk.179 000 in Peshkar Para and Tk. 86 000 in North Salimpur. Average values of total fixed cost were Tk.7.14 million for trawlers, Tk. 268 000 for large motorized boats, Tk.42 000 in Peshkar Para and Tk.23 000 in North Salimpur. Annual total cost equaled Tk.15.76 million for trawl fishing, Tk.818 000 for large motorized boats, Tk.220 000 in Peshkar Para and Tk.109 000 in North Salimpur.

Table 29 gives the proportions of different components of the total cost. Among the individual items, fuel cost constitutes a major expenditure item, claiming on the average 32% of the total cost in the case of trawlers, 26% in the case of large motorized boats, 39% in Peshkar Para and 38% in North Salimpur. The mean share of food-cost was 20% in Peshkar Para, 8% in North Salimpur and 17% in the case of large motorized boats. It was a minor expenditure item for trawlers with a mean share of 4%. In North Salimpur another major expenditure item was the labor cost with a mean share of 27%. The mean share of salary of crews was 10% for trawlers.

Mean share of total variable cost was 78% in North Salimpur, 81% in Peshkar Para, 67% for large motorized boats and 54% for trawlers. The total fixed cost was on the average 27% of the total cost in North Salimpur, 21% in Peshkar Para, 33% for large motorized boats and 46% for trawlers. The meanshare of the total fixed cost was found to increase with the degree of capital intensity (defined by the ratio of capital investment to the number of laborers engaged).

Earnings and Profitability

Net Income Levels of Fishing Units

Net income levels of fishers in each sample were calculated using the cost and revenue figures. Profit of net fishing income was calculated as the difference between the total revenue and total cost inclusive of total depreciation cost. It seems that the cost figures reported by some owners of trawlers and large motorized boats were biased upward. Consequently, net fishing income levels of five trawler-owners and seven large motorized owners turned out to be negative. We decided to exclude the observations with negative profit levels in calculating the mean profit levels of trawler-owners and motorized boats owners. Table 30 shows the mean profit levels of fishing units in four samples.

Table 30. Net income levels of fishing units for 1998.

Item	Sample Size	Average Fishing Income	Total Income	Per Capita Income
Trawler	5	3 236 800	N/A	N/A
Large Motorized Boat	6	421 220	N/A	N/A
Peshkar Para	27	120 394	126 179	25 834
North Salimpur	40	87 452	100 365	14 932

Note: N/A = not available

A trawler owner earned on the average Tk.3.24 million per annum from fishing. The mean annual income of the owner of a large motorized boat was Tk.421 000. The mean annual profit of a fishing unit in Peshkar Para was Tk.120 000, whereas its total income was Tk.126 000, yielding a per capita income of Tk.26 000. A fishing unit in Peshkar Para normally consists of many persons, *viz.* owners of boats and nets, sailors, laborers, etc. The mean fishing income in North Salimpur was Tk.88 000 per annum, whereas the mean total income was Tk.100 000. The annual per capita income in North Salimpur averaged Tk.14 932, which is greater than the national per capita income of Tk.12 680. The net income levels of the owner of a large motorized boat, a fishing unit in Peshkar Para and a fishing unit in North Salimpur averaged 6%, 5% and 3% of the total net income of a trawler owner.

Net Income by Fishing Gear

Table 31 shows the net income levels by fishing gear. In North Salimpur, most fishers use both *Tong* nets and set bag nets (SBN). *Tong* nets are one of the local variants of purse seine in Bangladesh. Fishers use *Tong* nets during four months of the peak season while they use SBN nets the whole year. As expected, *Tong* nets, which are much larger in size and weight, yield a higher level of profit than SBN. The average net income from operating *Tong* nets and SBN in our study was Tk.50 000 and Tk.41 000, respectively. In Peshkar Para, average profit from another local variant of purse seine nets called floating nets was Tk.195 000, which is more than four times the average profit made from two local variants of gillnet, pomfret nets (Tk.49 000) and *Lakkha* nets (Tk.41 000). Few fishers surveyed in Peshkar Para had floating nets because these nets involve a large investment.

Net Income by Fishing Groups

Table 32 shows the net income levels in 1998 of different groups of fishers in North Salimpur and Peshkar Para.

The average net income of nine owners of boats and nets was Tk.75 000 whereas the average net income of participating owners of boats and nets was Tk.115 000. The rate of return from capital investment was then estimated as the ratio of net returns (to capital investment) to total investment cost multiplied by 100. The average net income of a senior sailor was Tk.51 000 per annum. The average net income levels of the junior sailor, engine driver and laborer in Peshkar Para were Tk.51 000, Tk.26 000 and Tk.14 000, respectively. The number of senior sailors is low, only two in selected 27 cases. Each employee in a labor group comprising the senior sailor, junior sailor, engine driver and crew earns much less than an owner of boats and nets. There is an inegalitarian distribution of income among groups of fishers in Peshkar Para.

Table 31. Net income by fishing gear in 1998 .

Sample	Gear	Total revenue	Total variable cost	Total cost	Net income
North Salimpur	Purse Seine (Tong)	89 160	22 622	39 220	49 940
	Set bag net	115 724	68 250	75 170	40 553
Peshkar Para	Purse Seine (Floating)	N/A	N/A	N/A	194 487
	Gillnet (Pomfret)	N/A	N/A	N/A	49 169
	Gillnet (Lakkha)	N/A	N/A	N/A	47 674

Note: N/A = not available

Table 32. Net income of groups of fishers.

Sample	Group	Sample size	Fishing income	Total income	Per capita income
Peshkar Para	Owners of boats and nets	9	74 898	80 471	39 221
	Participating owners of boats and nets	8	114 710	123 440	17 072
	Senior sailors	2	50 845	N/A	N/A
	Junior sailors	27	26 301	N/A	N/A
	Drivers	27	14 068	N/A	N/A
	Laborer	27	13 441	N/A	N/A
North Salimpur	Boat owner	31	89 146	103 538	1 529
	Net owner	9	81 617	89 439	13 681
	Laborer	3	21 667	33 768	9 461

Note: N/A = Not Available.

There was no significant difference in income between participating and non-participating owners of boats and nets.

We also calculated mean values of income levels for three categories of fishers in North Salimpur (Table 31). Each boat owner in North Salimpur earned on the average Tk.89 000 per annum, which is a little higher than the corresponding figure in Peshkar Para. The mean annual income of a net owner in North Salimpur was Tk.82 000 whereas a laborer on the average earned Tk.22 000 per year. The results of "t" tests for differences in mean income levels showed no significant differences between owners of boats and owners of nets in North Salimpur.

In addition to calculating net profit of fishing households, we also worked out the capital: labor ratio for every fishing unit in each sample by dividing the total investment cost of a firm by the number of persons engaged in fishing. Table 33 below shows the average capital-labor ratio for four samples:

Table 33. Capital-labor ratio and net profit.

Sample	Capital-labor ratio (Tk.)	Net fishing profit (Tk.)
North Salimpur	15 902	96 387
Peshkar Para	13 490	162 132
Medium sized engine boat	109 389	210 869
Trawler	963 053	3 236 381

It is clear that fishing is most capital intensive in the case of trawlers and most labor intensive in Peshkar Para.

Economic Profit in North Salimpur

We calculated economic profit for all fishing households in North Salimpur. Economic profit was calculated by deducting from the net fishing income the implicit wages and food expenses for active family members who participate in fishing. Assuming that the peak season for two types of net consists of eight months in North Salimpur, we used the following formula to calculate economic profit of fishing households:

$$\text{Economic Profit} = \text{Net Fishing Income} - 20\,800^{*} \times \text{No. of Participating Members}$$

In the above formula, monthly salary has been assumed to be Tk.2 000 per person and monthly food expenses have been assumed to be Tk.600 per head. We derived the frequency distribution of economic profit of 50 fishing households. The mean economic profit was found to be Tk.54 156. It was found that 14 families of North Salimpur out of 50 had negative economic profits. Despite negative economic profits, these families are bound to stay in fishing because the opportunity for alternative employment is restricted. That is, their opportunity cost of labor is sufficiently low as to retain their employment in the fishery sector. The sufficiently high transactions and friction costs of exit from the fishery reinforces this labor inertia.

Forward Buying and Selling: *Dadan*

The artisanal fishers in North Salimpur often take loans from NGOs and local stockists, popularly known as *aratdars*. Instead of charging interest rates for the loans forwarded, the *aratdars* buy the fish from the fishers at a predetermined price, which is normally less than the spot market price, and sell at a higher price in the wholesale market. This method of selling fish to the *aratdars* at an agreed upon lower price may be called forward selling, popularly known as *dadan*. The difference between the selling and buying prices of the *aratdars* is the gain to the *aratdars* and the interest payments to the fishers. All fishers do not sell forward and those fishers who do so may not sell the whole lot of their fish at the predetermined price. In North Salimpur, a portion of fish caught in the *Tong* nets during the peak season is sold forward. The total amount of gain to the *aratdars* and wholesalers from forward buying or the amount of *dadan* has been calculated using data on the spot market price and forward price of fish. Using the customs of the fishers in the area, the quantity of fish is multiplied by the forward price where applicable at the time of calculating the total gross revenue of fishing households. The system of forward buying and selling is also in practice in Peshkar Para, but there is no partial forward selling in Peshkar Para. The implicit rates of interest per annum for a boat in North Salimpur and Peshkar Para are 340% and 162%, respectively.

The Sharing System

In North Salimpur, the sharing system is non-existent. Most of the fishers own either boats or nets or both, and they participate in fishing. In most cases, all active members of a family participate in fishing and the owners hire extra labor if necessary. The owners bear the expenses of food for the hired labor and pay a predetermined amount of monthly salary to the hired labor. The net gain of fishing expeditions goes to the owners of boats and nets.

The sharing system is very effective in Peshkar Para. Gross revenue of a fishing unit is calculated as the product of quantity of fish and price of fish. In the case of forward transactions, the quantity of fish is multiplied by the forward price, which is normally less than the spot price. Gross income of the fishing unit is equal to gross revenue less operating costs of fishing. Operating costs include the fuel cost, food cost, ice cost, maintenance cost, other cost, etc. Gross income is distributed among different factors of fishing units according to a traditional system, which may be called the residual sharing system. In the case of small motorized boats with less than 22 hp engines, one half of gross income goes to the owners of boats and nets. The remaining 50% of gross income is divided among the total number of persons engaged in fishing. Each sailor receives two shares, each engine operator receives one share and each of the remaining persons receives one share. In the case of large motorized boats with engine hp ranging between 22 and 33, the owners of boats and nets receive 62% of total gross income. The remaining 37.5% is divided among other crews and persons according to the sharing system. The senior sailor receives two shares, the junior sailor receives one share, and each of the remaining crew receives one share. For large motorized boats with engines having 33 hp or more, the distribution takes a different mode. The senior sailor receives Tk.60 out of each Tk.1 000 of gross income. Similarly, the junior sailor receives Tk.30, the engine operator receives Tk.20 and each other hired person receives Tk.20 for every Tk.1 000 of gross income. The remaining gross income after payments to the senior sailor, junior sailor, operator and all other crew is distributed to the owners of boats and nets. In some cases, the junior sailor may receive one and a half share or Tk.30 out of each Tk. 1000 of gross income, depending on the predetermined agreement. In the case of separate owners of boats and nets, the returns for boats and nets are equally divided between the owners.

Market Structure and Price of Fish

Owners of large motorized boats land their catch in landing stations. These are stations built by the BFDC in Cox's Bazar, Chittagong and other major fishing areas. Wholesale agents are available in these stations. After fish is landed, it is sold in open auction among the agents. Fish is then carried to the *arats* generally situated in large centers. In big market centers, the *aratdars* form a cartel, and decide on prices of different species. The retailers, who generally have fixed stalls or selling sheds in the market, receive fish from the *aratdars* at prices fixed by the latter. The retailers then sell to the general consumers at prices that may be established through bargaining. Nonetheless, all the stalls sell the major species at about the same price. Buyers' knowledge of fish and their respective prices in the markets is perfect. The story is different in a host of fishers' villages, where fishing is done with small motorized and non-motorized boats. Here the

landing stations known as *ghats* are not equipped with modern facilities. Most of these are traditional landing spots near the village without any *pucca* structures. Wholesale agents frequent these places during peak seasons. At other times, small traders who have connections with *aratdars* in local market centers or who themselves are fish traders, attend the *ghats* at the time of landing. If the amount of fish catch is small, the fisher conveys his catch to the local market himself. Table 34 shows the numbers of agents involved in marketing in peak and slack seasons in one of our study villages, which is the abode of traditional fishers. Forty-two out of 50 fishers used the services of wholesalers in the peak season, and in the slack season 21 fishers used the services of local traders while 22 fishers sold their catch themselves.

Table 34. Fish marketing in North Salimpur.

Agents	Peak Season	Slack Season
Wholesaler	42	7
Aratdar	4	0
Local trader	2	21
Fishers	2	22
TOTAL	50	50

Fishers of this village complained that they do not get a fair price for their catch. The reasons are two-fold. One, they have to sell to those people (wholesaler, *aratdar* or trader) from whom they previously received loans on condition of selling fish after harvest. Two, there is collusion among traders who also maintain "musclemen" to compel the fishers to sell at prices dictated by them.

Bioeconomic Modeling

Rationale

Bioeconomic analysis combines biological and economic analyses for efficient management of the fisheries. Economic analysis of management issues underlying the fisheries sector, which is sometimes based on modeling of economic relationships, is complementary to biological modeling.

Objectives

Both under-utilization and over-utilization of fishery resources are undesirable. In a developing country like Bangladesh, it is the over-exploitation, not under-utilization, which concerns us most. The objective of this study is to examine the degree of the over-utilization of the fishery resources taking place over time in Bangladesh.

In Bangladesh much of the fish comes from the inland sector. Coastal fisheries account for a small percentage of the total fisheries. Still, the number of artisanal fishers living along the coastal belts of the Bay of Bengal is quite large. The number of small and medium sized fishing crafts engaged in fishing in estuaries and shallow waters of the sea is rapidly increasing. Fisheries biologists and experts are of the opinion that the number of trawlers fishing offshore has exceeded the sustainable level. The coastal fishery in Bangladesh is subject to over-exploitation. The objective of this paper is to develop some economic models to assess the nature and extent of the over-exploitation. For lack of data, bioeconomic modeling of coastal fisheries will be limited to large scale fishing by trawlers. There are two types of bioeconomic models widely used in fisheries economics. These two models are Schaefer's surplus production model (Schaefer 1954) and Fox's variant of the model (Fox 1970). Equation (1) and equation (2) show the two types of models in econometric formats:

Schaefer's Model:

$$Y = \beta_1 f + \beta_2 f^2 + \in \qquad \beta_1 > 0, \beta_2 < 0 \qquad (1)$$

Fox's Model:

$$Y = f \exp(\alpha_1 + \alpha_2 f + V) \qquad \alpha_1 > 0, \alpha_2 < 0 \qquad (2)$$

where exp = exponential e.

The term "$\in$" in equation (1) and "V" in equation (2) signify random errors with population mean zero and identical variances. "Y" and " f " stand for total fish catch in physical units and total fishing days, respectively. β_1, β_2, α_1 and α_2 are the parameters to be estimated from regression analysis.

Framework and Estimation

Model Specification

The models shown by equations (1) and (2) cannot be easily estimated. The first model has no intercept and the second model is non-linear. To facili-

tate estimation, rearrangement of the above models is necessary. Dividing equation (1) by " f " on both sides, we get the following equation:

$$\frac{Y}{f} = \beta_1 + \beta_2 f + \in \quad (3)$$

Equation (3) is normally estimated using ordinary least squares method by regressing catch per unit of effort ($\frac{Y}{f}$) on effort (f). Estimated values of β_1 and β_1 can be used to estimate maximum sustainable yield (MSY), which is defined as the maximum rate of catch of fish which can be sustained during a long period of time without affecting the size of the stock of the fishery resources. The level of fishing effort corresponding to MSY is called maximum sustainable effort, MSY_f. MSY and MSYf from model (3) are given by:

$MSY = (-\hat{\beta}_1^2 / 4\hat{\beta}_2)$ $\quad \hat{\beta}_1 \equiv$ Estimate of β_1

$MSY_f = \frac{-\hat{\beta}_1}{2\hat{\beta}_1}$ $\quad \hat{\beta}_2 \equiv$ Estimate of β_2

Catch of fish in physical units (Y) in equation (3) can be converted into the value of the catch of fish in money terms, V (Y). A new estimable equation can be written as follows:

$$\frac{V(Y)}{f} = \theta_1 + \theta_2 f + U^* \quad (4)$$

A linear total cost function can be estimated using data on the total cost and fishing effort.

$$TC = \delta f + E \quad (5)$$

Open access equilibrium is obtained at the level " f " at which the total revenue and total cost of fishing is equal.

$$\hat{\theta}_1 f + \hat{\theta}_2 f^2 - \hat{\delta} f = 0 \quad (6)$$

Maximum economic yield (MEY) and maximum economic rent (MER) occur at the value of " f " which satisfies the following equations:

$$\hat{\theta}_1 f + 2\hat{\theta}_2 f - \hat{\delta} = 0 \quad \text{or} \quad f^* = \frac{\hat{\delta} - \hat{\theta}_1}{2\hat{\theta}_2} \quad (7)$$

MEY and MER are given by the following equations:

$$MEY = \hat{\theta}_1 f^* + \hat{\theta}_2 f^{*2} \quad (8)$$

$$MER = \hat{\theta}_1 f^* + \hat{\theta}_2 f^{*2} - \hat{\delta} f^* \quad (9)$$

The Fox model given by equation (2) can be rearranged as follows:

$$\text{In}\left(\frac{Y}{f}\right) = \alpha_1 + \alpha_2 f + V^* \quad (10)$$

Parameters of model (10) can be estimated by applying the OLS method to transformed data. MSY and MSY_f are given by the following equations:

$$MSY = -\exp(\hat{\alpha}_1 - 1) / \hat{\alpha}_2 \quad (11)$$

$$MSY_f = -1/\hat{\alpha}_2 \quad (12)$$

MEY and MER are obtained by estimating the following non-linear equation:

$$\exp(\hat{\alpha}_1 + \hat{\alpha}_2 f^*)(1 + \hat{\alpha}_2 f^*) - \hat{\delta} = 0 \quad (13)$$

Where f* denotes the level of fishing effort at which MEY and MER are obtained. The values of MEY and MER are given by the following equations:

$$MEY = f^* \cdot \exp(\hat{\alpha}_1 + \hat{\alpha}_2 f^*) \quad (14)$$

$$MER = MEY - \hat{\delta} f^* \quad (15)$$

where $\hat{\delta}$ is the estimated slope of the total cost function.

Data: Catch, Effort, Fishing Effort and Fish Price

Although artisanal fishing dominates marine fisheries of Bangladesh, time series of catch and fishing effort are not available for this type of marine fishing. Data on catch and effort in trawl fishing can be obtained for a period of 16 years from 1981 to 1997. Statistics on catch measured in metric tons (t) and on effort measured in fishing days are available for both shrimp and fish trawlers. Non-availability of data in Bangladesh restricts bioeconomic modeling to trawl fishing only.

Catch and effort data for trawl fishing published by the Department of Fisheries (DOF) need modifications for three reasons. First, the DOF publishes data on the total number of fishing days of all trawlers operating in a year. These data do not include the number of nets used by each trawler. A standard fishing day is defined as one fishing day of a trawler using two nets, each with a 25-m long head rope. On that count, a shrimp trawler fishing one whole day with one shrimp net is deemed to exert

half a day of fishing effort. Since the total revenue from a fish trawler measures a very small percentage of the total revenue from a shrimp trawler, more emphasis is placed on the catch and effort by the shrimp trawlers. It is, therefore, necessary to convert the effort level of a fish trawler into that of a shrimp trawler. Time series of catches by the shrimp and fish trawlers give the average daily shrimp catch of a shrimp trawler as 650 kg and that of a fish trawler as 190 kg. Based on the ratio of shrimp catches of the two types of trawler, productive capacity of one shrimp trawler is assumed to be at a par with that of three and a half fish trawlers. Effort data adjusted for the number of nets and the type of trawler used gives a standard fishing day (SFD). Dividing the total shrimp catch by SFD, we obtain the first type of catch per unit of fishing effort, CPUE1.

Second, standardization of effort data makes use of the fact that CPUE increases gradually over time due to technological progress. Hence, a fishing day in a later year is equal to more than a fishing day in an earlier year. To purge the DOF data of the effect of technological progress, two modification methods were used. First, data on the CPUE of the DOF research vessel, Anusandhani, were collected and used to estimate a trend line of CPUE values. Information about shrimp catch from different fish and shrimp cruises of Anusandhani carried out during 1984 to 1987 were processed to calculate the catch per fishing day (CPUE). The CPUE observations were then used to estimate a trend line, which gave the predicted CPUE values for different years. These trend values were supposed to be free of technological progress since the same research vessel was used during the whole period. The estimated trend and predicted values of the CPUE were then adjusted to match the average shrimp catches of the shrimp and fish trawlers. The CPUE values thus estimated were labeled CPUE3 and were used to find the standardized effort values as the ratios of the annual total shrimp catch to CPUE3 .

An alternative method of removing the upward bias in the CPUE due to technological progress sets out by regressing CPUE1 on standardized effort and a time variable. The estimated time effect is deducted from CPUE1 and the adjusted CPUE value, called CPUE2, is then regressed on the standardized fishing effort. The different sets of the CPUE data are shown in Table 35. As can be seen from the Table, CPUE3 is less than both CPUE1 and CPUE2 at initial stages, but exceeds them during the later years. This is contrary to expectations, and may be attributed to poor estimation results based on three data points only. The estimated coefficient showing the effect of technological progress using the second method was not found to be statistically significant. This led to using the CPUE1 series in the estimation of the bioeconomic models.

The preceding discussion focused on standardization of the fishing effort, but we need to standardize catch also. This is because the total shrimp catch consists of many species whose prices differ widely. For example, the price of the most valuable fish is almost two hundred times as high as the price of the least valuable fish. It is meaningless to add together the quantities of different fish species with divergent prices. Standardization of catch data can solve the problem of heterogeneity of fish species. This standardization can be based on the percentage catch composition. Data collected from 10 trawl fishing firms in Chittagong City give the following catch composition of shrimp:

Tiger shrimp	8.27%
White shrimp	5.88%
Brown shrimp	57.69%
Small shrimp	28.25%
TOTAL	100.00%

Data on prices of different categories of shrimp were also collected from the Sample Survey. Standardization of catch data proceeded as follows. First, data on the total shrimp catch were separated into catch data for different types of shrimp and fish using the percentage composition figures shown above. Small shrimp was chosen as the standard category because it has the lowest price among species of shrimp. The ratio of the price of a particular species of shrimp to the price of small shrimp was calculated and this ratio was then used to convert the quantity of that particular species into standard units of small shrimp. The following table shows the different price ratios.

Table 35. Catch and effort data for trawl fishing.

Year	Total fishing days	Total shrimp catch (t)	Standard Fishing Days (SFD)	CPUE1 (t)	CPUE2 (t)	CPUE3 (t)
1981 - 82	N/A	1 697	3 782	0.449	0.457	0.232
1982 - 83	N/A	3 120	7 024	0.444	0.461	0.139
1983 - 84	N/A	5 461	9 662	0.565	0.591	0.046
1984 - 85	N/A	5 518	8 159	0.676	0.710	0.047
1985 - 86	6 114	4 034	6 444	0.626	0.668	0.140
1986 - 87	6 969	4 488	6 928	0.648	0.698	0.233
1987 - 88	7 699	3 523	6 583	0.535	0.594	0.326
1988 - 89	8 423	4 893	6 945	0.705	0.772	0.419
1989 - 90	8 384	3 134	5 546	0.565	0.641	0.512
1990 - 91	6 379	3 430	4 499	0.762	0.847	0.605
1991 - 92	6 950	2 902	6 122	0.474	0.569	0.698
1992 - 93	8 133	4 188	7 065	0.593	0.694	0.791
1993 - 94	8 341	3 480	7 169	0.485	0.595	0.885
1994 - 95	8 045	2 416	6 761	0.357	0.475	0.978
1995 - 96	7 934	3 588	7 394	0.485	0.612	1.071
1996 - 97	8 470	3 536	7 107	0.498	0.633	1.164
1997 - 98	8 900	2 444	7 491	0.326	0.470	1.257

Source: Department of Fisheries, Ministry of Fisheries and Livestock.
Note: N/A = Not available.

Table 36. Price ratios of different varieties of shrimp.

Numerator	Denominator	Ratio
Price of tiger shrimp	Price of small shrimp	7.9099
Price of white shrimp	Price of small shrimp	3.6465
Price of brown shrimp	Price of small shrimp	2.0737

The total catch figures were converted into t of small shrimps by using the following conversion formula:

(SCST + SCFT) * 2.3473804 (16)

where
SCST = Total Shrimp Catch of Shrimp Trawlers
SCFT = Total Shrimp Catch of Fish Trawlers

Thus equation (16) measures the total shrimp catch in t of the small shrimp catch. Multiplication of the quantity of small shrimp catch by the price of small shrimp, (Tk.137 327.60 per t), gives the monetary value of the total shrimp catch.

Model Estimation

Schaefer and Fox models were estimated using each of the three CPUE series. The estimation results of the selected models have been given in Appendix Table 18. Each of these models was estimated using 14 observations covering the period 1984 - 98. Consideration of standardized effort data and estimation results led to acceptance of Schaefer's and Fox's models estimated by using CPUE1 series. Results of these models are shown in Table 37. Both the models have moderately large values of adjusted R^2 and the errors are not auto-correlated.

The estimated figures using Schaefer's model and Fox's model are shown in Figures 6 and 7, respectively. The MSY according to Fox's model is greater than the MSY of Schaefer's model. Similarly, the MSY effort level of Fox's model is much higher than the corresponding MSY effort level of Schaefer's model. However, in both cases the current effort level exceeds the MSY effort levels. It is evident from Table 37 that the levels of the MSY from both the models are much greater than the current level of catch. MSY is 4 029 t according to Schaefer's model and 4 136 t according to Fox's model. Both values of MSY exceed the current catch level of 2 444 t. The MSY effort level is 9 317 standard fishing days according to Schaefer's model and 11 822 standard fishing days according to Fox's model. The current effort level of 7 491 standard fishing days is smaller than the MSY effort levels in both models.

Although the current levels of catch and standardized fishing effort are less than the corresponding optimum (MSY) values determined by the Schaefer and Fox models, the maximum values of shrimp catch and effort level obtained previously in Bangladesh were much higher than these optimum values. For example, the maximum shrimp catch of 5 518 t caught in 1985 is higher than the MSY values in both models. Similarly, the maximum effort level of 9 662 standard fishing days exerted in 1984 exceeds the MSY effort level in Schaefer's model. Moreover, some of the previous catch and effort levels are greater than the MSY values and MSY effort levels. Figures 8 and 9 bear testimony to this observation. Some of the real catch values lie above the maximum points of the estimated Schaefer and Fox curves. It can be concluded that industrial fishing in Bangladesh is subject to over-exploitation. It is likely that the marine resources for trawl fishing will soon be exhausted. Signs of the extinction process of valuable commercial species in the Bay of Bengal are very visible these days. The government should take immediate steps to stop the massive over-exploitation of the fishery resources taking place in the EEZ of Bangladesh.

An estimated model expressing fish catch in money values is essential for estimating maximum economic rent (MER) and the corresponding fishing effort level. Such a model also provides information about the level of fishing effort corresponding to open access equilibrium. A linear total cost function relating the total cost to fishing effort is a prerequisite for finding the open access equilibrium. The standardized units of fish catch were multiplied by the average price of small shrimp. Data from our trawler sample gave the average price of small shrimp as Tk.137 327.60 per t. The estimated slope of a linear total cost function from the origin was Tk.87 459, implying that total cost increases by Tk.87 459 for each additional standard fishing day.

Table 37 shows the estimated values of MER and MEY and the corresponding effort levels for both Schaefer and Fox models. Figures 19 and 20 present the open access equilibrium positions in Schaefer's and Fox's model respectively. Table 37 shows that the MEY effort level in each models is much less than both the current effort and the MSY effort levels.

Table 37. Results of bioeconomic modeling.

Model	MSY (t)	MSY Effort (SFD)	Current Catch (t)	Current Effort (SFD)	MEY Effort (SFD)	MEY Million Tk.	MER Million Tk.	Result
Schaefer	4 029	9 317	2 444	7 491	6 452	1 176.0	622.8	Over Exploitation
Fox	4 136	11 822	2 444	7 491	6 223	1 126.8	593.2	Over Exploitation

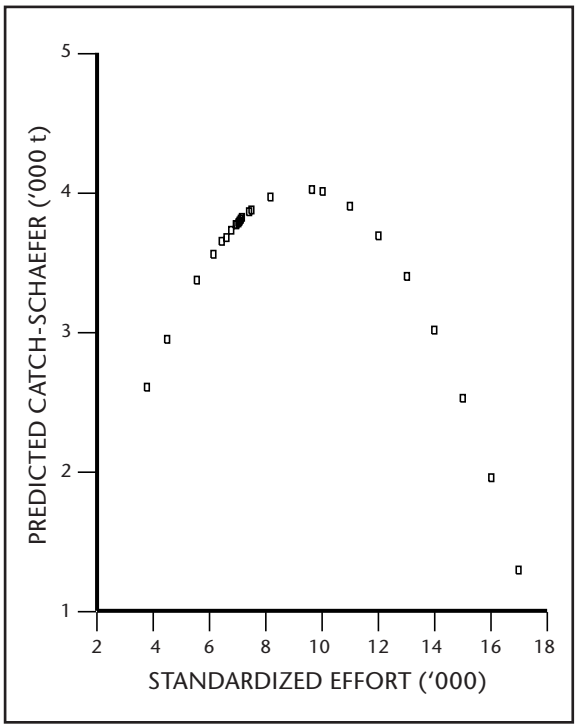

Fig. 6. Schaefer's Model: MSY = 4 029 t, MSY Effort = 9 317 SFD.

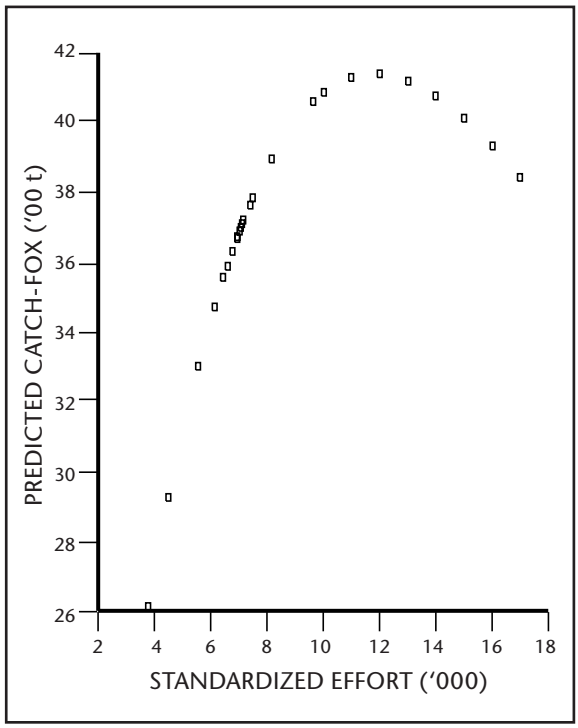

Fig. 7. Fox's Model: MSY = 4136 t, MSY Effort = 11 822 SFD.

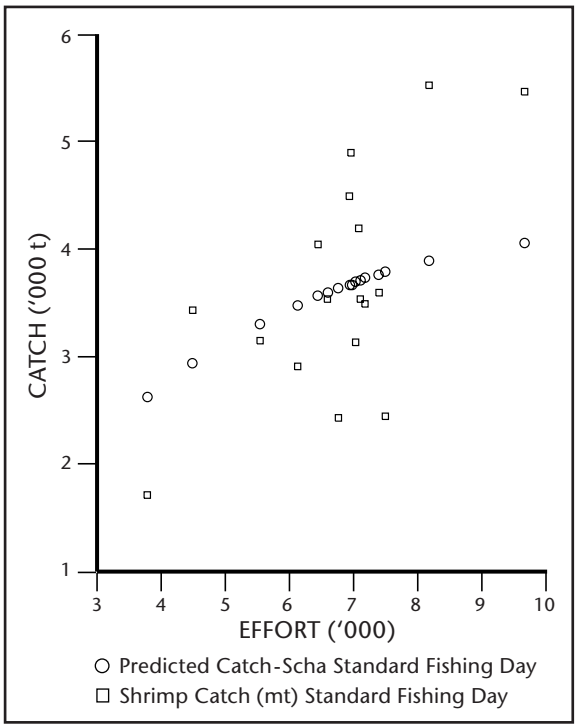

Fig. 8. Real and predicted catch using Schaefer's Model.

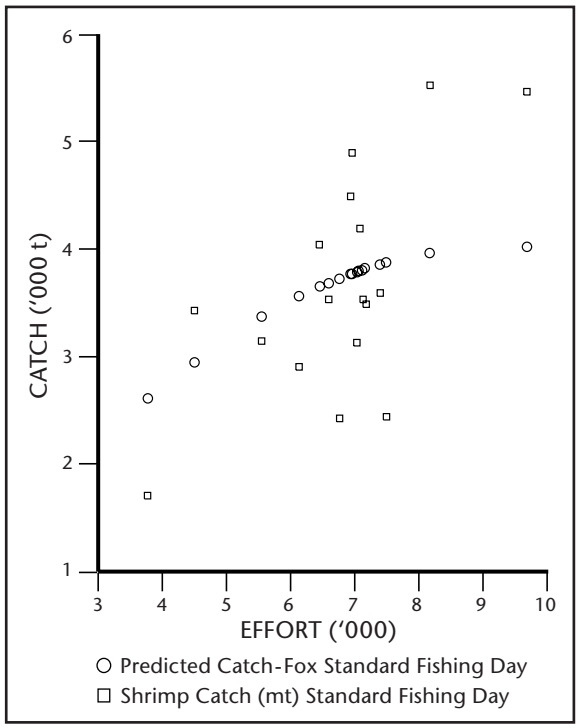

Fig. 9. Real and predicted catch in Fox's Model.

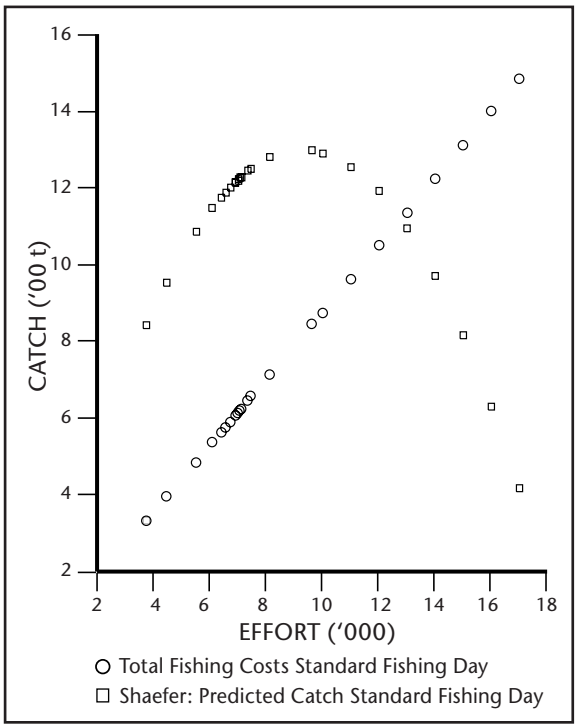

Fig. 10. Open access equilibrium in Schaefer's Model.

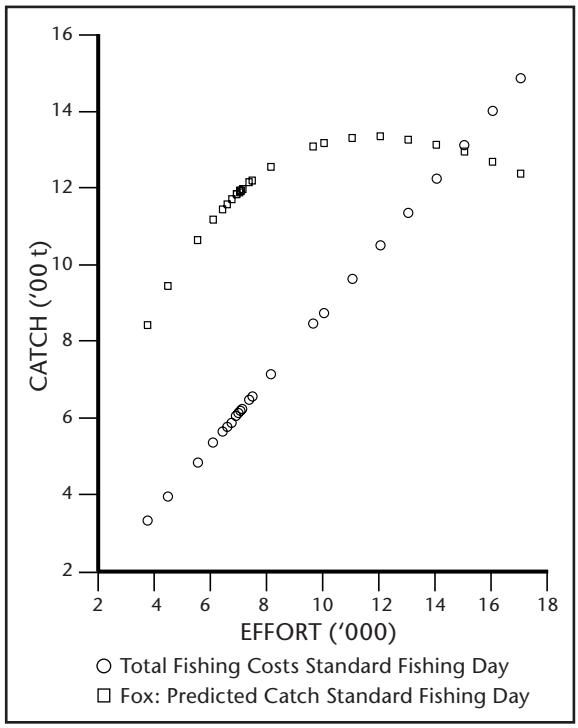

Fig. 11. Open access equilibrium in Fox's Model.

Conclusion and Recommendations

Time series data on catch and effort for trawl fishing in Bangladesh were standardized and used in estimating Schaefer's surplus production model and Fox's production model. The estimation results were good in terms of different statistical criteria used to judge estimated models. The estimated models show that industrial fishing in Bangladesh has already exceeded the maximum sustainable yield (MSY) level. There is no point in increasing the number of trawlers used in industrial fishing or increasing the intensity of fishing effort by increasing the number of annual fishing days. The previously caught maximum volume of total catch in industrial fishing is much higher than the MSY levels of catch. If this tendency of over-fishing lasts for long, the fishery resources in the EEZ of Bangladesh will soon be exhausted. The recent trend in coastal fishing shows omens of bad harvests and finally extinction of marine fishery resources in the Bay of Bengal. All fishers whom we interviewed in four sample sites reported declining fish catch in their daily fishing trips.

The responsibility for the stocks lies with all the parties involved in the use of the Bay of Bengal. The government, by enacting laws and ensuring their enforcement, has a key role to play. The present number of trawlers is very large - their number should not be allowed to increase. The trawl and large mechanized boat owners have to avoid intrusion into near-shore areas and over-fishing. Discarding by-catch at the present high rate should be stopped immediately. The artisanal fishers should give up some gear harmful to fish. Certain gear like ESBN, push nets and "*current jaal*" killing juveniles of Hilsha must be abandoned. However, to make all the stakeholders involved in the use of coastal waters do whatever is needed of them, some kind of co-management has to be developed, so that they act in an agreed manner. The initiative must come from the government, with cooperation of the international agencies.

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APPENDICES

Appendix Table 1. Volume of Fish Production in t.

Year	Marine Capture Fishery		Inland Capture Fishery	Culture Fishery		Total
	Large Scale	Small Scale		Coastal	Inland	
1985 - 86	11 898	195 503	441 799	19 951	124 772	144 723
1986 - 87	12 356	205 228	431 006	22 050	144 050	166 100
1987 - 88	10 395	217 187	435 598	25 248	150 677	175 925
1988 - 89	10 353	222 928	424 140	27 172	156 333	183 505
1989 - 90	11 379	227 684	423 872	27 505	165 087	192 592
1990 - 91	87 60	232 778	443 404	28 431	182 562	210 993
1991 - 92	96 23	235 851	479 742	30 147	196 716	226 863
1992 - 93	12 227	238 265	532 419	33 773	203 970	237 743
1993 - 94	12 454	240 590	573 376	39 447	224 743	264 190
1994 - 95	11 715	252 935	591 145	47 331	269 742	317 073
1995 - 96	11 959	257 743	609 151	68 349	310 738	379 087
1996 - 97	13 564	261 140	599 900	79 020	353 115	432 135

Source: Bureau of Statistics 1998.

Appendix Table 2. GNP* and value-added by sectors at constant prices (Million Taka) (Base Year 1984 - 85).

Year	GNP	GDP	Agri.	Fishery	Marine	Inland	Industry	Marine
1972 - 73	221 687	220 802	117 376	14 317	627	13 690	14 280	4
1973 - 74	254 025	254 356	129 640	14 362	724	13 638	16 781	8
1974 - 75	262 454	262 973	128 335	14 412	822	13 590	27 036	4
1975 - 76	294 752	295 184	1 432	14 367	920	13 447	28 989	4
1976 - 77	299 040	299 122	138 976	14 367	1 017	13 350	30 173	4
1977 - 78	319 889	318 593	150 979	14 536	1 115	13 421	30 627	20
1978 - 79	335 219	333 114	148 775	10 494	1 212	9 282	34 849	16
1979 - 80	341 925	337 480	149 018	10 464	1 344	9 120	35 564	16
1980 - 81	367 753	360 361	156 987	10 484	1 359	9 125	37 498	4
1981 - 82	369 616	363 294	158 412	11 088	1 426	9 662	38 090	8
1982 - 83	389 930	376 412	165 725	11 842	1 545	10 297	37 478	4
1983 - 84	404 198	392 346	168 383	11 927	1 738	10 189	38 844	4
1984 - 85	413 549	406 933	169 970	12 206	1 816	10 390	40 112	4
1985 - 86	435 435	424 593	175 549	12 406	2 000	10 406	41 156	3
1986 - 87	455 091	442 347	176 250	12 685	2 106	10 579	44 403	4
1987 - 88	470 751	455 135	174 901	12 822	2 202	10 620	44 682	2
1988 - 89	482 581	466 603	173 037	12 871	2 251	10 620	45 927	3
1989 - 90	512 546	497 527	190 354	13 135	2 270	10 865	49 256	66
1990 - 91	530 789	514 442	193 421	13 899	2 308	11 591	50 423	80
1991 - 92	556 219	536 189	197 662	14 799	2 361	12 438	54 117	94
1992 - 93	583 159	560 229	201 230	15 780	2 435	13 345	59 033	107
1993 - 94	611 399	583 840	201 915	17 145	2 508	14 637	63 665	121
1994 - 95	638 802	609 793	199 822	18 803	2 684	16 119	69 165	137
1995 - 96	672 071	642 441	207 126	19 914	2 696	17 218	72 823	174
1996 - 97	714 641	680 206	220 456	21 626	2 928	18 698	75 401	222
1997 - 98	753 570	718 674	226 959	23 485	3 180	20 305	82 601	293

Note: * - Data collected and adjusted from different issues of Statistical Year Book of Bangladesh.

Appendix Table 3. Structure of households in Peshkar Para (PP) and North Salimpur (NS).

Value	Number of rooms		Area of main room (ft^2)		
	Freq. (NS)	Freq. (PP)	Class	Freq. (NS)	Freq. (PP)
1	5	0	15 - 40	0	3
2	6	5	40 - 65	4	4
3	8	11	65 - 90	13	16
4	20	22	90 - 115	7	15
5	9	6	115 - 140	16	8
6	1	1	140 - 165	7	2
7	0	4	165 - 190	2	1
8	1	0	190 - 215+	1	1
9	0	1			
Mean	3.6	4.08	Mean	109	109.91
Median	4	4	Median	120	96
Mode	4	4	Mode	120	90
Std. Dev	1.4	1.4	Std. Dev	34.27	109.44

Source: Bureau of Statistics 1998.
Note: PP = Peshkar Para, NS = North Salimpur, Freq = Frequency of families.

Appendix Table 4. Availability and frequency of eating specific food items.

	Normal		More than normal		Less than normal		Never		Always		Weekly		Monthly	
	NS	PP	NS	PP	NS	PP	NS	PP	NS	PP	NS	PP	NS	PP
Beef & Mutton	0	4	0	0	9	46	41	0	1	3	2	21	39	26
Chicken	0	4	0	0	11	46	39	0	1	3	10	18	39	29
Eggs	0	5	1	0	48	45	1	0	1	4	43	23	6	23
Fish	48	38	1	11	1	1	0	0	47	45	2	5	0	0
Gur	3	3	1	0	45	37	1	8	3	6	32	33	15	1
Milk	1	6	0	1	12	33	36	9	0	7	11	30	11	3
Sugar	48	4	0	1	2	43	0	2	49	5	1	41	0	2
Pulse	0	12	0	0	0	33	0	5	50	12	0	33	0	0

Source: Bureau of Statistics 1998.
Note: PP = Peshkar Para, NS = North Salimpur.

Appendix Table 5. Durable assets of households (North Salimpur).

Radio			Wrist watch		Wall clock		Chairs		Table		W. TV		Color TV	
Va.	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.
0	30	60	23	46	27	54	27	54	33	66	40	80	46	92
1	19	38	8	16	18	36	3	6	12	24	10	20	4	8
2	10	2	13	26	5	10	7	14	5	10	0	0	0	0
3	0	0	5	10	0	0	7	14	0	0	0	0	0	0
4	0	0	1	2	0	0	4	8	0	0	0	0	0	0
5	0	0	0	0	0	0	2	4	0	0	0	0	0	0
1 - 5	20	40	27	54	23	4	23	46	17	34	10	0	4	8

Source: Bureau of Statistics 1998.
Note: Va.= Value, F. = Frequency of families, P.= Percentage of families.

Appendix Table 6. Durable assets of households (Peshkar Para).

Radio			Wrist watch		Wall clock		Chairs		Table		W. TV		Color TV	
Va.	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.
0	33	66	19	38	43	86	19	38	23	46	39	78	49	98
1 - 5	17	34	28	56	7	14	19	38	27	54	11	22	1	2
6 - 10	0	0	3	6	0	0	8	16	0	0	0	0	0	0
11 - 15	0	0	0	0	0	0	3	6	0	0	0	0	0	0
16 - 20	0	0	0	0	0	0	1	2	0	0	0	0	0	0

Source: Bureau of Statistics 1998.
Note: Va.= Value, F. = Frequency of families, P.= Percentage of families.

Appendix Table 7. Livestock of households.

	Goats				Cows				Buffalo			
	N. Salimpur		Peshkar Para		N. Salimpur		Peshkar Para		N. Salimpur		Peshkar Para	
Value	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.
0	40	80	43	86	50	100	49	98	50	100	47	94
2	0	0	1	2	0	0	0	0	0	0	0	0
3	3	6	3	6	0	0	0	0	0	0	0	0
4	1	2	0	0	0	0	0	0	0	0	0	0
5	1	2	2	4	0	0	0	0	0	0	1	2
6	2	4	0	0	0	0	1	2	0	0	1	2
7	1	2	1	2	0	0	0	0	0	0	0	0
9	1	2	0	0	0	0	0	0	0	0	0	0
12	1	2	0	0	0	0	0	0	0	0	0	0

Source: Bureau of Statistics 1998.
Note: F. = Frequency of families, P.= Percentage of families.

Appendix Table 8. Age distribution of respondents and wives.

Age Limit	North Salimpur		Peshkar Para	
	Respondent	Wife	Respondent	Wife
17 - 21	2	5	0	10
22 - 26	9	7	7	10
27 - 31	4	5	10	10
32 - 36	7	10	17	2
37 - 41	7	4	9	2
42 - 46	10	4	2	2
47 - 51	4	3	4	3
52 - 56	2	1	0	0
57 - 61	4	0	1	0
62 - 66	0	0	0	0
67 - 71	1	0	0	0

Source: Bureau of Statistics 1998.

Appendix Table 9. Main and non-main occupations of respondents.

Occupation	North Salimpur				Peshkar Para			
	Occupation		Non-main Occupation		Occupation		Non-main Occupation	
	F.	P.	F.	P.	F.	P.	F.	P.
Fishing	46	92	3	6	48	96	3	6
Trade in fish	2	4	16	32	1	2	9	18
Other business	1	2	6	12	1	2	2	4
Housewife	1	2	25	50	0	0	1	2
Nothing	0	0	0	0	0	0	35	0

Source: Bureau of Statistics 1998.
Note: F. = Frequency of families, P.= Percentage of families.

Appendix Table 10. Change of roles in fishing -north salimpur.

Group of the fishermen	Owner of boat	Owner of net	Participate	Organize	Frequency 15 years ago	Frequency 10 years ago	Frequency 5 years ago
1	Yes	Yes	No	Yes	3	1	3
2	Yes	Yes	Yes	Yes	18	20	32
3	No	Yes	Yes	No	22	27	15
4	No	Yes	No	Yes	No	02	00

Source: Bureau of Statistics 1998.

Appendix Table 11. Change of roles in fishing - Peshkar Para.

Group of the fishermen	Owner of boat	Owner of net	Hired net & boat	Participate in fishing	Organize fishing	Frequency 15 years ago	Frequency 10 years ago	Frequency 5 years ago
1	Yes	Yes	Yes	No	Yes	1	4	5
2	Yes	Yes	Yes	Yes	Yes	1	2	3
3	Yes	Yes	No	Yes	Yes	3	5	6
4	No	Yes	No	Yes	No	12	24	25
5	Other					10	10	11

Source: Bureau of Statistics 1998.

Appendix Table 12. Attitudes towards Fishing.

Attitude	North Salimpur	Peshkar Para
Satisfied	3	7
Anxious	2	16
Not Satisfied	45	27

Source: Bureau of Statistics 1998.

Appendix Table 13. Numbers of fishing craft and gear.

Year	Type of Fishing											
	Industrial		Gillnet		SBN Fishing		Long-line		Trammel		Other fishing	
	Craft	Gear	Craft	Gear	Craft	Gear	Craft	Gear	Craft	Gear	Craft	Gear
1989 - 90	53	53	6 389	6 389	7 452	12 615	1 382	2 064	500	500	1 608	2 222
1990 - 91	54	54	6 389	6 389	7 452	12 615	1 382	2 064	500	500	1 608	2 222
1991 - 92	51	51	6 389	6 389	7 452	12 615	1 382	2 064	500	500	1 608	2 222
1992 - 93	51	51	6 389	6 389	7 452	12 615	1 382	2 064	500	500	1 608	2 222
1993 - 94	53	53	6 389	6 389	7 452	12 615	1 382	2 064	500	500	1 608	2 222
1994 - 95	53	53	6 389	6 389	7 452	12 615	1 382	2 064	500	500	1 608	2 222
1995 - 96	53	53	6 389	6 389	7 452	12 615	1 382	2 064	500	500	1 608	2 222
1996 - 97	54	54	6 389	6 389	7 452	12 615	1 382	2 064	500	500	1 608	2 222

Source: Department of Fisheries, Ministry of Fisheries and Livestock.
Total: Trawler - 53; Total Mechanized - 3 317; Non- Mechanized 14 014.

Appendix Table 14. Number of fishing craft and gear by type.

	89 - 90	90 - 91	91 -92	92 -93	93 - 94	94 - 95	95 - 96	96 - 97
A. Industrial Fishing								
1. No. of shrimp trawlers	40	41	37	37	41	41	41	41
2. No. of fish trawlers	13	15	14	14	12	12	12	13
3. Total no. of trawlers	53	54	51	51	53	53	53	54
B. Gillnet Fishing								
1. No. of mechanized boats & nets	2 880	2 880	2 880	2 880	2 880	2 880	2 880	2 880
2. No. of non-mechanized boats	3 509	3 509	3 509	3 509	3 509	3 509	3 509	3 509
C. Set Bag net Fishing								
1. No. of seasonal MB	182	182	182	182	182	182	182	182
2. No. of nets of seasonal MB	5 400	5 400	5 400	5 400	5 400	5 400	5 400	5 400
3. No. of seasonal NMB	2 680	2 680	2 680	2 680	2 680	2 680	2 680	2 680
4. No. of all seasons NMB	4 590	4 590	4 590	4 590	4 590	4 590	4 590	4 590
5. No. of nets of all seasons NMB	7 215	7 215	7 215	7 215	7 215	7 215	7 215	7 215
D. Long-line Fishing								
1. No. of MB	255	255	255	255	255	255	255	255
2. No. of nets of MB	1 121	1 121	1 121	1 121	1 121	1 121	1 121	1 121
3. No. of NMB	127	127	127	127	127	127	127	1 127
4. Other long-line NMB	1 000	1 000	1 000	1 000	1 000	1 000	1 000	–
5. Nets of other long-line NMB	963	963	963	963	963	963	963	963
E. Trammel Net Fishing								
1. No. of NMB & net	500	500	500	500	500	500	500	500
F. Other Gears Fishing								
1. No. of NMB	1 608	1 608	1 608	1 608	1 608	1 608	1 608	1 608
2. No. of nets of NMB	2 222	2 222	2 222	2 222	2 222	2 222	2 222	2 222

Source: Department of Fisheries, Ministry of Fisheries and Livestock.
Note: MB = mechanized boats
NMB = non-mechanized boats

Appendix Table 15. Estimation results of first type of production functions.

Sample	Model/ Method	Area of craft	Tonnage of craft	HP of craft	Wt. of FM/ *Tong* nets	Wt.of FM/SB nets	Wt. of *Lakkha* nets	Wt. of other nets	Mesh size	Length of head rope	Fishing days	Dep. cost of nets	Adj. R^2
Trawler	CD - OLS	0.17 (1.02)	0.46 (1.09)	-1.44 (-1.72)	–	–	–	–	-0.45 (-0.46)		1.29 (0.85)	-	0.24
Motorized	CD - OLS		0.37 (0.55)	-62 (-0.64)	–	–	–		-0.62 (-0.74)	0.62 (0.43)	1.26 (0.98)	–	0.31
Peshkar Para	CD - OLS	-0.29 (1.14)	0.50 (1.82)	0.66 (1.67)	0.06 (1.48)	-11 (2.00)	0.16 (2.00)	0.08 (1.94)	–	–	–		0.66
N. Salimpur	CD - OLS	0.65 (0.42)	0.46 (27)	-0.11 (0.15)	0.61 (4.47)	0.05 (-0.34)	–	–	–	–	0.65 (1.75)	-0.65 (-1.44)	0.78

Source: Bureau of Statistics 1998.
Note: CD = Cobb Douglas Production Function, OLS = Ordinary Least Squares, Dep. = depreciation.
Figures in parentheses indicate "t" values.

Appendix Table 16. Fishing assets.

Types of Assets		North Salimpur				Peshkar Para			
		Present		Past		Present		Past	
		Full.	Partial	Full.	Partial	Full.	Partial	Full.	Partial
Boat	Non-Motorized	7	0	7	0	12	0	14	0
	Motorized	43	3	29	1	37	2	7	0
Net	*Tong Jal*	300	0	210	0	0	0	0	0
	SBN	174	0	125	0	0	0	0	0
	Floating	0	0	0	0	9	0	3	0
	Pomfret	0	0	0	0	30	4	16	0
	Lakkha	0	0	0	0	20	1	0	0
	Push Net	26	0	0	0	0	0	0	0
	Other	2	0	0	0	17	0	0	0

Source: Bureau of Statistics 1998.

Appendix Table 17. Estimation Results of Schaefer's Production Models.

Serial	Model	Type	Method	Intercept	Slope	R^2	'd' statistic	MSY	MSY_f
1.	Schaefer	SU-P	OLS	0.86491	-4.642E-05	0.11	1.56	4 029	9 317
2.	Fox	SU-P	OLS	-5.031E-02	-8.459E-05	0.10	1.42	4 136	11 822
3.	Schaefer	SU-M	OLS	0.27883E+06	-14.964	0.11	1.56	4 029	9 317
4.	Fox	SU-M	OLS	12.633	-8.459E-05	0.10	1.42	4 136	11 822

Source: Bureau of Statistics 1998.
Legend SU = Standardized Units, P = In Physical Units, M = In Monetary Units, OLS=Ordinary Least Squares.