DGIS/DANIDA GOB



MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD




# MEGHNA ESTUARY STUDY

## DRAFT MASTER PLAN

VOLUME 6 : FISHERIES



September 1998

DHV CONSULTANTS BV

in association with

KAMPSAX INTERNATIONAL
DANISH HYDRAULIC INSTITUTE

DEVELOPMENT DESIGN CONSULTANTS
SURFACE WATER MODELLING CENTRE
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## ABBREVIATIONS

| | |
|---|---|
| BAU | Bangladesh Agriculture University |
| BFDC | Bangladesh Fisheries Development Corporation |
| BFRSS | Bangladesh Fisheries Resources Survey System |
| BOBP | Bay of Bengal Programme |
| BWDB | Bangladesh Water Development Board |
| CPUE | Catch per Unit of Effort |
| EEZ | Exclusive Economic Zone |
| ESBN | Estuarine Set bagnets |
| FAP | Flood Action Program |
| FCDI | Flood Control Drainage and Irrigation |
| FRI | Fisheries Research Institute |
| GDP | Gross Domestic Product |
| GOB | Government of Bangladesh |
| HH | Households |
| MAEP | Mymensingh Aquaculture Extension Project |
| MES | Meghna Estuary Study |
| MOFL | Ministry of Fisheries and Livestock |
| MSBN | Marine Set bagnets |
| MSY | Maximum Sustainable Yield |
| mt | Metric ton |
| ODA | Overseas Development Administration |
| T&B | Thompson and Bell |
| TOR | Terms of Reference |
| VPA | Virtual Population Analysis |
| T&B | Thompson and Bell |

## SUMMARY

The main goals of the Meghna Estuary Study (MES) are to retain and increase the operational knowledge of hydraulic and morphological processes in the Meghna Estuary and to develop appropriate approaches and techniques for efficient land reclamation as well as effective river bank protection measures. In the long term the physical safety and social security of the people living in the coastal areas and on the islands in the estuary should be improved. Fisheries and aquaculture was an integrated part of the MES and this report presents the present status, constraints and recommended development strategies. With its different habitats and fishing techniques, fisheries is an integral part of the coastal belt therefore it was decided not to limit the analysis to the MES area, but to cover the whole coastal area of Bangladesh.

Fisheries in the Meghna estuary is a interactive process between ecological (the fish), socio-economic (the fishermen) and physical (the estuary) processes. Any intervention or development in the Coastal area should encompass the three inter related elements and this concept can be considered to be the frame of the present study.

### *Socio Economics*

Fisheries in the coastal areas of Bangladesh is "Poverty driven". The Bay of Bengal is one of the few "open common resources" left in Bangladesh, still attracting numerous labourers from the poorest segment of the population. Since 1984 the growth of the number of households, the number of fishermen, the number of gears, etc., in the fishing villages, was about ten times higher as the average population growth in Bangladesh.

Table 1: Increase in population, fishing population and fishing boats,1984-1998

Unit: percent

| | Annual increase | Increase since 1984 |
|---|---|---|
| No of Households | 0.30 | 4.27 |
| Total Population | 0.24 | 3.30 |
| No Fishing Households | 0.44 | 6.20 |
| Total Fishermen | 0.25 | 3.47 |
| Total boats | 0.47 | 6.65 |

At present about 7.3 million people are living in the coastal marine fishing villages. For 22 per cent or 350,000 households fishing is the major professional occupation and 96,000 boats are operated by 350,000 fishermen. These figures do not include newly established fishing villages and all the fishermen living further inland along the major rivers. The distribution of the fishermen among the different thanas in the coastal belt as indicated that the majority of the fishermen are living in Laksmipur district (Ramgati), Chittagong district (Anwari & Banshkali) and Cox's Bazar district (Moheshkali & Cox's Bazar).

The annual income of a fishing household and their differences among the different types of fishing households varies considerably. The annual income of a boats owner is about Tk. 430,000 while fishing labours make about Tk. 16,000 per year. The majority (70-80 per cent) of the fishermen in the coastal area are engaged as fisheries labourers by the *Bahaddar.* In general it can be stated that fishing in the coastal area of Bangladesh is controlled and indirectly owned by the *dadondar* (money lender) and the *Bahaddar* (boat owner) due to the fact that the fisheries labourers depend on the money lender for credit. This debt trap has large consequences for sustainable fisheries management.

Catching of shrimp fry is an important economic activity as over 50 per cent of all households in villages surveyed by MES are engaged in Bagda fry catching, earning about 7.000 Tk/Household per year which is a substantial percentage (25-30 per cent) of the households annual income.

*Ecology*

Biologically, the estuary provides major spawning and nursery areas for a large number of fish and crustacean which spend the remainder of their life cycles at sea, or in fresh water. Further, the estuary provides avenues of entry and exit for migration of anadromous and catadromous fishes. Within the Meghna estuary a number of species are known to be estuarine dependent, that is that passing a portion of their life cycles in the estuary is obligatory for the completion of their life cycles. The total annual catch of the estuarine species is estimated at 240,000 mt with an annual value of US$ 125 million.

Table 2: Annual catch and value of estuarine dependent fish species

| Species | Annual catch (mt.) | Value of catch (million US$) |
|---|---|---|
| Hilsha | 235,000 | 117.5 |
| Fresh water prawn | 405 | 1.62 |
| Tiger shrimp | 700 | 3.5 |
| Brown shrimp | 2,300 | 2.3 |
| White shrimp | 350 | 0.7 |
| TOTAL | 238,755 | 125 |

Within MES accelerated land reclamation through the construction of cross dams have been studied. In principle this is an "alteration of the habitat" as water changes to land and impacts on fisheries can be expected. Quantification of these impacts is difficult as data/knowledge of the system is lacking. The proposed accelerated land reclamation must be treated carefully as;

- 25 per cent of the total fish catch of Bangladesh consists of Hilsha (*Tenualosa ilisha*) and according to FRI three major spawning areas are located in the MES area. Two of them located exactly in the area where accelerated land reclamation is proposed (Nijum Dwip and Char Montaz). The results of the FRI study however does not allow a conclusion to be drawn as to if Hilsha spawns at the mud flat or in the main channel.

- One cross dam most likely does not have a significant impact. The cumulative impact of a number of cross dams could however have a impact similar to that of FCD/FCDI schemes on the inland fisheries, especially if Hilsha spawns at the mud flat. With the present knowledge we do not know if in the future the spawning places will move with the changing land/water patterns. Considering the economic importance of Hilsha (240,000 mt/year, US$ 117 million/year) and the large number of households depending on it for its livelihood, and the fact that most interventions are irreversible, a very cautious approach is essential.

- The numerous creeks and mudflats in the intertidal area serves as nursing area for three other important economic important species; Bagda, Golda and Pangash. The studied interventions will reduce this specific habitat and will reduce the survival of the post larvae/fry of these species, which are already under heavy pressure due to the earlier mentioned shrimp fry collection.

Therefore MES recommended that spawning of the major estuarine species is more studied in detail before major interventions in the MES are carried out.

*Fisheries*

In 1993/94 the total fish production of Bangladesh was estimated at 2.08 million mt, with 0.22 million mt obtained through marine fisheries (23 per cent), 0.57 million mt from inland fisheries (54 per cent) and 0.26 mt from aquaculture (24 per cent). Since 1983 the total fish production increased with 3-4 per cent annually mainly due to an increased aquaculture production such as shrimps and carp culture, and an increased marine catch.

The marine industrial catch remained more or less stable around 10,000 mt/year over the last decade and contribute for 5 per cent of the total catch. Artisanal catch however increased from 150,000 mt/year in 1983-84 to 240,000 mt/year in 1993-94.

The majority of the catch (51 per cent) is caught by gillnets operated from mechanised boats. These gears catch mainly Hilsha and it should be realised that the estuarine Hilsha catch is not included, which give an indication of the importance of the Hilsha catch in the Coastal area. The marine set bagnets contribute to 19 per cent of the total catch followed by the Estuarine set bagnets with 9 per cent.

Analysis of length based stock assessment data through Yield per Recruit curves and Thompson and Bell models clearly indicated that the number Estuarine Set bagnets operated are much too high. A similar analysis made for trawler and trammel nets indicated that their fishing effort is around the optimum level.

A basic bottleneck for the application of holistic or analytical stock assessment programmes is the lack of reliable data on the number of gears operated. Large differences were found for different monitoring programmes operated in the Bay of Bengal. Updating the frame for marine fisheries has a high priority, without a reliable frame no realistic fisheries management policy can be formulated.

***Shrimp farming***

Shrimp farming development in Bangladesh lacked careful planning and design. It resulted in what happened in so many other countries: declining yields and massive losses. First in Taiwan (1988: 42,000 Mt loss), Thailand and Sri Lanka (1989: US$ 27 million loss), thereafter in China (1992/93: the production declined from 200,000 mt to 50,000 mt) and in 1994-95 massive losses were obtained in the semi-intensive shrimp farms in Chittagong. These massive losses are usually referred to as *the shrimp disease,* and are caused by a combination of poor planning and design, pond pollution, and outbreaks of viral diseases and finally leads to the fact that shrimp farming becomes an unsustainable activity.

The main reason for the non-sustainability of shrimp farming in the is its non-planned development. The major factors are

- Poor pond design and siting. Most of the ponds are large and difficult to manage and depend completely on the tides for water supply. Most of the ponds are however located on relatively high land, which makes proper water management extremely difficult. Secondly, due to its uncontrolled development a proper supply and drainage network does not exist or does not function resulting in the practice that effluent water of one pond will re-enter a neighbouring pond, facilitating transmission of diseases and self pollution among the shrimp farms.

- Shrimp diseases. First diseases started in 1994 during the second crop of semi-intensive shrimp farming in Cox's Bazar. The major agent causing the disease was the China Virus also know as White Spot disease. Next to the China Virus, heavy infections of Monodon Bacilli Virus (MBV), Type C Baculovirus (T-CBV) and Septic Hepatopancreas with bacterial sepsis was found in imported larvae and shrimps in grow-out ponds. The China Virus infects a wide range of shrimps species such as *P. monodon*, *P. indicus*, *P. chinensis*, *P. merguensis*, *P. japonicus* and *P. vanamei* and it is suspected that planktonic shrimps may be the carriers and that natural stocks are infected. There is no treatment against the China Virus and intensive farms in Thailand and Malaysia changed there water management system and disinfect all their intake water nowadays.

*Development strategies*

*Fisheries*

Fisheries in the coastal areas of Bangladesh is "Poverty driven". The Bay of Bengal is one of the few "open common resources" left in Bangladesh, still attracting numerous labourers from the poorest segment of the population. This trend will continue till the moment the system collapse.

In principle there are two major basic problems to be covered in a long term strategy:

- how to encourage existing fishermen already in fisheries to leave the fisheries for good, this in terms of labour and capital

- how to stop the flow of new entrants into marine fisheries.

Both can only be tackled with integrated development projects creating investment opportunities and employment outside the fisheries sector with as basic aim to channel surplus labour to other sectors of the economy. Benefits of such an integrated system of development includes improved education, alternative employment generation, development of rural enterprises, improved communication and access to markets, accessible credit systems, diversification of income sources at household level, awareness building, etc. This will be a long-term and difficult task. There will be a high risk that the system will collapse beforehand as in the whole region only Malaysia succeeded to reduce its fishing labour force, mainly due to its high economic growth and development of the industrial sector.

The long-term strategies should be covered on a national level and will be a long-term, gradual development process. However in order to try to slow down the process of degradation several actions, summarised below, should be undertaken immediately.

- In co-operation with NGOs an adapted credit programme should be developed for the fisherfolk community in order to reduce their indebtedness to the money lender.

- On a pilot basis a ESBN replacement programme should be executed, which encompasses the introduction of alternative gears, alternative income generation and introduction of credit facilities in order to guarantee a higher fish price The results can be used for the gradual replacement of all ESBN nets in the Coastal area.

- Set up a programme for the reduction of post harvest losses, and improvement of transport and storage fish. This programme should cover the fishermen as well as the fish traders.

- The capacity of fish stock and catch/effort monitoring should be improved immediately and institutionalised and a number of fisheries biologist should be trained in fisheries stock assessment, further development of fisheries management information system through updating of the existing frame. This a programme should encompass the major economic species and used gears and special attention should be given to ESBN, pushnets and Jatka gears and would result in a more complete picture on a regular basis on the status of the marine and estuarine fisheries.

- There is a risk that accelerated land reclamation will affect several fish and shrimp stock at present reliable data on this subject are lacking. Therefore a major research programme on the spawning and nursery of estuarine dependent fish and shrimp species should be carried out before major interventions in the MES area are carried out.

- There is a serious resource conflict between offshore shrimp trawling and the catching of Bagda fry for shrimp farming. On the long run this will most likely result in the collapse of both activities and complete collapse of the whole shrimp industry. Considering the social-economics of Bagda fry catching for the local communities. it should be investigated what

will be the biological, social and economic impact of closing the shrimp trawling as a management measure.

- A further increase in the total marine catch can only be attained through exploitation of the under utilised pelagic resources. This resource can not be exploited by the artisanal fishermen and it should be investigated if this resource can be exploited through international joint ventures.

All fisheries related activities should be part of an Integrated Coastal Management Strategy.

*Shrimp farming*

It is now generally recognised that shrimp farming must enter a new era. compared to other sophisticated poultry, cattle or even fish production shrimp farming is primitive. In order to compete in the future and become a more sustainable activity shrimp farming should use a long term strategy as used by other livestock industries based on;

- proper planning of shrimp farming through coastal management plans, zoning of suitable shrimp farming sites, formulation of a land use policy, development of proper structures and marketing systems, etc.

- domestication and genetic improvement of stocking material

- further development of sustainable rearing techniques, disease diagnostics and treatment methods

- development of advanced feeding strategies

- development and implementation of sound environmental management plans.

The following development strategies and projects are recommended for further development of aquaculture in the coastal area.

- Development of a shrimp farming master plan. The master plan should cover: present land use and cropping pattern, soil and topographic maps, indicate which areas are suitable for sustainable shrimp farming, redesign of the major water ways in such a way that all shrimp areas are supplied with separate inlet and outlets. Shrimp culture should be banned from areas where separate inlet and outlet structures can not be constructed and in areas where the tidal movement does not allow proper water exchange of the ponds. Geographical Information Systems will be a major tool within the master plan.

- Shrimp health management plan. Under this programme profound knowledge on shrimp diseases should be acquired. The programme should include the set up of a shrimp disease unit, rehabilitation of DoF/FRI hatcheries which can serve as research and training centres, testing of broomstick, post larvae, introduction of gene probing for shrimp viruses, dissemination of simple stress tests for post larvae and assistance to hatchery operators and grow-out farmers. This programme would provide the scientific basis for viable pathogen free hatchery industry.

- Development of a viable pathogen free hatchery industry. This programme would reduce the need for imported Post larvae and on the long run the use of wild caught larvae could be avoided. Assistance will provided to private hatchery operators, introduction of improved hatchery management, introduction of a testing and certification programme for disease free status for specific pathogens as well as for general quality standards (stress tests). The certification will be linked with the development of an independent certification control unit.

- The development of a hatchery industry will be a long-term process. In the mean time wastage larvae of shrimp and fish through the Bagda fry catchers should be reduced as much as possible through an awareness and assistance programme. The programme should introduce and propagate the use on non destructive gears, proper handling and transport procedures. There is a serious resource conflict between offshore shrimp trawling and the catching of Bagda fry for shrimp farming. On the long run this will most likely result in the collapse of both activities and complete collapse of the whole shrimp industry. Considering the social-economics of Bagda fry catching for the local communities. it should be investigated what will be the biological, social and economic impact of closing the shrimp trawling as a management measure.

- Fresh water fish culture in the MES is well below the target level of 2000 kg/ha/year and the production could be easily increased by an aquaculture extension programme.

- Improvement and assurance of the quality of exported shrimps and fish which could lead to an increased income for the shrimp farmers as it allows higher "farm gate" prices.

- Further diversification of the aquaculture industry should be studied i.e. sea-bass farming, mud crab farming, milkfish, etc.

In the context of the development strategies the following projects were formulated by MES:

| | |
|---|---|
| **Title of Project** | **Development of adapted credit programmes for fisherfolk communities** |
| Duration | 5 years |
| Output | Adapted credit programme tested with 500 fisherfolk households |
| **Total Costs** | **Tk 90,394,150 US$ 1,965,090** |

| | |
|---|---|
| **Title of Project** | **ESBN replacement programme** |
| Duration | 5 years |
| Output | An acceptable method for the replacement/reduction of ESBN |
| **Total cost** | **Tk 81,638,425 US$ 1,774,748** |

| | |
|---|---|
| **Title of Project** | **Spawning areas of Hilsha** |
| Duration | 3 years |
| Output | Location of the major spawning and nursing areas of estuarine species |
| **Total costs** | **Tk 49,730,670 US$ 1,081,102** |

| | |
|---|---|
| **Title of Project** | **Marine fisheries information system** |
| Duration | 3 years |
| Output | Updated knowledge of the status of fisheries and stocks in the coastal area |
| **Total costs** | **Tk 64,801,330 US$ 1,408,725** |

| | |
|---|---|
| **Title of Project** | **Comparison Bagda fry catching vs shrimp trawling** |
| Duration | 3 months |
| Output | Simulation model which predicts the impact of different management options |
| **Total costs** | **Tk 1,984,400 US$ 43,139** |

| | |
|---|---|
| **Title of Project** | **Shrimp farming master plan** |
| Duration | 1 year |
| Output | Zoning of land use in the coastal area and formulation of a shrimp farming development plan |
| **Total costs** | **Tk 22,187,770 US$ 482,343** |

| | |
|---|---|
| **Title of Project** | **Shrimp health programme** |
| Duration | 3 years |
| Output | Production technology of healthy post-larvae and certification of hatcheries |
| Total cost | **Tk 55,313,995** **US$ 1,202,478** |

| | |
|---|---|
| **Title of Project** | **Shrimp fry catching awareness programme** |
| Duration | 5 years |
| **Total costs** | **Tk 82,366,240** **US$ 1,790,570** |

# 1. INTRODUCTION

## 1.1 The Meghna Estuary Study

The Meghna Estuary Study (MES) is a component (FAP 5B) of the Flood Action Plan (FAP). The project is being implemented under a co-operation programme between the Governments of Bangladesh, The Netherlands and Denmark. The executing agency is the Bangladesh Water Development Board (BWDB). The co-ordination with other projects under the Flood Action Plan is to be maintained by the Flood Plan Co-ordination Organisation (FPCO), now WARPO.

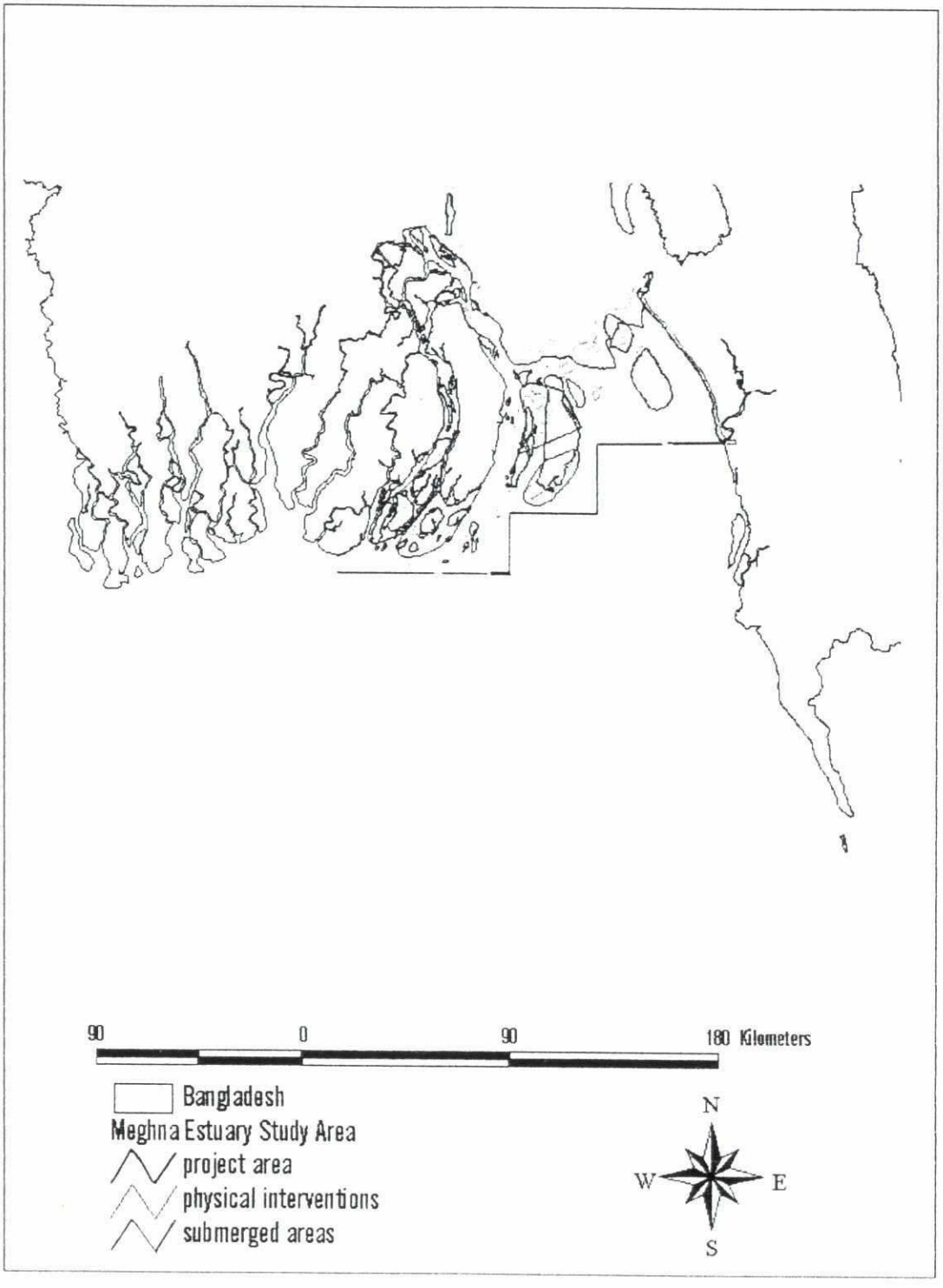
The Meghna Estuary Study can be considered as the follow-up of the "marine based" activities of the Land Reclamation Project. The main goals of the study are to retain and increase the operational knowledge of hydraulic and morphological processes in the Meghna Estuary and to develop appropriate approaches and techniques for efficient land reclamation as well as effective river bank protection measures. In the long term the physical safety and social security of the people living in the coastal areas and on the islands in the estuary should be improved.

The development objectives of the project are to increase the physical safety and social security of the inhabitants and promote sustainable development in the coastal areas and on the islands.

The immediate objectives of MES are to enhance and strengthen operational knowledge of hydraulic and morphological processes in the Meghna Estuary, find suitable land reclamation and bank protection methods, increase the capacity of BWDB to reclaim new land and protect the eroding river banks and finally to prepare a plan with priority project and programmes for flood protection, agricultural and socio-economic development for early implementation.

MES area covers the Lower Meghna River from Chandpur town (the downstream extent of FAP9B) to the Bay of Bengal. The eastern boundary follows the left bank and the coast line to the mouth of the Karnafuli near Chittagong (the boundaries of FAP5 and FAP5C). The western boundary follows the right banks of the Lower Meghna and Tetulia Rivers and the coastline to the bay (partly the boundary of FAP4). The southern boundary, which covers the eastern area and the offshore islands, is not specifically defined. But the eastern side should cover the entrance to the Karnafuli (see Figure 1.1).

Figure 1.1: The MES study area



Fisheries was not conceived as a separate discipline in the original TOR of the Meghna Estuary Study, however this discipline was included in the revised TOR and covered the following topics;

- assessment of fisheries potential in the lower Meghna and estuarine areas.
- impact assessment of land development on fisheries, both capture or culture fisheries.
- formulation of a fisheries development plan

There are two types of fisheries in Bangladesh:

- *Capture fisheries*: carried out at sea in the inshore and offshore waters and in inland water bodies such as beels, khals, rivers and the flood plain.
- *Aquaculture*: which comprises the pond raising of carp *spp* and shrimps in respectively fresh and brackish water.

This reports presents the results of the fisheries and aquaculture aspects in the Meghna Estuary Study. Fisheries and aquaculture in the coastal zone can not be pin pointed to a certain area like the MES study area only. Therefore it was decided to cover the whole of the coastal zone.

## 2. THE COASTAL AREA OF BANGLADESH

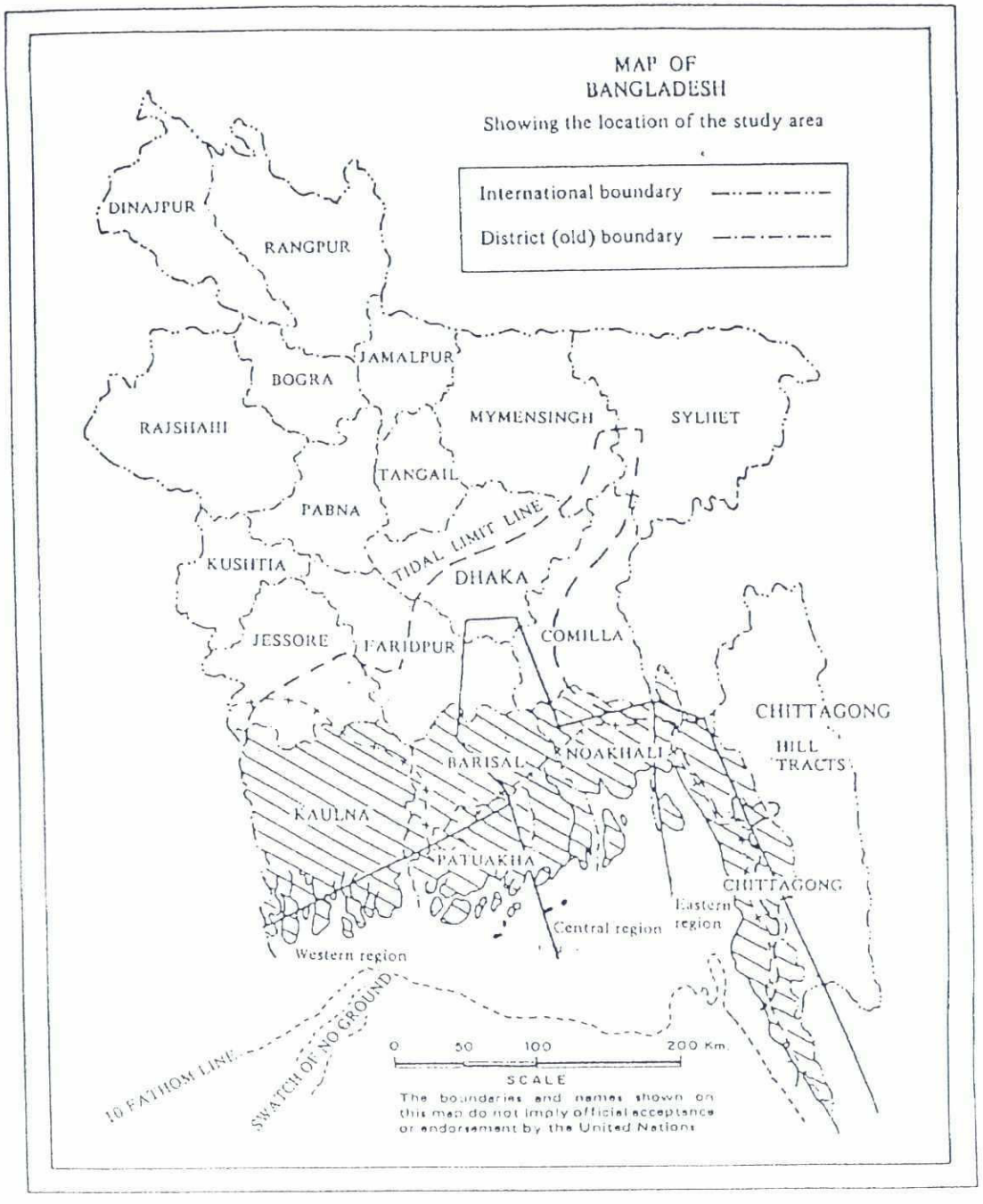
Bangladesh has a land area of 144,045 $km^2$ and a population of over 110 million. The Bangladesh coastline extends 460[1] kms along the northern edge of the Bay of Bengal, from the mouth of the Naaf river in the Southeast, to the mouth of the Raimangal River in the southwest. In the dry season , the salt water limit follows an irregular line. Its width varies from less than 2 km, bordering some parts of Cox's Bazar Coastline, to as much as 50 km in the district of Khulna and Sathkira.

Most of the country is drained by the Ganges, Brahmaputra and Meghna Rivers, which constitutes one of the largest river systems in the world. It has its origin in the Himalayas and the Khasi-Jaintia Hills in the north of the country. While flowing through Bangladesh on its way to the Bay of Bengal, the system carries an annual estimated sediment load of 2.4 billion tons. These sediments are subjected to coastal dynamic processes generated mainly by river flow and tidal and wind actions, leading to accretion and erosion in the coastal area of Bangladesh. The coast of Bangladesh can be classified into three distinct regions on the basis of geomorphologic conditions (Figure 2.1);

- the eastern region, from Big Feni River to Badar Mokam (southern tip of the mainland);
- the central region, from Tetulia River to the Big Feni River, including the mouth of the Meghna River;
- the western region, covering the coastline from the Tetulia River to the international border at Hariabhanga River.

[1] MES estimated a total coastline of 2600 kms If the periphery of the islands in Bangladesh is included.

Figure 2.1: Geomorphical characteristics of the coastal area.




Legend:

— — — — — Tidal limit line.

+ – + – + – Line showing the salinity limit of 1,000 micro-mhos (approx. 6.76 ppt).

——— Three broad regions of the Bangladesh coastal area.

## 2.1 Marine Habitats

### 2.1.1 Estuaries

The coastline of Bangladesh is intercepted by a network of interconnected waterways varying in width from a few meters to several kilometres. These generally run in a north to south direction. Some of the world largest rivers, such as the Ganges, Brahmaputra, Meghna and Karnafuli enter the Bay of Bengal through this estuarine system

The principle feature in estuarine hydrology is the presence of a prolonged low salinity regime every year, during the monsoon and the post-monsoon.

An important aquatic resource is the estuarine brackish water zone. Estuaries are the most efficient aquatic systems in terms of transfer of solar energy into biomass. This intertidal zone is a transition area between terrestrial and aquatic systems. Its nutrients are primarily derived from upstream catchments or from tidal flooding. This organic material represents a major source of food for a variety of aquatic species. A large number of fish, shellfish, prawns and shrimps spend their early life in the coastal lagoons and mangrove areas and natural prawn and shrimp productions relies heavily on these areas. It has been demonstrated that the length of the shore line in estuarine areas is a controlling factor in marine shrimp fisheries (Fuller[2], 1979)

### 2.1.2 Mangroves

Generally, mangrove forests play an important role in coastal protection and land reclamation. Along the erosion coast they buffer the impact of wave action and slow down the erosion process. Along those stretches of the coast, where accretion takes place, mangroves were planted in the newly formed mud flats in order to trap and stabilise the sediment.

The Bangladesh cost supports about 580,000 ha of natural mangroves and a further 100,000 ha of planted mangroves (Mahmood, 1986[3]). The Sundarbans mangrove forests, one of the largest mangrove ecosystems in the world, is situated in the southwest, mostly in Khulna District covers 577,000 ha, of which one third is tidal channel. The numerous rivers and streams which dissects the Sundarbans in a north south direction are or were distributaries of the Ganges. These rivers form five main estuaries which provide major points of ingress for saline intrusion. The five main estuaries from west to east are (ESCAP[4], 1988);


- Raimongal-Harinbhanga estuary
- Malancha estuary
- Kunga estuary formed by the Sibsa and Pussur rivers.
- Bangra estuary
- the Baleshwar estuary at the eastern edge of the Sundarbans formed by the combined flow of the Bhola and Baleswar river.

Mangrove trees provide a variety of valuable wood products such as timber, fuelwood, charcoal, tannins. The high amount of leaf litter produced by the mangrove trees provides the base of the food chain that characterises the estuarine and coastal waters. During the decomposition

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[2] Fuller, K.H., 1979, Shoreline as a controlling factor in commercial shrimp production. NASA Technical memo, 72/73, 227 pp

[3] Mahmood, N, 1986. Effect of shrimp farming and other impacts on mangroves of Bangladesh, Paper presented at the 3rd session of the IPFC working party of experts on Inland Fisheries, Bangkok, Thailand, June 19-27, 1986, FAO Fish Report. No. 370, pp 46-66.

[4] ESCAP, 1988, Coastal Environmental Management Plan for Bangladesh. Vol 2, Bangkok, Thailand, 149 pp.

process, the leaves are enriched by proteins from micro-organisms that break down the leaves. This protein-enriched plant detritus provides the main food for juveniles of the commercially important shrimp (Penaeidae), which spend part of their life cycle in the brackish waters of the tidal swamps. Plant detritus is transported by the current in seaward direction; the nutrients released from the mineralisation process support the primary production by phytoplankton in the estuarine and coastal waters. Moreover, many estuarine organisms feed directly on the detritus. Mangrove swamps play a very important role as nursery areas for a large number of marine species.

The mangrove sediment is colonised by a variety of molluscs and crabs (*Scylla*, *Uca*, *Sesarma*). Those parts of the trees, which are regularly inundated by the tides (mainly the aerial roots), are colonised by filter feeders such as barnacles and oysters. Molluscs and crabs belonging to the family of Grapsidae (especially *Sesarma*) play an important role in the fragmentation of leaf litter and detritus formation. At high tide, large numbers of fish, shrimp and crab move into the mangrove areas to feed.

The importance mangrove for marine fisheries has been demonstrated by Primavera[5] (1992), de Graaf and Xuan[6](1998, in press) reported that one ha of mangrove supports an annual marine catch of 450 kg and Shahid[7] (1985) showed that the largest fishing ground in the Bay of Bengal can be identified with the Sundarbans.

### 2.1.3 Islands

The river system, which carries an enormous quantity of silt, empties through the coastal zone in to the Bay of Bengal and results in the formation of a large number of temporary and permanent islands called Chars.

### 2.1.4 Offshore waters

The Bangladesh exclusive economic zone extends 310 km from the coast[8] , covering an area of about 70,000 $km^2$ . As early as 1911, the possibilities of commercial exploitation of fish resources in the Bay of Bengal were explored by the research vessel Golden Crown. Since then several surveys have been conducted to estimate the resource potential of the Bay of Bengal. As a result of these surveys three potential fishing grounds for demersal stocks were identified (Figure 2.2);

- south patches (6,200 $km^2$ ) between 20° 50'N - 21° 40'N and 91° E - 91° 50' E.
- middle ground (4,600 $km^2$ ) between 20° 50'N - 21° 20' N and 90° E - 91° E.
- swatch of No ground (3,800 $km^2$) between 21° N - 21° 40'N and 89° E - 90° E.

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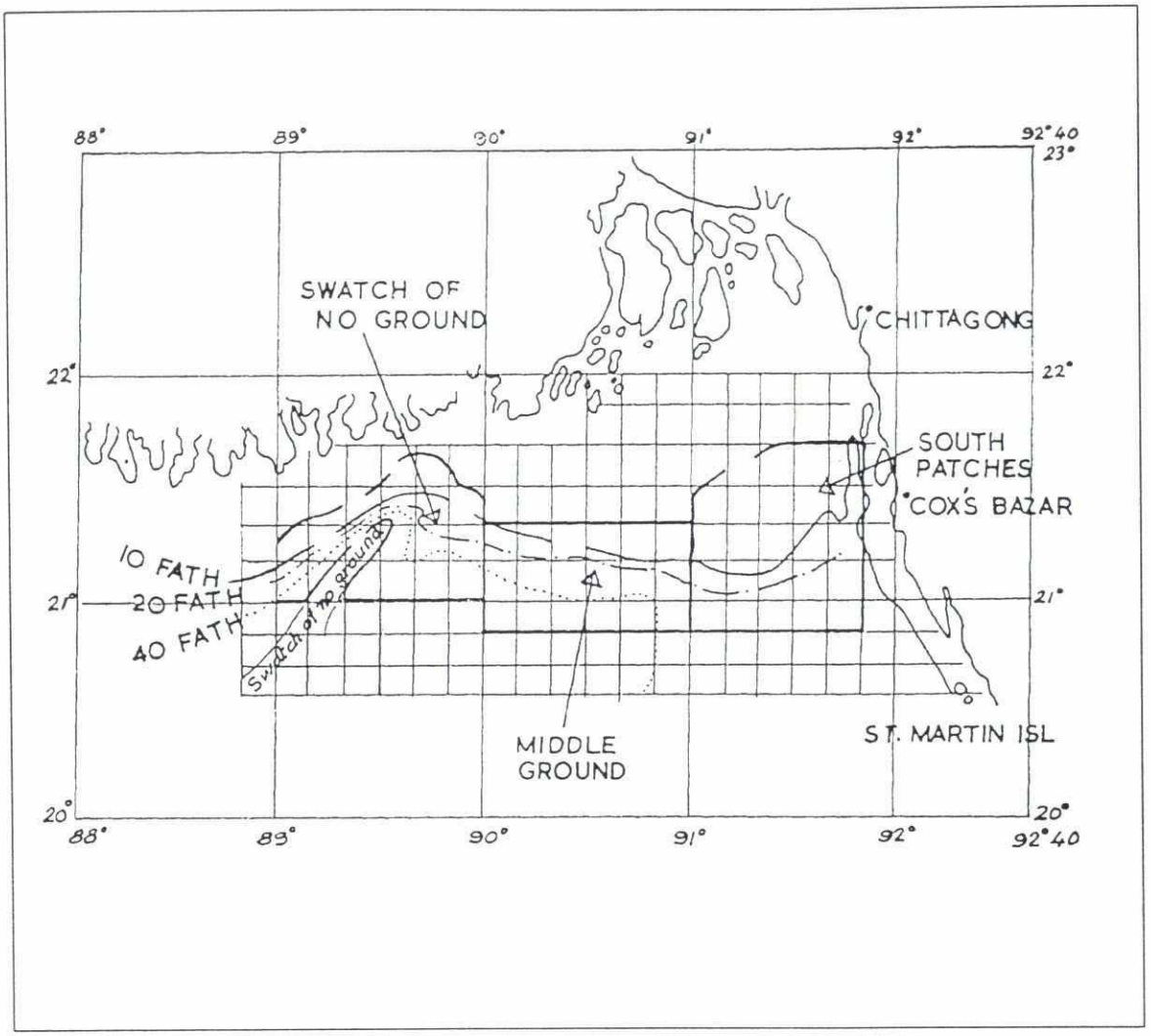
[5] Primavera, J., 1991. Intensive prawn farming in the Philippines: Ecological, Social and Economic implications. Ambio, 20, p 28-33.

[6] de Graaf and Xuan, 1998. Extensive shrimp farming, mangrove clearance and marine fisheries in the southern provinces of Vietnam, Mangroves and Salt Marshes (in press)

[7] Shahid, M.A., 1985. Remote sensing data: fisheries resources and mangrove forest of the Bangladesh coastal region. CNRS/Universite Paul Sabatier, Toulouse, France, pp 1-57.

[8] The exact figures are confusing as Mahmod et al. (1986) states:More than 120,000 $km^2$ is under national economic and management jurisdiction. Moreover during the Law of the Sea Convention, 1982, Bangladesh established rights over an area within a 200-350 nautical mile limit.

Figure 2.2: Fishing grounds in the EEZ of Bangladesh



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# 3. FISHERIES

## 3.1 Introduction

The Bengali expression *" Mache bhate Bangali"*[9] expresses the importance of fish in Bangladesh. The fisheries sector contributes about 80 per cent to the nation's animal protein intake, nearly 3 per cent to GDP and accounts for 8 per cent of the total export earnings of the country. It is estimated that about 8 million people in Bangladesh are directly or indirectly involved in fishing and fishing related occupations.

In the last decade the fish production in Bangladesh increased annually with approximately 3 per cent, from 790,000 mt. in 1985 to 1,170,000 mt. in 1996 (BFRSS, 1996)) and a similar growth has been reported for the project area (MES, 1996). Major contributors to this growth are:

- the development of aquaculture
- marine artisanal and flood plain fisheries.

Even if the statistical data reflect the trends in the field[10], it does not mean that fisheries is in healthy stage growth as it is most likely due to the increased number of fishermen while at the same time the catch per fishermen decreased. The latter is the first sign of over-exploitation of fish stocks.

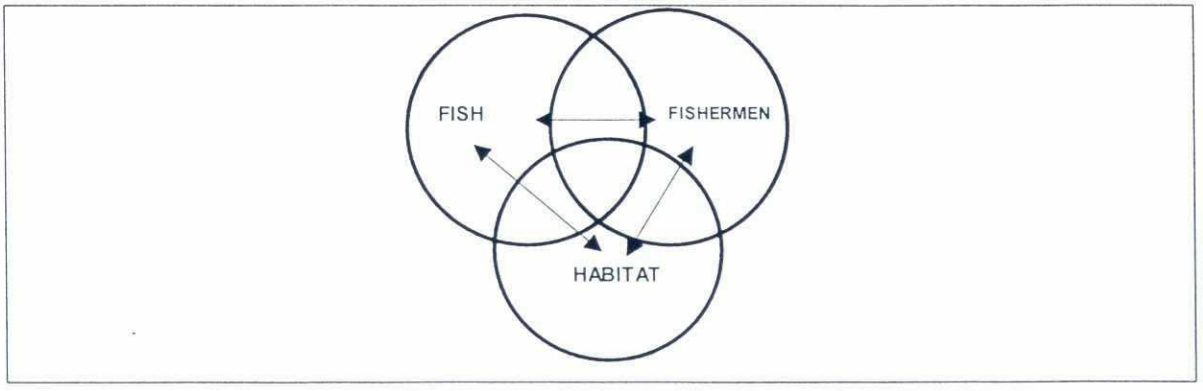
With a total population of 117.5 million the availability of fish protein is 27 g/person/day and total availability is 40 g/person/day with 13 g/person/day available through meat, eggs and milk. A progressive decline in protein intake over the last 30 years has been indicated before (INFS, 1983) and at present we arrived at a situation of protein deficiency (Table 3.1).

Table 3.1: Average per capita protein intake in Bangladesh

| | 1962 - 64 | 1975 - 76 | 1981- 82 | 1995- 96 | Requirement |
|---|---|---|---|---|---|
| Protein intake (g/capita/day) | 57.9 | 58.5 | 48.4 | 40.0 | 45.3 |

Fisheries in the Meghna estuary is a interactive process between ecological (the fish), Socio-economic (the fishermen) and physical (the estuary) factors. This process is visualised in Figure 3.1. Any intervention or development in the Coastal area should encompass these three inter-related elements.

Figure 3.1: Major components of fisheries in Bangladesh




[9] Fish and rice makes a Bengali

[10] A number of studies (MIS, FAO, FAP 17, etc.) indicated that the BFRSS is hampered by its small sample size, an outdated frame and logistic problems in analyses of data.

- **The fishermen.** The total biomass of fish for each species in the estuary (the stock) is directly influenced by fishing activities or fishing effort. Over-exploitation of stocks will occur when the number of gears operated is higher then the stocks can support.

- **The fish.** The different species their ecology and behaviour in the estuary is a given biological fact and will not change over time.

- **The habitat.** Alteration of the habitat e.g. the estuary or intertidal area will directly influence the stocks and consequently the catch of the fishermen, as 60-80 per cent of all fish and shrimp in the Bay of Bengal are "estuarine dependent". Reduction of the estuarine area through accelerated land reclamation will have a direct impact on fisheries production.

### 3.2 Past and present status of fisherfolk communities

Fisheries is a major economic activity in the MES area. The majority of the fishermen are traditional artisanal fishermen and operate in the coastal zone and its marine waters. Considerable changes have taken place in the traditional structure of fisheries, with many Hindu fishermen migrating to India over the last decades. This, in conjunction with increased population pressure and steady contraction of fisheries resources, has resulted in significant changes in the social groups involved in fisheries.

In 1974/75 a survey indicated that 250,000 persons were engaged in marine and estuarine fisheries. Furthermore in 1980/81 the total number was estimated at 412,000 while in 1983/84 their number was estimated at 515,000 indicating an annual growth rate of 8 per cent.

The numbers are however confusing as the marine fishing village survey of 1983/84 found 105,000 active fishermen in the coastal area.

A major problem of the different surveys is the definition of *"fishermen"*, most likely sometimes *"fishermen"* and the *"total household of a fishing family"* are mixed up. This is illustrated in Table 3.2, where the results[11] of the marine fishing villages survey of 1983/84 are summarised. The total number of households with fishing as major occupation was estimated at 60,500 comprising about 360,000 family members. The active number of fishermen from those households however was estimated at 105,000 using 15,000 boats. From the data it becomes clear that the largest number of fishermen are living in Noakhali, Cox's Bazar and Chittagong District.

Table 3.2: A summary of the results of the marine fishing village survey 1983/84

| DISTRICT | Marine village HH | Marine Village pop | Fishing HH | Fishermen | Boats | Fishing HH in marine villages (%) |
|---|---|---|---|---|---|---|
| BARISAL | 4531 | 25096 | 113 | 177 | 44 | 249 |
| BHOLA | 24193 | 85415 | 3176 | 3999 | 417 | 1313 |
| BORGUNA | 28375 | 159675 | 3389 | 6135 | 924 | 1194 |
| CHITTAGONG | 102365 | 644462 | 18191 | 31344 | 5694 | 1777 |
| COX'S BAZAR | 87572 | 585156 | 15980 | 28831 | 2869 | 1825 |
| FENI | 8104 | 49291 | 442 | 605 | 30 | 545 |
| JHALAKATI | 14119 | 70710 | 756 | 1511 | 254 | 535 |
| KHULNA | 11479 | 69210 | 1484 | 2668 | 846 | 1293 |
| LAKSMIPUR | 18052 | 102358 | 5376 | 12502 | 1276 | 2978 |
| NOAKHALI | 35271 | 199818 | 6349 | 7937 | 944 | 1800 |
| PATUAKHALI | 33010 | 185773 | 3177 | 6324 | 991 | 962 |
| PIROJPUR | 19854 | 113338 | 1668 | 2834 | 567 | 840 |
| SATKHIRA | 3217 | 18803 | 162 | 300 | 60 | 504 |
| TOTAL | 390,142 | 2.309,105 | 60,263 | 105,167 | 14,91 | 1,545 |

[11] The raw data were provided by DoF, and re-analysed by MES, approximately 10 per cent of the data could not be analysed due to missing entries..

Another confusion could be the area covered for marine fisheries i.e. is fishing in the Lower Meghna, *"marine fisheries"* or *"Inland fisheries"* and the question if those fishermen were included in earlier mentioned surveys. Within further analysis of fisheries in the Coastal area of Bangladesh the village surveyed in 1983/84 serve as a baseline and *"fishermen"* are those persons involved in active fishing.

It was realised that most likely the real figures are out of date due to the population growth and immigration during the last decades. Comparison of villages/thanas surveyed in 1983/84, 1990 and 1997 are presented in Table 3.3 and Table 3.4.

Table 3.3: Comparison of frame survey results for marine fishing villages, 1984 & 1990

| THANA NAME & SURVEY YEAR | Fish HH | Total Fish HH members | Tot fishermen | Fish HH (%) | Fishermen (%) | No of Boats |
|---|---|---|---|---|---|---|
| Pathuakhali-1983 | 1180 | 6844 | 1886 | 2.0 | 1.0 | 435 |
| Pathuakhali-1990 | 3182 | 22274 | 4773 | 6.0 | 2.0 | na |
| INCREASE | 2.70 | 3.25 | 2.53 | 2.6 | 2.4 | |
| Mirzaganj-1983 | 232 | 1392 | 316 | 1.0 | 0.0 | 91 |
| Mirzaganj-1990 | 988 | 5928 | na | 5.0 | na | na |
| INCREASE | 4.26 | 4.26 | | 4.7 | | |
| Kalapara-1983 | 435 | 2610 | 726 | 2.0 | 1.0 | 163 |
| Kalapara-1990 | 2293 | 20840 | na | 9.0 | na | 961 |
| INCREASE | 5.27 | 7.98 | | 5.0 | | 5.9 |
| Galachipa-1983 | 1066 | 6289 | 2861 | 3.0 | 1.0 | 302 |
| Galachipa & Dasmina, -1990 | 6848 | 41082 | na | 17.0 | na | 1380 |
| INCREASE | 6.42 | 6.53 | | 6.4 | | 4.6 |
| Barguna-1983 | 739 | 4360 | 1333 | 2.0 | 1.0 | 192 |
| Barguna-1990 | 675 | 4050 | na | 2.0 | na | na |
| INCREASE | 0.91 | 0.93 | | 0.9 | | |
| Patharghata-1983 | 1851 | 11106 | 3336 | 9.0 | 3.0 | 477 |
| Patharghata-1990 | 3930 | 23580 | 5700 | 20.0 | 5.0 | na |
| INCREASE | 2.12 | 2.12 | 1.71 | 2.22 | 1.7 | |
| Bamna-1983 | 348 | 2018 | 643 | 16.0 | 5.0 | 119 |
| Bamna-1990 | 190 | 1140 | na | 2.0 | na | 206 |
| INCREASE | 0.55 | 0.56 | | 0.1 | | 1.7 |
| Betagi 1983 | 210 | 1197 | 419 | 3.0 | 1.0 | 47 |
| Betagi-1990 | 1200 | 6642 | na | 7.0 | na | 235 |
| INCREASE | 5.71 | 5.55 | | 2.2 | | 5.0 |
| AVERAGE ANNUAL INCREASE | 0.54 | 0.61 | 0.21 | 2.68 | 0.2 | 0.7 |

Sources: 1) 1984 data from original fishing village frame survey.
2) Socio economic conditions of fishermen in eleven thanas of Patuakhali and Barguna District, Department of Fisheries, Bay of Bengal Programme, 1990, 90 pp.

Table 3.4: Comparison of frame survey results for marine fishing villages, 1984 and 1997/98

| | Char Montaz | Nijum Deep | Bara Baishia | Char Majid | Kukri Mukri | Urir Char | Avg annual increase |
|---|---|---|---|---|---|---|---|
| No HH 84 | 121 | 99 | 221 | na | 542 | 497 | |
| No HH 97 | 288 | 1083 | 150 | 720 | 935 | 2031 | |
| % increase | 2.38 | 10.9 | 0.7 | | 1.72 | 4.09 | 0.30 |
| Tot Pop 84 | 883 | 721 | 1381 | na | 2875 | 3828 | |
| Tot Pop 97 | 2081 | 5719 | 921 | 4241 | 4936 | 10195 | |
| % increase | 2.36 | 7.93 | 0.7 | | 1.72 | 2.66 | 0.24 |
| No Fish HH 84 | 45 | 81 | 136 | na | na | na | |
| No Fish HH 97 | 107 | 569 | 33 | 7 | 168 | 63 | |
| % increase | 2.39 | 7.02 | 0.24 | | | | 0.25 |
| % Fish HH 84 | 37 | 82 | 62 | na | na | na | |
| % Fish HH 97 | 37 | 53 | 22 | 1.0 | 18.0 | 3.0 | |
| % increase | 1.0 | 0.6 | 0.36 | | | | 0.05 |
| Fishermen 84 | 65 | 131 | 290 | na | na | na | |
| Fishermen 97 | 298 | 824 | 65 | 20 | 452 | 87 | |
| % increase | 4.9 | 6.3 | 0.23 | | | | 0.28 |
| Boats 84 | 25 | 11 | 31 | na | na | na | |
| Boats 97 | 76 | na | na | na | | na | |
| % increase | 3.0 | | | | | | 0.23 |

Sources: 1) 1984 data from original fishing village frame survey.
2) MES socio-economic survey for 1997/98

The average annual increase of the different parameters is presented in Table 3.5.

Table 3.5: Population, fishermen and fishing boats in the coastal belt, 1984-1998

| | Annual increase | Increase since 1984 |
|---|---|---|
| No of HH | 0.30 | 4.27 |
| Total Population | 0.24 | 3.30 |
| No Fishing HH | 0.44 | 6.20 |
| Total Fishermen | 0.25 | 3.47 |
| Total boats | 0.47 | 6.65 |

The data of 1984 can be raised to 1998 levels (Table 3.6), assuming that these incremental rates are representative for the whole of the coastal zone.

Table 3.6: Present (1998) characteristics of marine fishing villages in Bangladesh.

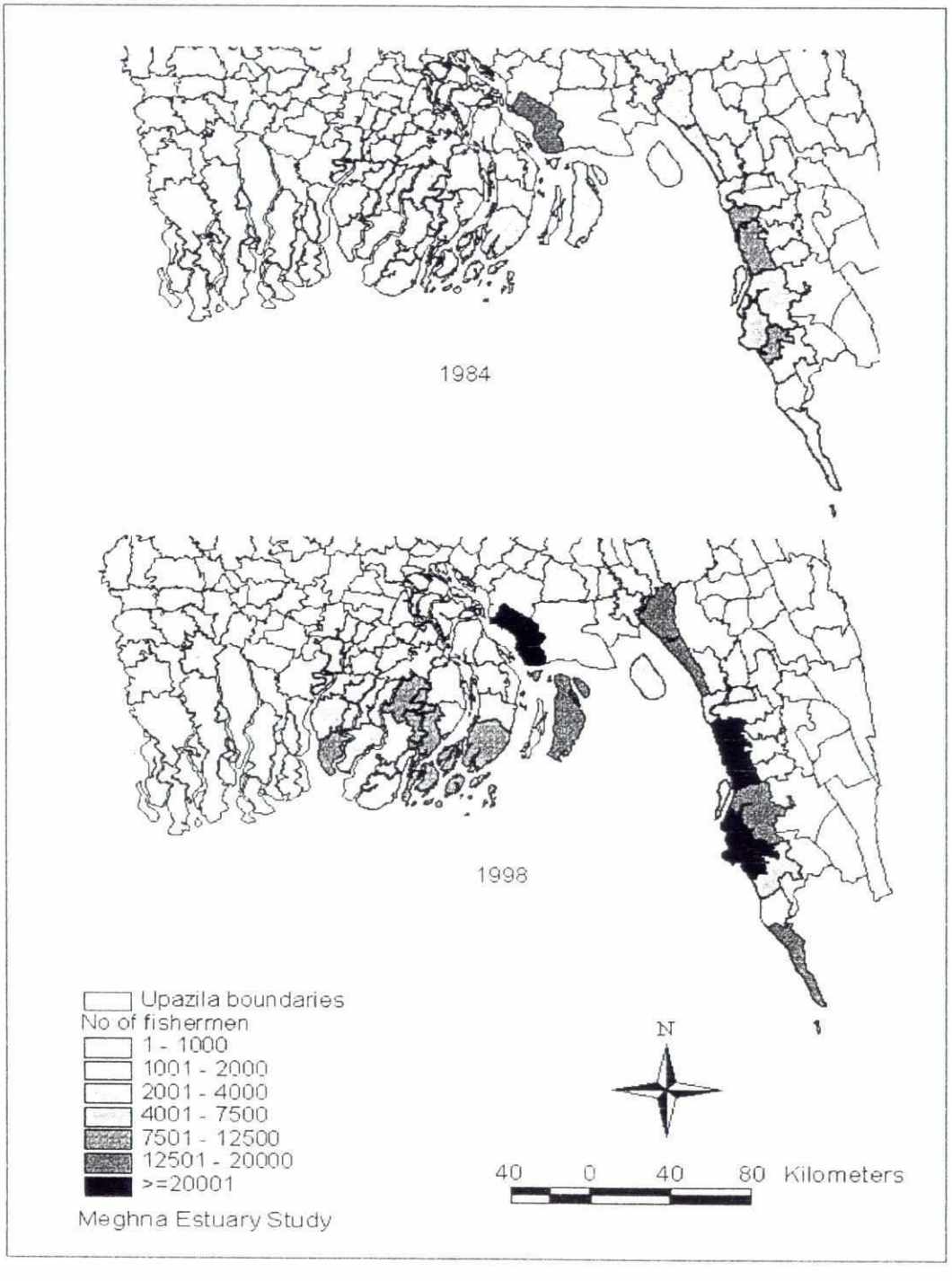
| DISTRICT | Marine village HH | Marine Village pop | Fishing HH | Fishermen | Boats | Fishing HH in marine villages (%) |
|---|---|---|---|---|---|---|
| BARISAL | 19343 | 82892 | 701 | 613 | 292 | 3,62 |
| BHOLA | 103280 | 282126 | 19691 | 13861 | 2772 | 19,07 |
| BORGUNA | 121133 | 527407 | 21012 | 21264 | 6142 | 17,35 |
| CHITTAGONG | 436996 | 2128658 | 112770 | 108638 | 37848 | 25,81 |
| COX'S BAZAR | 373845 | 1932770 | 99076 | 99928 | 19070 | 26,50 |
| FENI | 34596 | 162808 | 2740 | 2097 | 199 | 7,92 |
| JHALAKATI | 60274 | 233555 | 4687 | 5237 | 1688 | 7,78 |
| KHULNA | 49004 | 228601 | 9201 | 9247 | 5623 | 18,78 |
| LAKSMIPUR | 77064 | 338088 | 33331 | 43332 | 8482 | 43,25 |
| NOAKHALI | 78110 | 343155 | 19759 | 13826 | 3157 | 25,30 |
| PATUAKHALI | 140920 | 613608 | 19697 | 21919 | 6587 | 13,98 |
| PIROJPUR | 84757 | 374355 | 10342 | 9823 | 3769 | 12,20 |
| SATKHIRA | 13733 | 62106 | 1004 | 1040 | 399 | 7,31 |
| TOTAL | 1,593,054 | 7,310,130 | 354,012 | 350,825 | 96,028 | 22.22 |

If the assumptions are correct at present about 7.3 million people are living in the coastal marine fishing villages. For 22 per cent or 350,000 households fishing is the major professional occupation and 96,000 boats are operated by 350,000 fishermen.

These figures do not include newly established fishing villages and all the fishermen living further inland along the major rivers. The distribution of the fishermen among the different thanas in the coastal belt as estimated for 1984 and 1998 is presented in Figure 3.2. The results indicate that the majority of the fishermen are living in Laksmipur district (Ramgati), Chittagong district (Anwari & Banshkali) and Cox's Bazar district (Moheshkali & Cox's Bazar)

The last frame survey has been carried out in 1983/84 and considering the number of people involved in fishing and related activities, the execution of a new *"sub sampled frame"*, is a high priority.

Figure 3.2: Number of fishermen by thana, 1984 and 1998




Sources: DOF for 1984 data, MES survey for 1998 data.

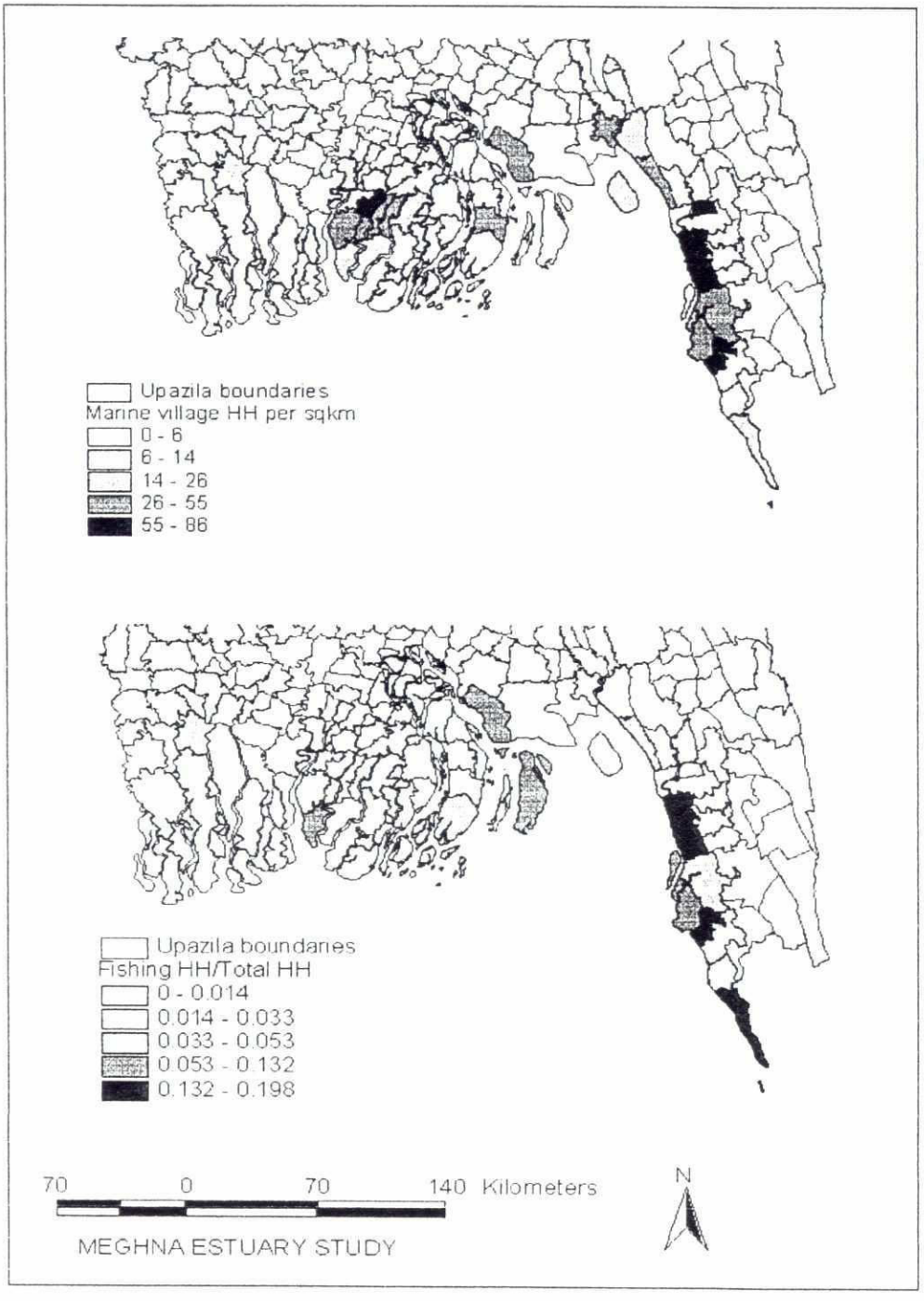
### 3.2.1 Spatial analysis of data from the 1983/84 marine fishing villages survey

The original raw data of the Marine Fishing Village Survey were obtained from DoF and used for the development of a preliminary Marine Fisheries Management Information System (see Appendix 1). All data of each individual fishing village together with its BBS geode were entered in a Database programme. The georeferences of the villages were taken from LGED maps and transposed to BTM references. Finally a Geographical Information System (GIS) was used for spatial presentation and analysis of the original data. The results of the analysis are presented in the following sections.

*Distribution patterns for the thanas*

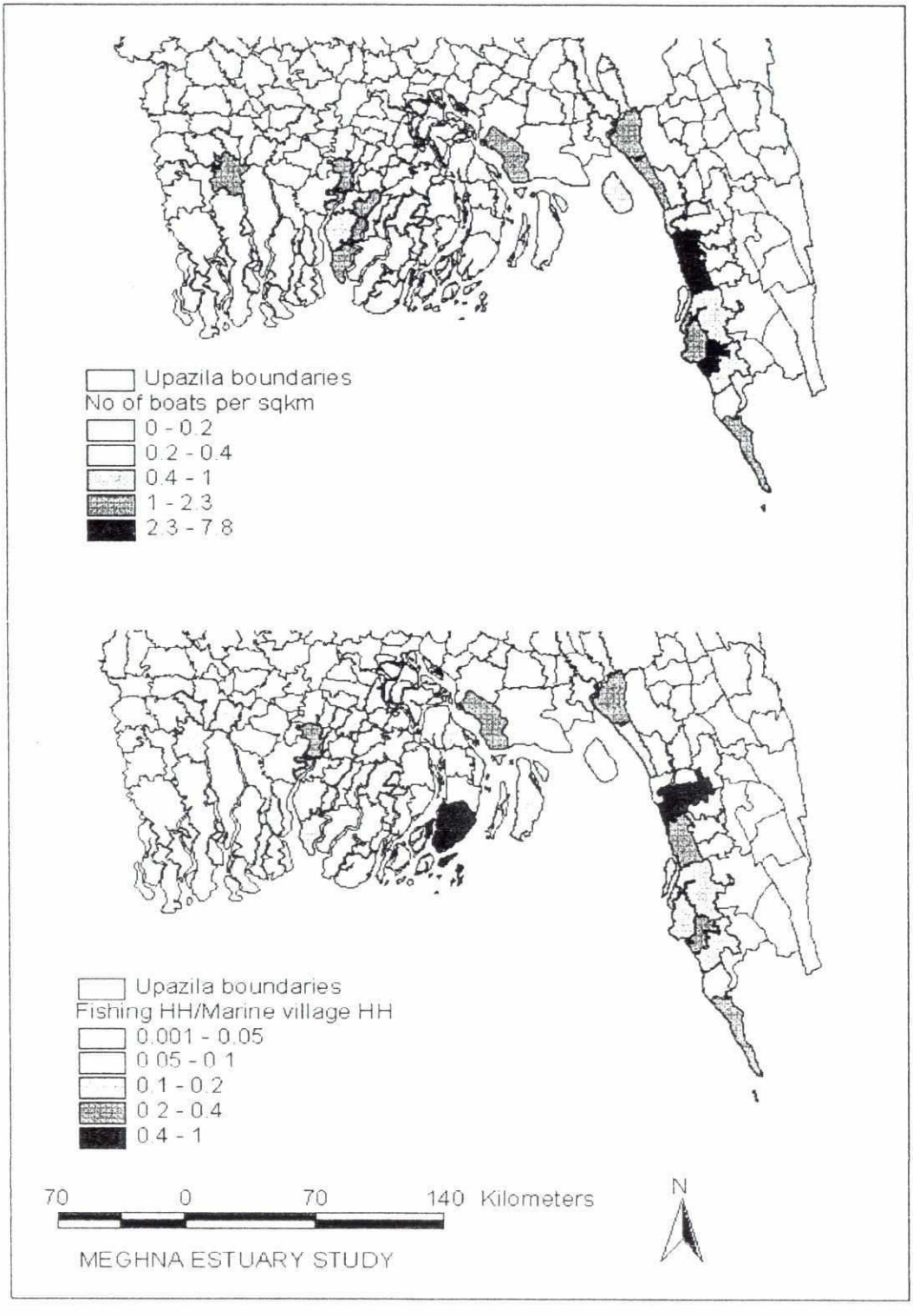
Fishing villages and the fisherfolk community are most likely not evenly distributed over the Coastal districts, distance to fishing ground, fish trading centres, and socio economic factors, employment, etc. are of importance. In Figure 3.2 the number of fishermen in the different thanas was presented. However a better comparison among the thanas would be provided if the numbers are related to the total area or the total population of the different thanas. In Figure 3.3 the number of fishing households per $km^2$ and the proportion of the total households with fishing as major occupation (fishing HH/total HH) is presented for each thana. In Chittagong and Cox's Bazar both parameters have a more or less similar pattern. In Char Fassion and Hatia however the pattern changes as the proportion of fishing households increase, indicating a higher economic dependency on fisheries.

Figure 3.3: Fishing households per km$^2$ by thana in the coastal area, 1984




In Figure 3.4 the number of boats per km$^2$ and the proportion of the households in the marine villages with fishing as major occupation (fishing HH/marine village HH) is presented for the different thanas. The highest boat densities are found in Chittagong, Cox's Bazar, Laksmipur. In Chittagong and Cox's Bazar the proportion of fishing households follows the general demographic pattern with a high number of fishermen (see also Figure 3.3) while again in Bhola and Char Fassion this pattern shifts towards a higher dependency on fishing.

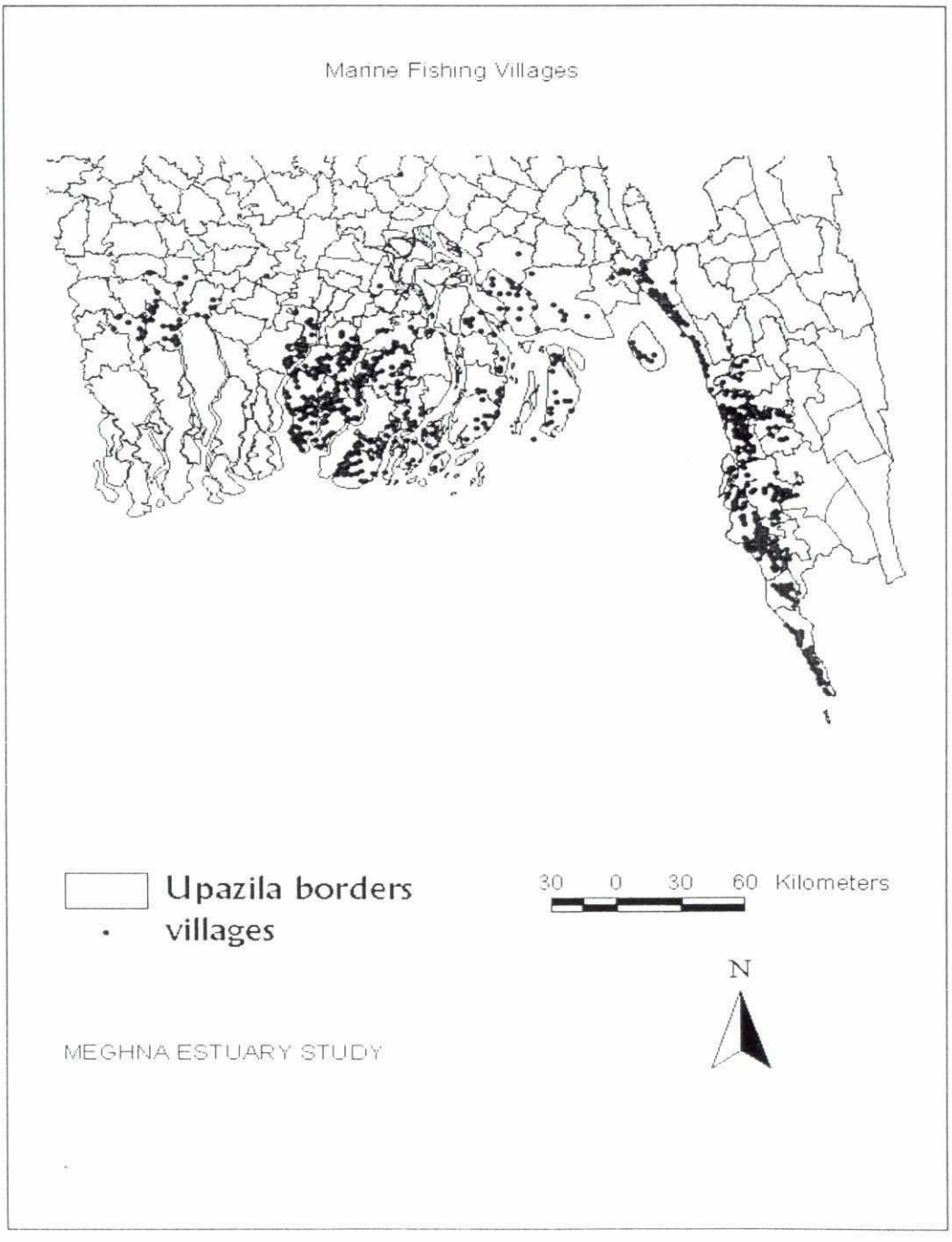
Figure 3.4: Boats per km$^2$ and marine village households with fishing as major occupation, by thana



*Details of villages and boat distribution*

More detailed distribution patterns of villages, fishing households, boats, etc. can be obtained from the developed information system. In Figure 3.5 the location of the 836 marine fishing villages in the coastal area is presented.

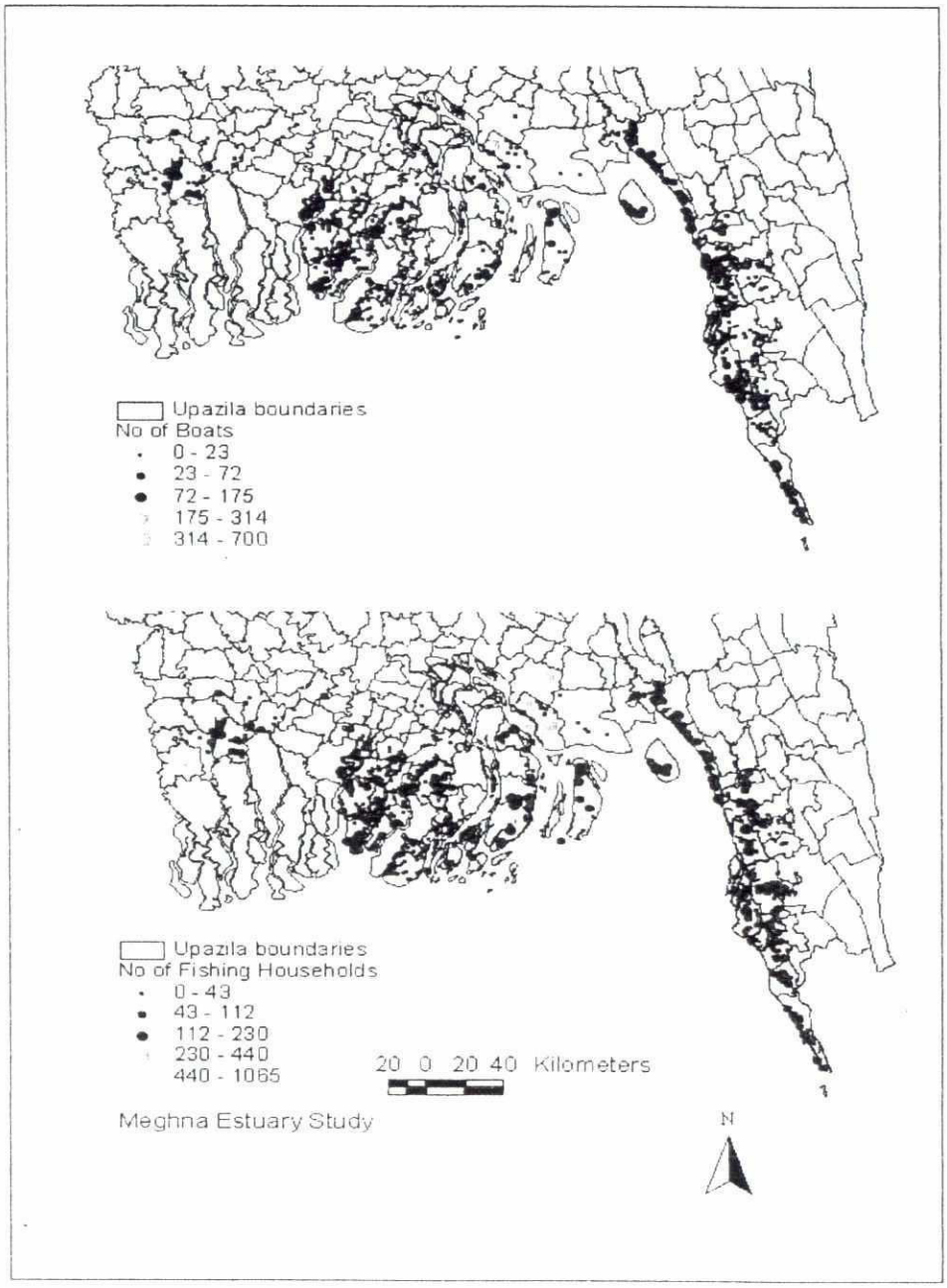
Figure 3.5: Location of marine fishing villages in the coastal area.



The largest number of villages are located in Pathuakhali, Chittagong and Cox's Bazar. At first hand it seems that the distribution of the villages is not in line with the distribution of boats and fishing households (See Figure 3.3 and Figure 3.4) as obtained from thana level as large numbers of villages are located in Chittagong, Cox's Bazar as well as in Pathuakhali and in Laksmipur only a few villages are located.

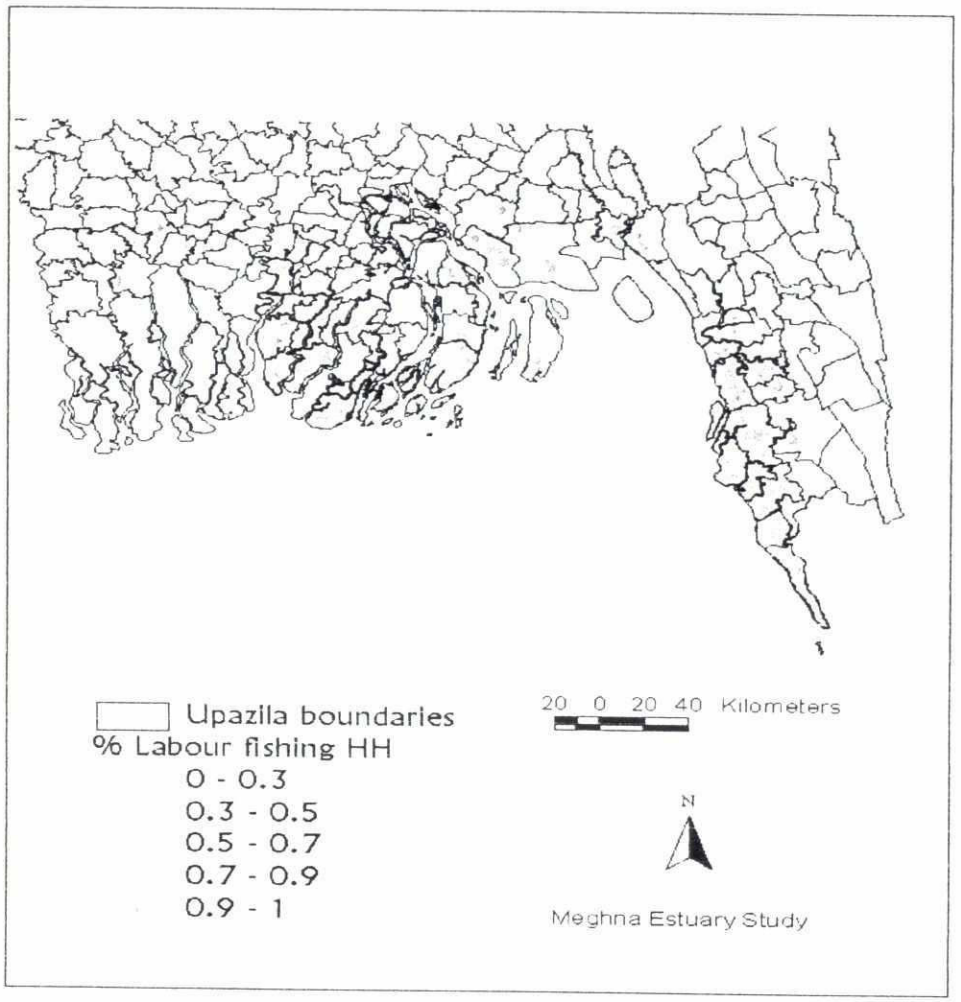
Plotting the same villages with the household number and the number of boats indicates that the fishing villages in Chittagong, Cox's Bazar and Laksmipur are very large if compared with the ones in Pathuakhali (Figure 3.6), which makes the picture more clear.

Figure 3.6: Distribution of fishing villages, boats and fishing households



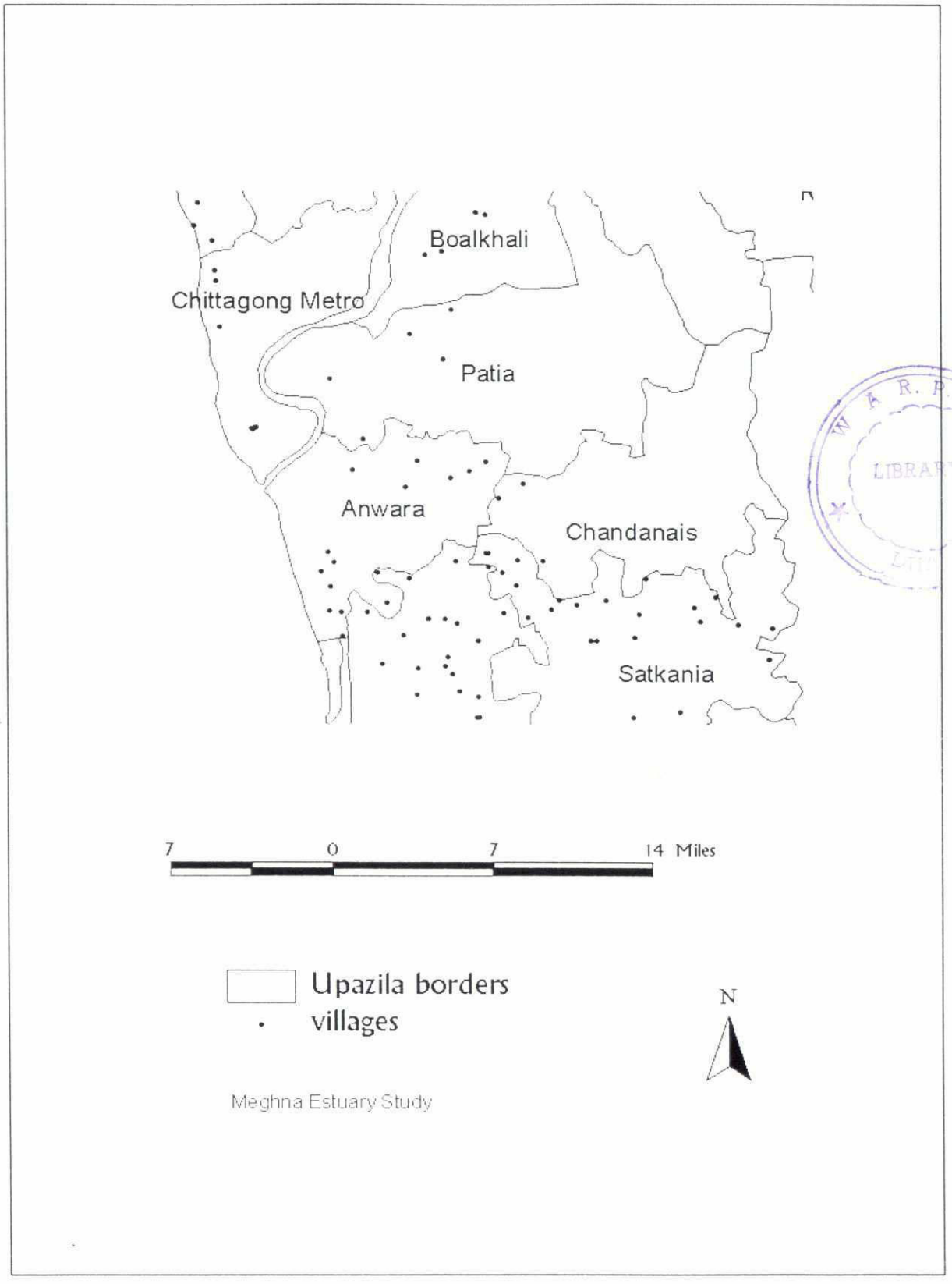
In Figure 3.6 indirectly the overruling aspect of fishing labour becomes visible. In Bhola, Hatia and Laksmipur large fishing communities are found but the number of boats in the villages are rather low and 70-80 per cent of the fishermen are engaged by the "*Bahaddar*" as fishing labour. From Figure 3.7 it becomes clear that the majority of the fishermen in the coastal area are fishing labour.

Figure 3.7: Percentage of fishing households working as fishing labour



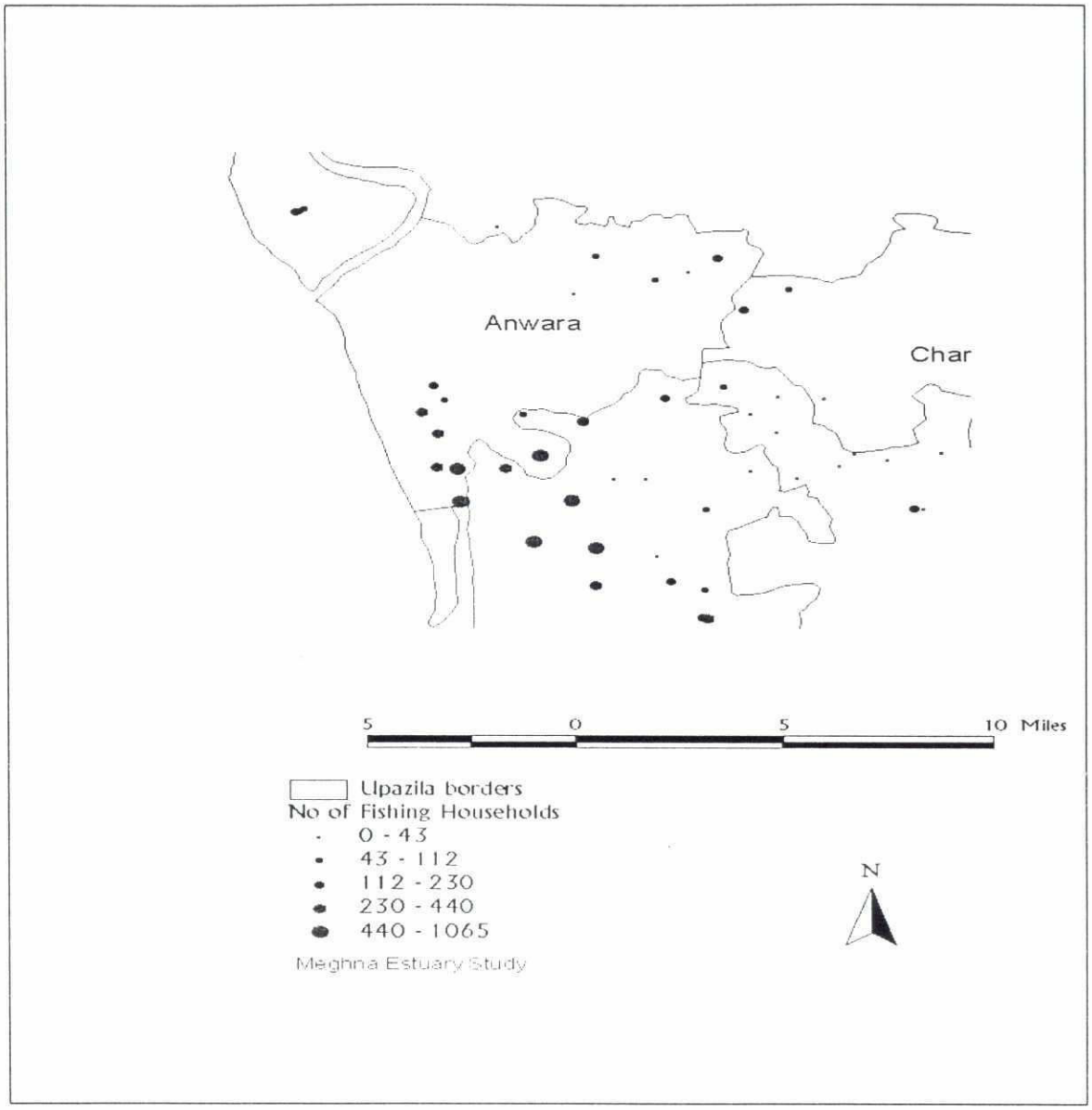

In Chittagong and Cox's Bazar some of the villages are located far inland because they follow the major coastal rivers (Figure 3.8).

Figure 3.8: Details of marine villages in Chittagong




In a similar way details of fishing villages can be made visible (Figure 3.9) and analysed on district, thana or union level. Further it provides us a major tool for the design of stratified monitoring programmes or frame surveys as the different types of villages can be located easily.

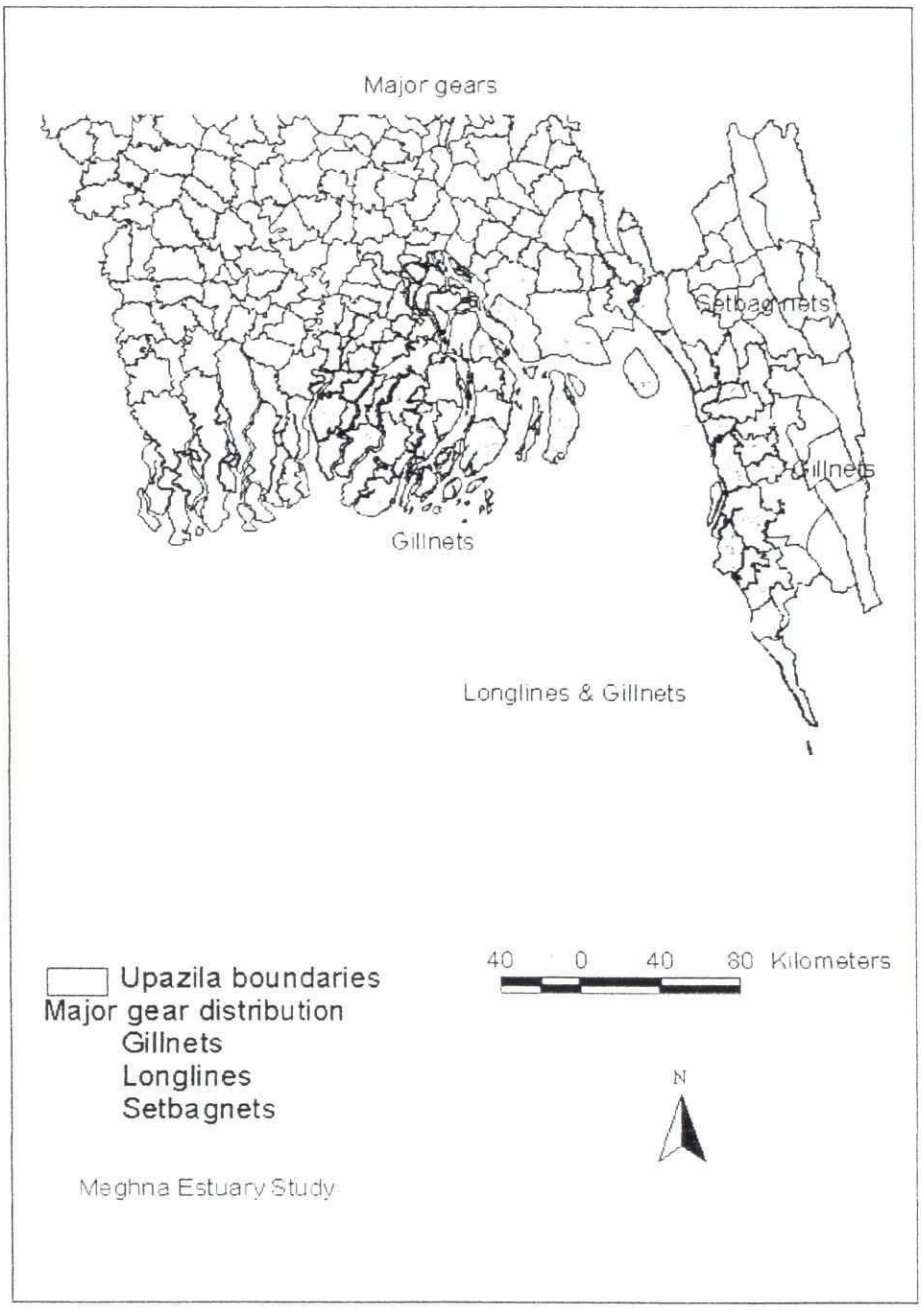
Figure 3.9: Location and number of fishing villages in Chittagong district




*Gears used*

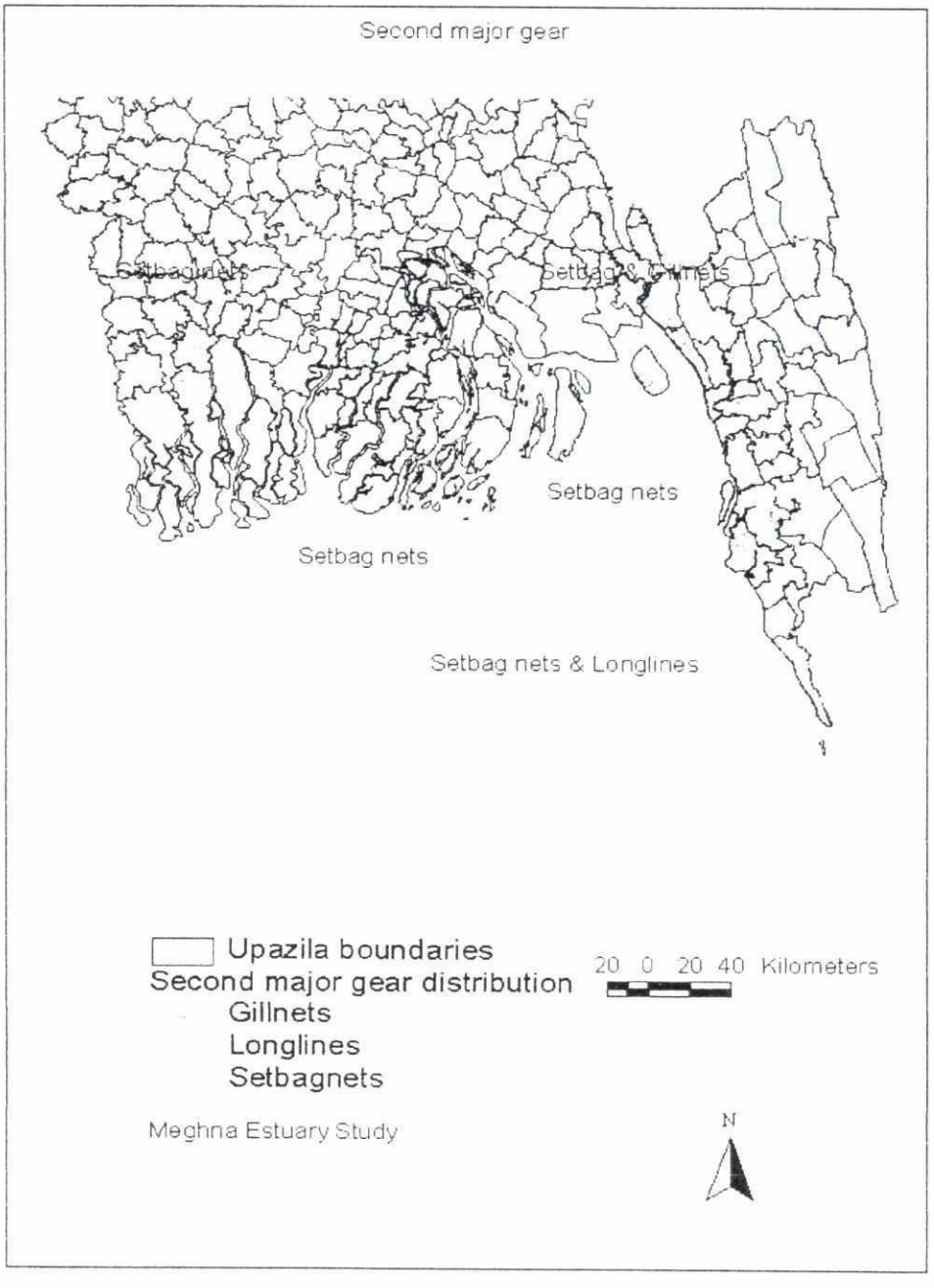
During the survey of 1983/84 the most important gears operated from the villages were determined and counted and classified as "first major gear", "second major gear" and "third major gear". The three major gears operated in the Coastal area are Gillnets, Set bagnets and Longlines. With the presentation of the different distribution patterns it should however be realised different gears are used for different species during different times of the year. The first major gear is the gillnet (Figure 3.10). They are mainly operated from two areas; a central area comprising of Hatia, Lasksmipur, Bhola, Barisal Faridpur and Patuakhali, and the central part of the coastline of Chittagong-Cox's Bazar. In the northern part of Chittagong, set bagnets are the first major gear while in the south of Cox's Bazar (Teknaf) longlines are important. In Khulna almost no gillnets are operated.

Figure 3.10: Distribution pattern of the first major gear in the coastal area



The second major gear is the set bagnet (Figure 3.11). They are operated from three areas; Khulna, Barisal-Faridpur and the central area of the Chittagong/Cox's Bazar coastline. In the northern part of Chittagong gillnets play an important role as second gear while in the southern part of Cox's Bazar, Longlines are important. Set bagnets are not operated from Bhola, Patuakhali and Laksmipur.

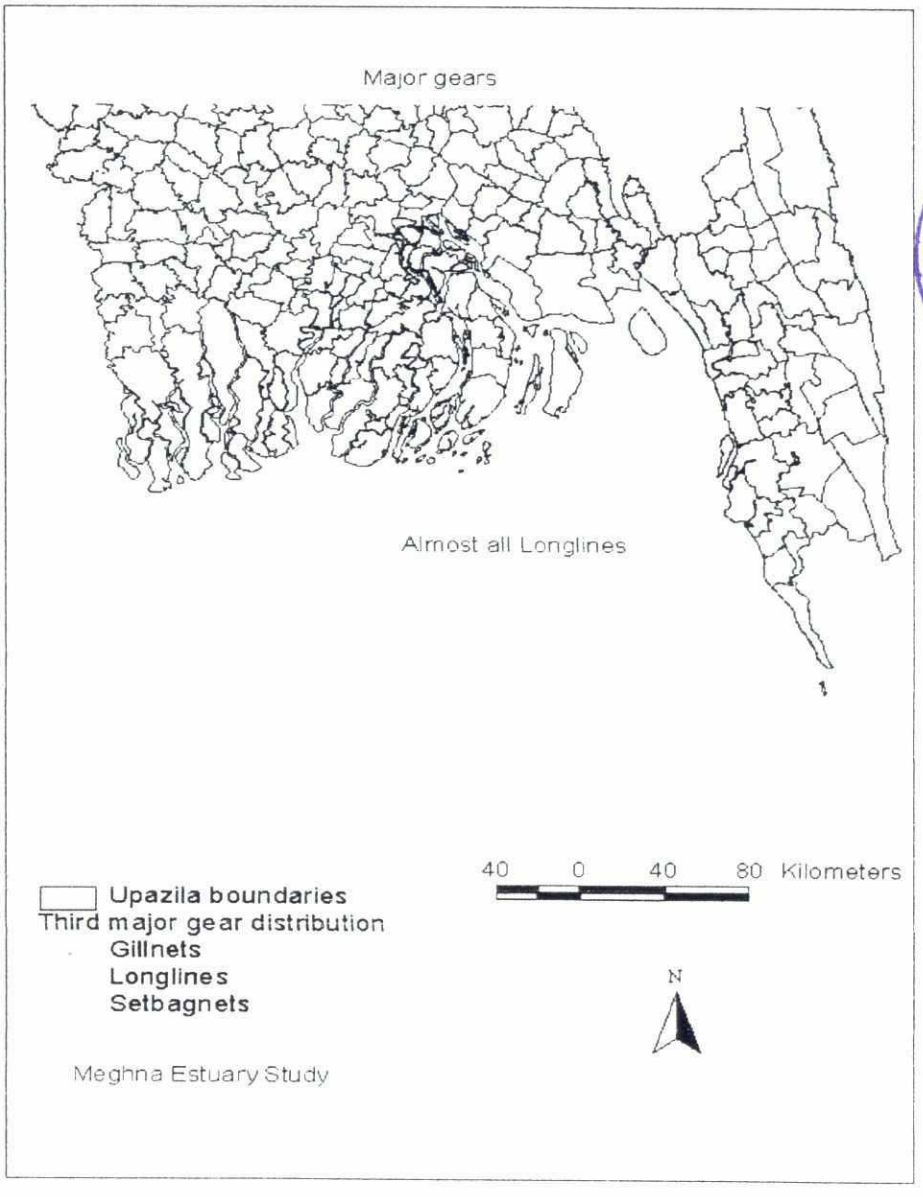
Figure 3.11: Distribution pattern of the second major gear in the coastal area



The fact Gillnets are not operated from Khulna and that Set bagnets are not operated from Bhola and Pathuakhali is most likely determined by the physical characteristics of the fishing grounds in these areas.

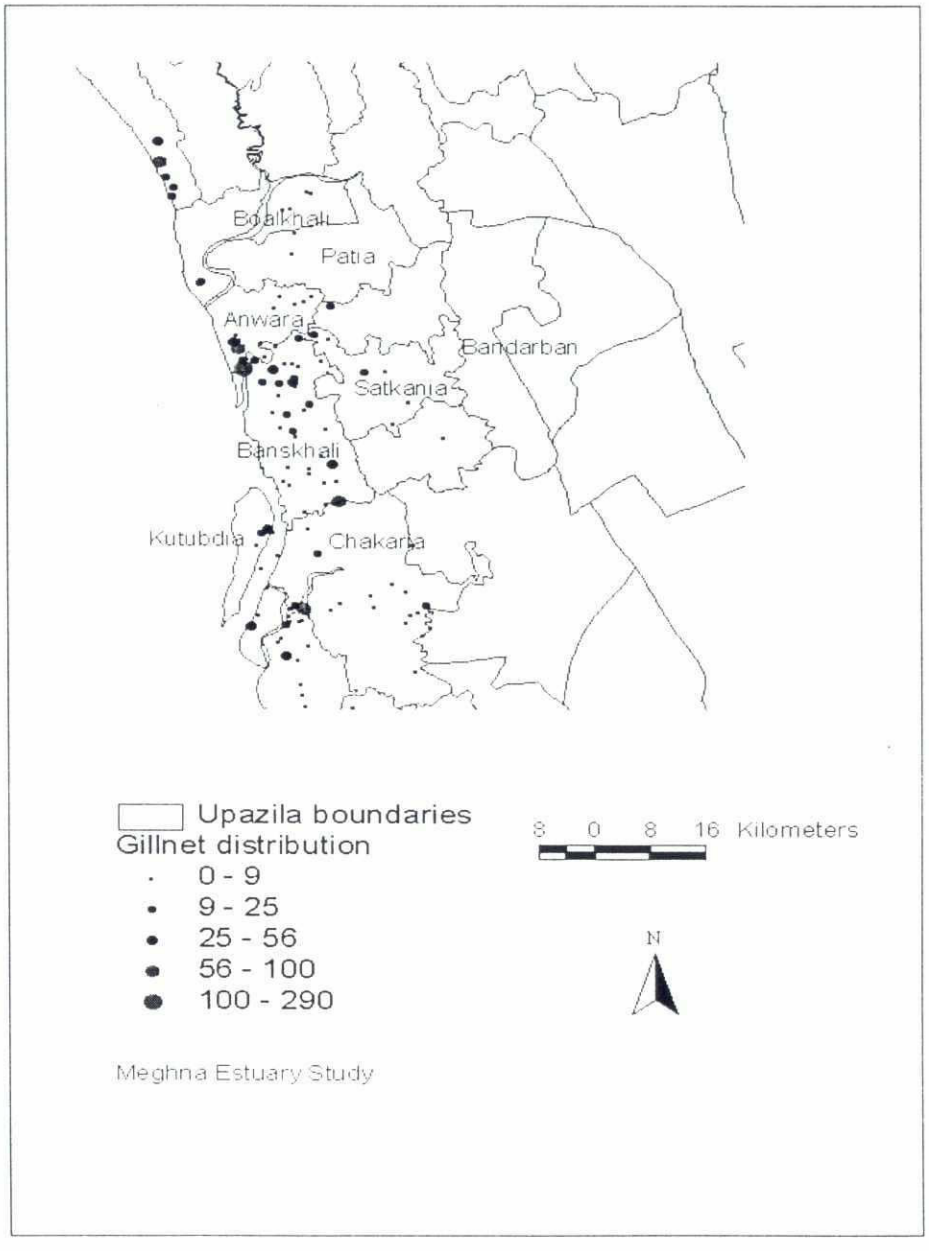
The third major gear is the longline (Figure 3.12) and they are operated from almost all areas, except Bhola, Pathuakhali and Noakhali.

Figure 3.12: Distribution pattern of the third major gear in the coastal area



The developed information system can be used to select eventual sampling sites for different gears in the Coastal area as distribution of the gears can be visualised at thana level (Figure 3.13).

Figure 3.13: Distribution and number of gillnets in thanas of Chittagong district



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### 3.2.2 Socio-economics

***General characteristics***

In Bangladesh, marine fisheries is dominated by small scale marine fisheries as they catch about 95 per cent of the total marine catch. As indicated before the small scale fishermen live in 800-1000 marine fishing villages which are defined as those villages where even a small number of families are directly involved in fish catching[12]. Such "Jele" (fishing families) live in a cluster of households ("para") in the village.

Fishing is not a socially respectable occupation in Bangladesh, and traditionally, marine fisheries was practised by Hindu from the "Jaladas" sub-caste of fisherfolk. But with the increasing demand and commercialisation of fisheries and decrease in land assets due to the population pressure, a large number of Muslim took up fishing as a full time job. Most of the motorised small scale fishing boats owners are now Muslim who hire Hindu or Muslim fishermen as crew.

Table 3.7 shows that the importance of heritage in marine fishing most likely is declining as a the majority of the different type of fishermen reported that the ancestors were not involved with fishing

Table 3.7: Occupational status of ancestors of different categories of fishermen

| *Ancestors* | *Category of fishermen* | | | | | |
|---|---|---|---|---|---|---|
| | Boat owner | Mazhi | Assis Mazhi | Skipper | Labour | Others |
| Fathers occupation (per cent) | 9.3 | 21.6 | 7.7 | 23.2 | 22.1 | 18.3 |
| Forefathers occupation (per cent) | 42.6 | 38.7 | 7.7 | 13.0 | 22.6 | 24.4 |
| Not in fishing (per cent) | 48.1 | 39.6 | 84.6 | 63.8 | 55.3 | 57.3 |

Source: Islam and Elahi, 1993

At present three groups of fishermen are visible among the fishermen in the coastal area of Bangladesh:

- those fishing with traditional fishing craft and gear (owner-operators)
- those fishing with mechanised boats and improved gear or *Bahaddars* or boat owners
- the fishing labourers.

There is a distinct difference between boat owners and the crew.

*Bahaddars* or the boat owners organise fishing fleets and invest money in hull, fishing equipment and undertake to support the families of fish workers during their long stay (5 months) at sea. They bear the risk of losing the fishing venture as well. *Bahaddars* undertake fishing ventures at a long distance in coastal areas. Most of the fishing labourers have an inextricably bonded relationship with them due to credit systems. Each fishing trip, with fish workers, 18-25 in number, by one motor-operated fishing boat along with gears and other logistics is resourced by *Bahaddars*. Apart from providing those fishing equipment, these coastal entrepreneurs have to undertake the responsibility of maintaining the families left behind by the fish workers .

The major fishing expedition in the coastal areas normally last 5 month; mid -September to mid-February. Fish workers have to live together, fish together and go back home together on the same hull.

[12] Rahman , A.K., 1994, The small scale marine fisheries of Bangladesh. In: socio economic issues in coastal fisheries management. Proceedings IPFC symposium, Bangkok, November 1993, pp 295-315.

The crew of a boat works as actual fishermen and take different responsibilities in fishing such as the *mazhi* who heads a team of seven to eight crew members. The enumeration is based on catch sharing principles with fixed rates for the boat owner and the crew. An intermediate system also exists where the *mazhi* obtains the boat from the boat owner for a fixed price or catch sharing per centage.

**Delipar vilage**

**Fishing crews**

Men fish in a team, each team working on one boat. The team consists of the boat-owner-cum operator (Bahaddar) plus others. Although in some cases the operator may lease the boat from its owner for a share in the catch or a fixed sum. Some team members own their own nets and use the boat to place their nets. These users are called *"Po Unna"* and use the *"Bahaddars"* boat under the following conditions;

- The *Bahaddar* places more nets than the Po Unna (e.g. four nets compared to two), and the physical work is divided equally between them;
- The *Bahaddar* take two-thirds of the catch, and the Po Unna divide the remainder of the catch between them;
- The *Bahaddar* decides where the nets are placed, where the boat is to be directed and, indeed, whether to take the boat to sea at all;
- When the *Bahaddar's* boat is repaired, Po Unna's may be called upon to pay Tk 3,000-5,000 as contribution to the costs of repair. The Po Unna's will also be obliged to pay the share of the costs of repairing the Bahaddars's sister vessel which go to sea with the mother craft.

The *Bahaddar* typically own 4-5 nets and had an average income of Tk 40,000-50,000. Agreements with the crew members carry on for several year depending on the crew member's skills, his trustworthiness and his credit-worthiness. This latter is important as the *Bahaddar* often borrows money on behalf of crew members and uses this as means of control

From: Blowfield and Haque, 1993

Basic characteristics of fishing households as obtained from a survey in 1985[13] and 1997/98[14] are presented in Table 3.8.

Table 3.8: Basic characteristics of fishing households, 1985 and 1997/98

| | 1985 | | | 1997/98 | | |
|---|---|---|---|---|---|---|
| | Marine I | Marine II | Estuarine | Char Montaz | Nijum Deep | Urir Char |
| Family size | 6 | 7.3 | 6.3 | 6.2 | 7.2 | 6.1 |
| Adult males (15 years) | 1.9 | 2.2 | na | 1.9 | 1.9 | 1.6 |
| Adult females (15 years) | 1.4 | 1.8 | na | 1.8 | 1.8 | 1.4 |
| Children | 2.8 | 3.3 | 3.2 | 2.6 | 2.9 | 3.1 |
| Percentage Illiterate | 57% | 86% | 97% | 66% | 54% | 43% |
| Percentage below primary | 34% | 3% | 3% | 11% | 16% | 16% |
| Own arable land (% of HH) | 13% | 16% | 58% | na | na | na |
| Operate arable land (% of HH) | 8% | 8% | 78% | na | na | na |
| Fishing as Principal occupation | 92% | 94% | 97% | 28% | 53% | 13% |

Fishing is the major occupation of the household heads of fishing households in the coastal area, other sources i.e. agriculture, business, etc. contribute little to the income of the fishing household (see Table 3.9).

Table 3.9: Major occupation of fishermen (household heads) in the coastal area

Unit: percent

| Main occupation | Category of fishermen | | | | | |
|---|---|---|---|---|---|---|
| | Boat owner | Mazhi | Assist Mazhi | Skipper | Labour | Others |
| Fishing | 77.8 | 89.6 | 98.3 | 96.6 | 94 | 75.0 |
| Agriculture | 6.7 | 3.6 | 1.4 | 2.2 | 4.4 | 5.4 |
| Business | 49.6 | 2.6 | 0.4 | 1 | 1.2 | 10.5 |
| Others | 2.2 | 4.3 | 0.0 | 0.2 | 0.4 | 9.3 |

Source: Islam and Elahi, 1993

Table 3.10 shows the main occupation pattern of other male family members of different categories of fishing households. The majority took up fishing as main occupation, with the mazhi category with the highest percentage (80 per cent) and the boat-owners with the lowest percentage (52 per cent). Business was the second main occupation among the boat owners family and agriculture was the second occupation among the other categories.

Table 3.10: Major occupations of other male family members of fishing households in the coastal area

Unit: percent

| Main occupation | Category of fishermen | | | | | |
|---|---|---|---|---|---|---|
| | Boat owner | Mazhi | Assist Mazhi | Skipper | Labour | Others |
| Fishing | 51.8 | 80.2 | 58 | 63.2 | 71.7 | 72.4 |
| Agriculture | 5.1 | 7.9 | 16 | 18.8 | 17.8 | 11.3 |
| Household | 0.9 | 2.2 | 0 | 3.0 | 1.6 | 0.3 |
| Business | 34.1 | 6.6 | 4 | 6.8 | 5.3 | 9.7 |
| Others | 7.9 | 3.1 | 6 | 8.3 | 3.5 | 6.4 |

Source: Islam and Elahi, 1993

[13] Haq, M., 1986. "A case study of marine fishing community" in A. Muq, ed., Socio economic study of typical fishing community in Bangladesh, 1986, Polders of the World (ILRI, Netherlands).
[14] MES socio economic survey

*Income*

The annual income of a fishing household and their differences among the different types of fishing households varies considerably. The annual income of a boats owner is about Tk 430,000 while fishing labourers make about Tk 16,000 per year (Table 3.11).

Table 3.11: Average annual income of fishing households from different sources

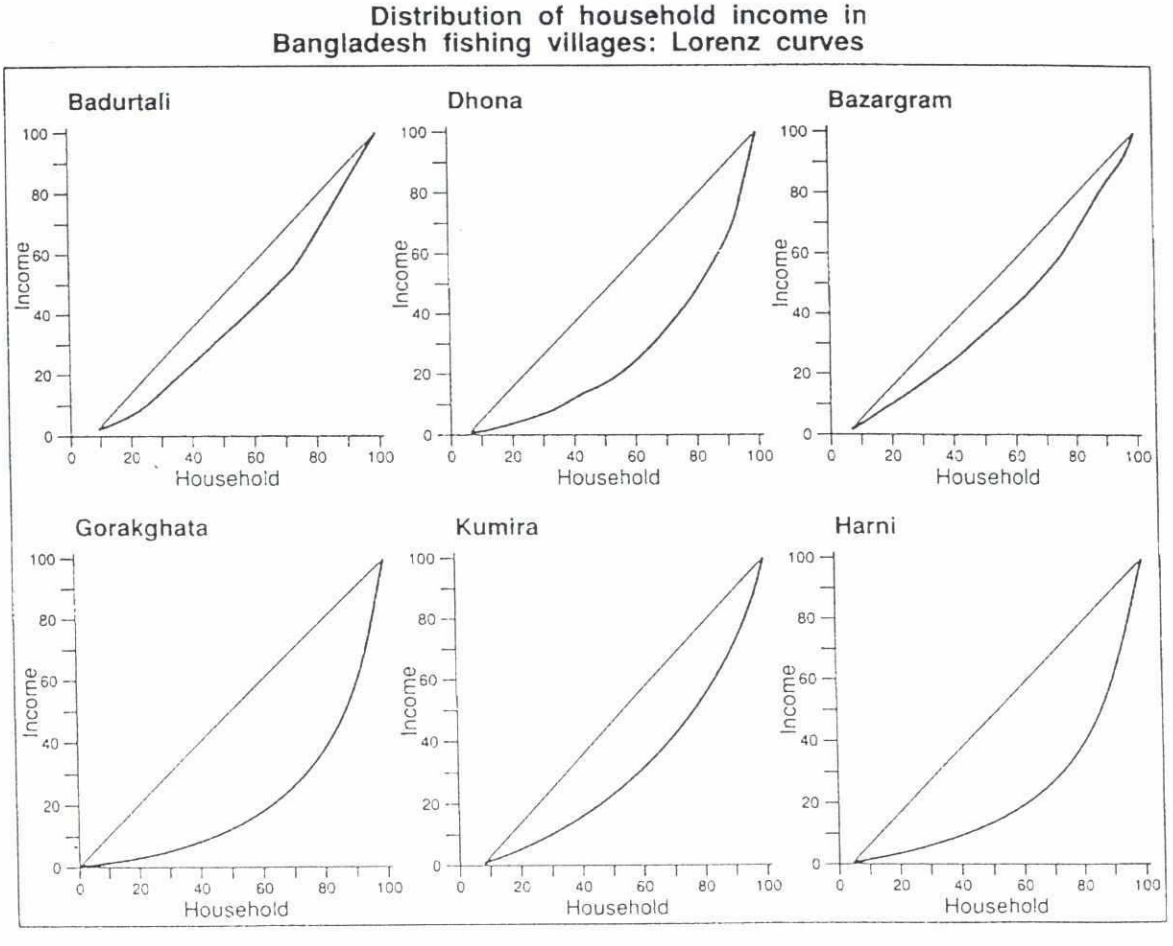
Unit: Taka

| Main occupation | Category of fishermen | | | | | |
|---|---|---|---|---|---|---|
| | Boat owner | Mazhi | Assist Mazhi | Skipper | Labour | Others |
| Agriculture | 710 | 510 | 150 | 510 | 540 | 740 |
| Business | 2900 | 1360 | 40 | 70 | 260 | 1100 |
| Others | 1700 | 200 | 0 | 120 | 100 | 450 |
| Fishing | 429900 | 34700 | 19500 | 18000 | 16300 | 12700 |
| TOTAL | 435210 | 36770 | 19690 | 18700 | 17200 | 14990 |

Source: Islam and Elahi, 1993

It is clear that a large number of fishing households in the coastal area are in a vulnerable position as on the average the earn less then the minimum monthly subsistence income of Tk 3333/month (Thompson et al., 1993). Only the Boat owners are relatively well off. Income inequality is found in all fishing villages in the coastal area as and can be made more clear with a Lorenz curve (Figure 3.14).

Figure 3.14: Distribution of household incomes in fishing villages in the coastal area




Source: Thomson et al., 1993

In Gorakghata the income inequality is the highest as 85 per cent of all the households of the village are earning only 25 per cent of the total income of the village. This inequality, is primarily due an unequal distribution of the gears and boats and due to the debt trap of the fishing labour households.

**Delipar fishing village**
**Fish Trade**

When the fishing boats arrives, there is a surry of activity. But this has little to do with eagerness to bid for the fish. Most of the Fish are already promised under the *"Dadondar"* loan agreements and the *"Dadondar"* agents are only concerned that the *"Paikar"* do not get a to the boats first and try to buy the promised fish for a higher price. Only the minority of fishermen who have not taken out loans from *"Dadondar"* are free to sell their fish as they want. For the rest, the activity around the boats is to do with counting the fish and setting the value off against outstanding loans. As Delipara fisherfolk are almost entirely illiterate and in any case must ultimately accept whatever price the *"Dadondar"* offers, this is a one sided series of transactions. Furthermore, it is not the individual fishermen who decides where to sell the fish, but the *"Bahaddar"* who then divides out the income.

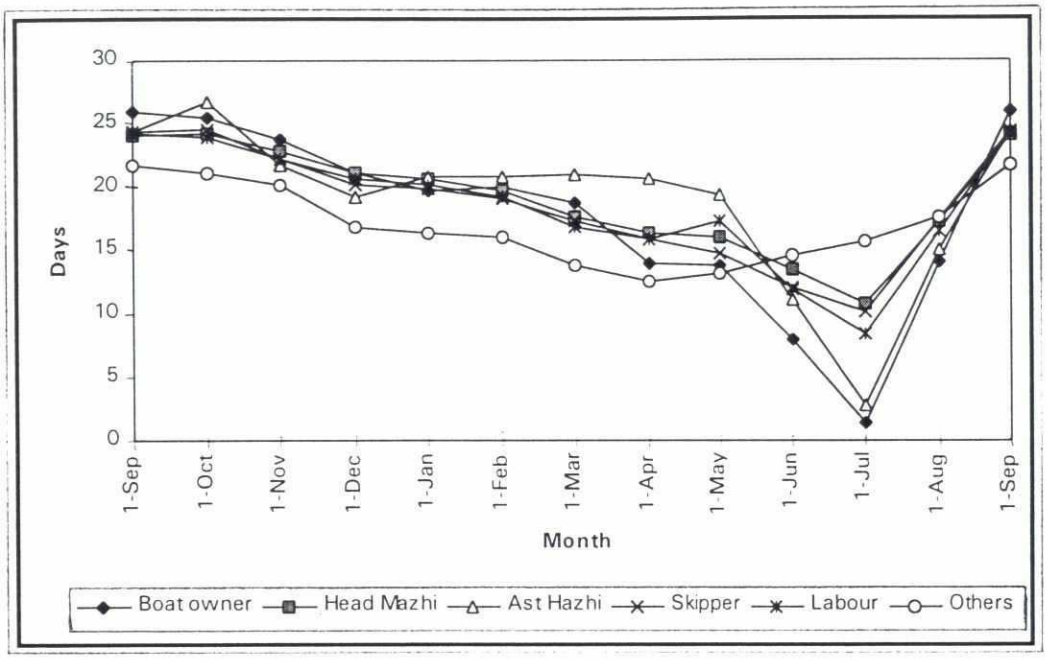
From: Blowfield and Haque, 1993

***The seasonality of fishing and its relation to indebtedness***

In general it can be stated that the income from fishing is highly seasonal, with two different fishing times clearly demarcated, namely August to January with high catches and January to August with low catches. This is mainly due to the fact that the major portion of the catch consists of Hilsha which has a seasonal migration pattern. During September - February marine set bagnets are operated mainly fishing for shrimps but these catches are limited if compared with the Hilsha catch.

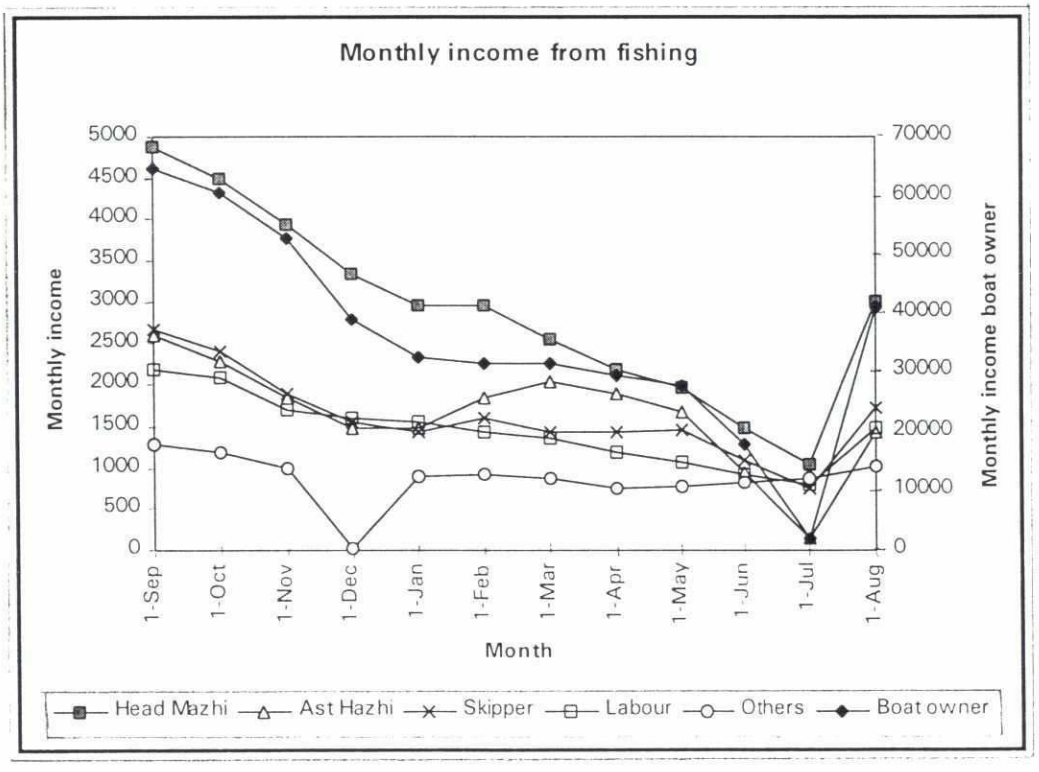
The monthly labour employment in fishing and their monthly income from fishing for different fishermen categories are presented in Figure 3.15 and Figure 3.16.

Figure 3.15 : Monthly employment for different categories of coastal fishermen




Source: Islam and Elahi, 1993

Figure 3.16: Monthly income for different categories of coastal fishermen



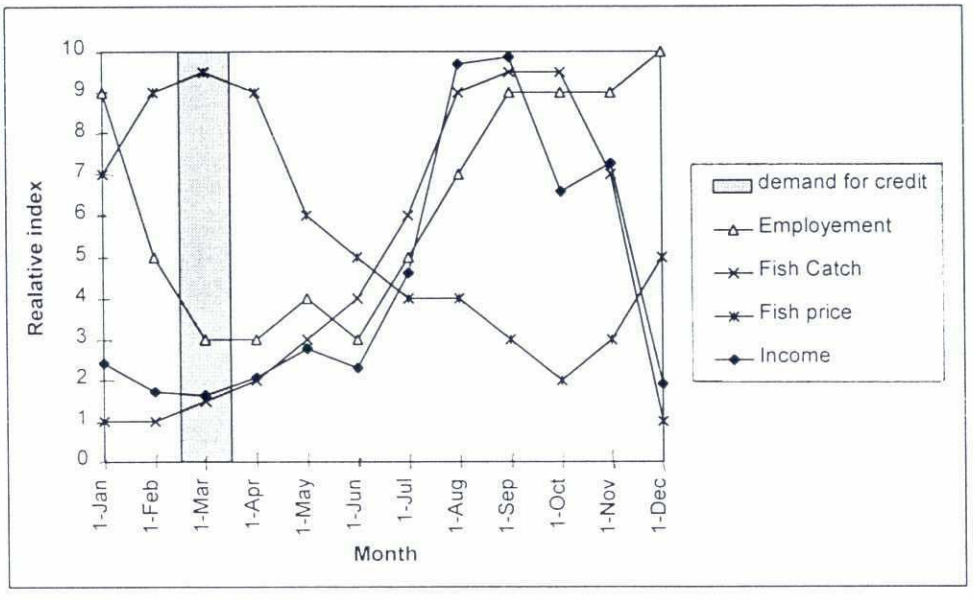

Source: Islam and Elahi, 1993

The seasonal activities in fishing cause wide variations in the flow of household income and aggravates the socio-economic vulnerability especially of those not owning boats and gears.

In general it can be stated that fishing in the coastal area of Bangladesh is controlled and indirectly owned by the "dadondar" (money lender) and the "Bahaddar" (boat owner) due to the "debt trap" of small fishermen and this particular aspect has large consequences for sustainable fisheries management.

The basic determinants of this phenomena is are visualised in Figure 3.17 and is well described by Blowfield and Haque (1993) and is cited below.

Figure 3.17: Seasonal variations in catch, income, fish prices and demand for credit




Source: modified from Rahman et al., 1997

Modified from Blowfield and Haque (1993);

"During the Hilsa season from June until September, the communities are crowded with buyers, boat repairers sales persons and tinkers. When the season ends the money stops and the stranger go away. Many of the community turns to push nets or setbag nets, and the household incomes are less than five per cent of what they are during the Hilsa season, But although the fish buyers do not visit the communities during the lean season, their presence is still felt. When a household needs credit at the local shop or money to repair equipment, somebody will contact the buyer or his representative. Buyers do not simply purchase fish, they are also money lenders, the most available source of credit that many coastal fishing communities have. The buyers cum lenders are known as "Dadondar" and are often member of neighbouring farming communities. Their dual role distinguishes them from other fish traders the "Paikar", who do not offer loans. The "Dadondar" are in turn linked to "Aratdar", large-scale traders who sell Hilsa to the major urban and export markets and who have access to the large amounts of capital that the "Dadondar" demands., all this comes at price and "Dadondar" loans charge high levels of interest. But for fishers without access to banks and largely ignored, the "Dadondar" is the only source of credit and at least fill a real need.

The "Dadondar" or his agents makes loans during the leanest fishing period (see **Error! Reference source not found.**) when there is a high need of cash and credit to survive and to prepare for the coming fishing season. The loans are made either in cash or by facilitating credit at local shops and kiosks. These loans are made to the boatowners ("Bahaddar") or captains ("Mazhi") who are responsible for their repayments. The "Dadondar" traces therefore the economic hierarchy within the communities, providing loans to the wealthier "Bahaddars" who in turn provides loans to their crew. Anyone who is not a crew member does not have access to these loans. Boatowners tend to prefer crew who own their own nets (Po Unna), in itself a indicator of wealth. Women, who are excluded from fishing, can only obtain loans through their husbands or other male relatives, limiting their access to capital for fish vending and also their control over the amount of money available for domestic purposes. The "Dadondar" sets the rate of interest for these loans at 60-150% per annum depending on the community and on the credit record of the "Bahaddar" . As most "Bahaddar" are illiterate, the "Dadondar" also serves as bookkeeper in the transaction. **A condition of the loan is that the "Bahaddar" must sell the catch to the "Dadondar" , and the "Dadondar" sets the buying price at several taka less than the price offered by other traders. Furthermore payment is only made at the end of the fishing season.**

**But there is a special twist to the** "Dadondar" . No matter what the size of the loan is, the "Bahaddar" must promise to sell all his catch through the "Dadondar" for that season. Thus, a fisher who requires a loan of Tk 1000 and one requiring a loan of Tk 10.000 must both hand over exclusive right to their entire seasons catch to the "Dadondar". If the loan is not repaid in one season it is carried over to the next season and the "Bahaddar" must again surrender the right to sell his fish on the open market"

This "debt trap" has serious consequences for community based fisheries management as the majority of the fishermen, the fishing labour force have no control over their natural resource. Improved fisheries management will not improve their economic situation, so why bother, they will only continue trying to survive. Traditional fishermen in the coastal area know their resource, in some places there is a traditional community based fisheries management system but the situation can only be improved if the fishermen will get a higher share of the profit from their fishing activities. The latter can only be obtained through breaking the debt trap.

The study of Rahman[15] et al. (1997) strongly indicated that the fisherfolk community know their major problem and availability of credit was the highest in fishermen's priority ranking for needs but was the lowest on the fishermen's ranking of availability.

Delipara Fishing village

Fishing Rights through *"fars"*

The sea along the coast of Delipara is divided in lots and families have specific fishing grounds where they can place their *"far"* fishing grounds were nets and poles for catching Hilsa are placed. For these purposes the sea is divided into northern, middle and southern sections. Each far is allocated to a fishing boat or fishing household. Those "fars" that are not to deep are the most valued because fish catch decreases as the sea becomes deeper.

Villagers say that the right to fish these particular waters was given during the colonial period and claim that there was a large copper plate in which these rights were embossed. Nobody admits knowing where the plate is today, but it still forms the basis of present claims.

Although there are no tolls or levies for the right to a particular *"far"* , the villagers follow set norms and guidelines in allocating *"fars.* The right to a particular "far" is tied to the family's standing in the community. Right toa "far" depends on use, and if neglected for a season it will be reallocated by the village elders.

From: Blowfield and Haque, 1993

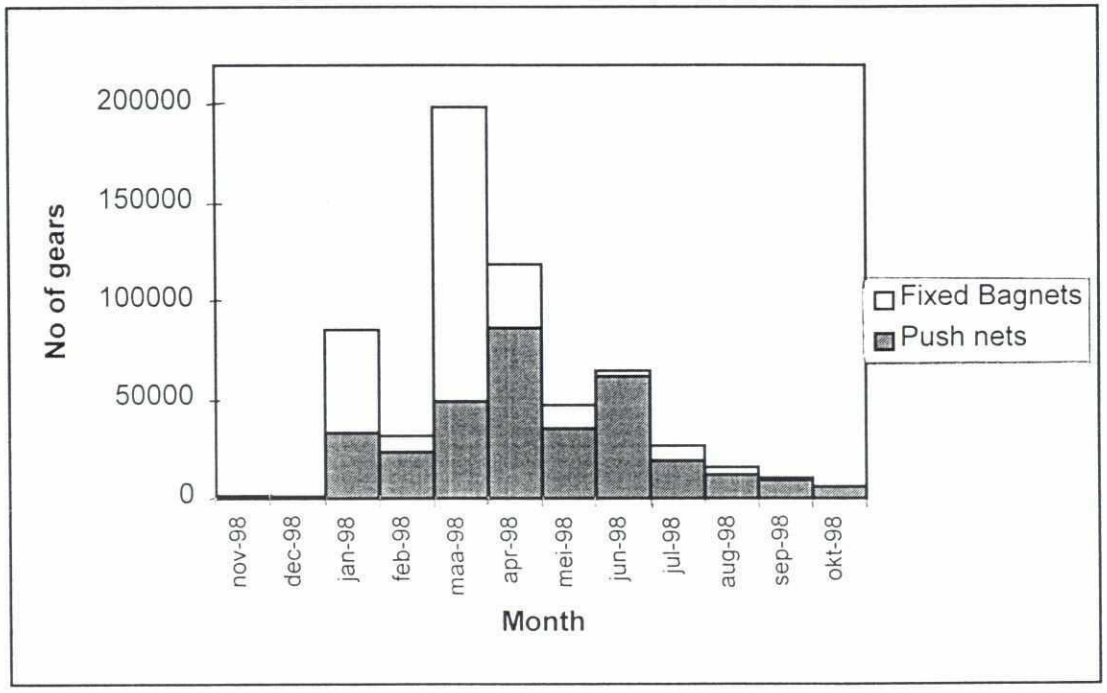
[15] Rahman, M., Chowdhury, F., Khan G., Dastidar, R and Sengputa, R., 1997. Report on participatory rural appraisal in two coastal fishing villages. FAO , Dhaka, Bangladesh.

### 3.2.3 Bagda fry catching

In 1983/84, the area under shrimp farming was 52,000 ha, but in 1989/90 it had more than doubled to 100,000 ha a trend which continued till recently. The increasing demand for shrimp fry for the rapidly growing shrimp farming industry created a new source of in come in the coastal area - the catching of Bagda fry.

More than 40,000 persons, men, women and children, are engaged in shrimp seed collection in the coastal belt of Cox's Bazar, and Chittagong. In the Satkhira/Khulna areas their number is estimated at 120,000 - 150,000 (BOBP, 1990). Bagda fry catching is a seasonal activity with 200.000 people engaged during March/April and only about 2,000 - 10,000 between September and December (Paul *et al.*, 1993). The same authors report that about 2,000 million fry of *P. Monodon* were caught in the coastal waters of Bangladesh during the season 1989/90.

Figure 3.18: Number of persons catching shrimp fry in the coastal area in 1989/90




Source: Paul et al, 1993

This new small scale activity certainly will have an impact on the natural shrimp stocks but it also provides an important source of income for the households in the coastal areas.

**Charpara village -Shrimp fry collection**

In Charpara, "a foreign engineer who looked Japanese" came and "examined the seawater with a machine". He found abundant fry of Bagda. These fry looked like pieces of thin black thread. When he asked the people to catch them with a net, a new occupation started in Charpara.

From: BOBP, 1990

Little is known of the socio-economic impact of Bagda fry catching in the coastal area.[16] Therefore MES included data collection on this subject during the socio-economic survey in Char Montaz and Kukri Mukri and the results are presented in Table 3.12.

Table 3.12: Socio-economic characteristics of shrimp fry catching in Char Montaz and Kukri Mukri

| | Char Montaz | Kukri Mukri |
|---|---|---|
| No HH sampled | 110 | 50 |
| per cent of HH engaged | 69.0 | 46.0 |
| No of persons fishing per HH | 1.88 | 1.83 |
| No Fishing days peak season | 4.64 | 4.78 |
| Annual income per HH (Tk) | 27000 | 22500 |
| Annual Income Bagda catching per HH (Tk) | 6697 | 6818 |
| per cent earned by HH from Bagda fry catching | 25.0 | 30.0 |
| Income per person from Bagda fry catching (Tk/yr.) | 3559 | 3734 |
| Minimum annual earning from Bagda fry (Tk) | 0.0 | 1480 |
| Maximum annual earnings from Bagda fry (Tk) | 142000 | 25000 |
| Price fry Tk/100 | 28.8 | 28,5 |

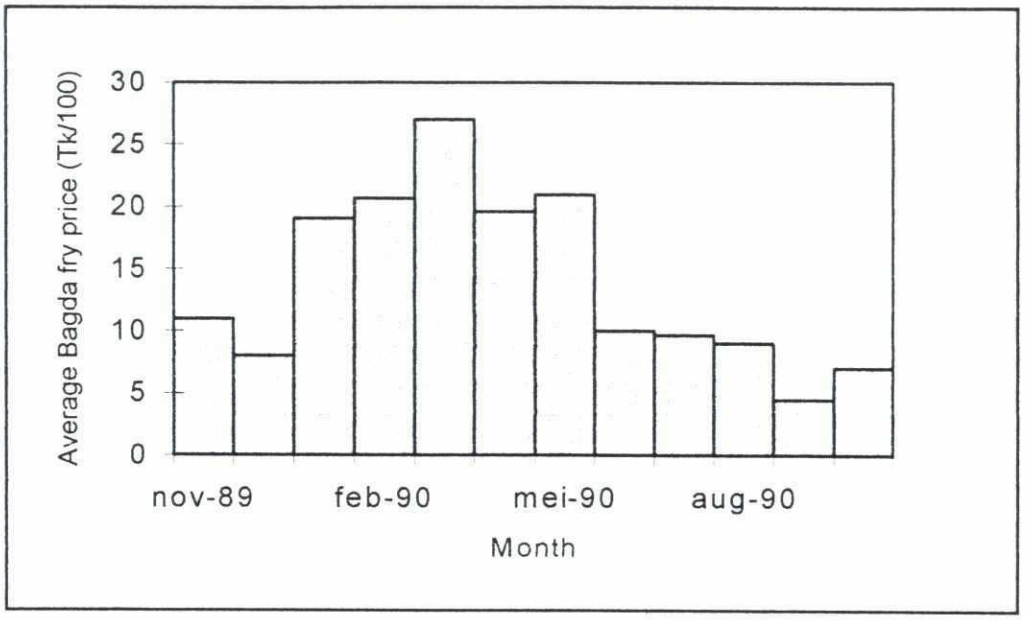
Source: MES socio-economic survey, 1998

The results indicate that over 50 per cent of all households are engaged in Bagda fry catching, earning about Tk 7,000 per household per year which is a substantial percentage (25-30 per cent) of the households annual income. Each gear operator earn about Tk 3,600 per year which is less than earlier reported earnings of Tk 5,400 per year (Paul et al., 1993).

The average price of Bagda fry was reported to be Tk 29 per 100 which is substantially higher than the average price of Tk 14 per 100 reported for 1989/90 (Figure 3.19). The higher price and lower incomes could be an indication of scarcity of Bagda fry, on the other hand it could be also a local phenomena because only two villages were surveyed.

[16] BOBP, 1990. Shrimp seed collectors of Bangladesh. BOBP/WP/63-GCP/RAS/118/MUL

Figure 3.19: Monthly average price of Bagda fry in 1989/90




Source: Paul et al., 1993

## 3.3 Fisheries Resources

### 3.3.1 Species and fish ecology

There are 475 species of fish identified so far in the Bay of Bengal of which about 100 species are of commercial value, 25 shrimp species have been identified of which 10 commercial species are available for trawl fisheries. The principal commercial species are Indian Shad (Hilsha), Bombay Duck, Ribbon fish, Round Scad, Indian Salmon, Spanish Mackerel, Threadfin, Croaker, Pomfret, Eel, Red Snapper, Tiger shrimp, Brown shrimp and Yellow shrimp.

Biologically, the estuary provides major spawning and nursery areas for a large number of fish and crustacean which spend the remainder of their life cycles at sea, or in fresh water. Further, the estuary provides avenues of entry and exit for migration of anadromous and catadromous fishes. Within the Meghna estuary the following species are known to be estuarine dependent, that is that passing a portion of their life cycles in the estuary is obligatory for the completion of their life cycles.

***Hilsha or Indian Shad***

The Indian or Hilsha Shad (*Tenualosa ilisha*) is an important diadromous Clupeid fish in South and South east Asia, especially in Bangladesh were the majority is caught. In Bangladesh Hilsha is the largest single species fisheries and contributes about 20-25 per cent of the total fish production of the country.

Hilsha in Bangladesh most likely comprises of a riverine and of a marine/estuarine stock. Adults of the riverine stock migrate from the sea/estuary into the Meghna going further upstream into the Meghna/Pabna/Jamuna and Old Brahmaputra river. They spawn upstream in these rivers and their larvae are transported downstream with the river flow towards the nursery grounds in the river and estuaries (de Graaf *et al*[17]., in press).

[17]de Graaf, G.J., Born, B., Uddin, A.M.K. and Huda, S., 1998. Larval fish movement in the Lohajang river, tangail, Bangladesh. Journal of fisheries Management and Ecology, in press,

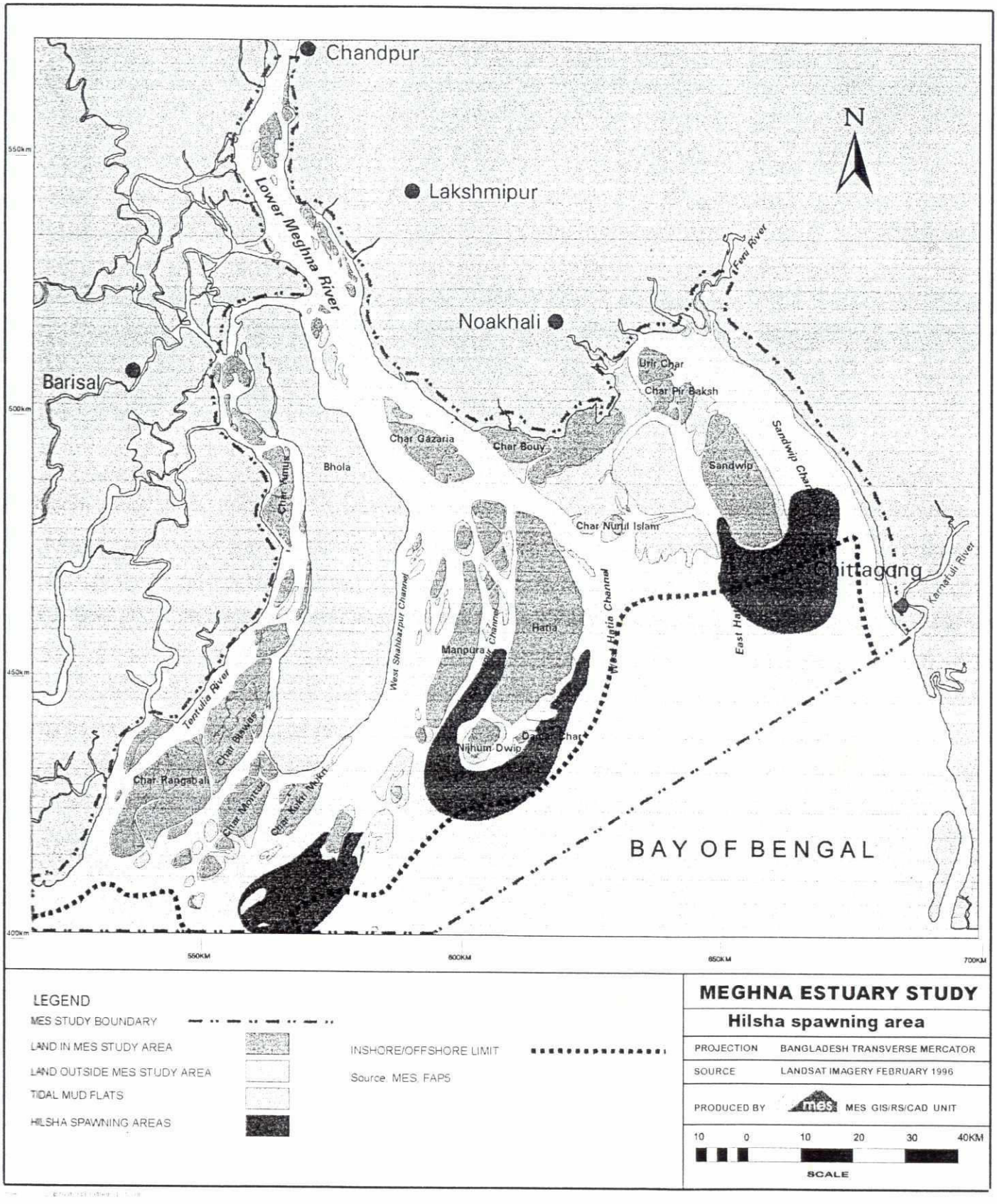
A major riverine nursing area is located in the Meghna river in and around Chandpur from Mushiganj to Hazimara. Another important nursing area is located in the estuary/sea from Kuakata (Patuakhali) to Dubla Island. The marine stock spawns in the lower stretches of the Meghna river near Hatia, Sandwip and Bhola. However, de Graaf et all. (in press), found that large numbers of Hilsha larvae are entering the floodplain during August-October. Which could indicate that the floodplain is another important fresh water habitat for Hilsha larvae.

The most important spawning areas (Figure 3.20) were identified by the presence of a large number of ripe and oozing males and females (FRI, 1992, Rahman, 1998);

- Moulavirchar area, in and around south Hatia, in the confluence of the Hatia and the Meghna river with the Bay of Bengal.
- Manpura area, east and southeast of Manpura (from southwest Hatia, extending up to the Northwest of Moulavirchar) in the confluence of the lower stretches of the Meghna with the Bay of Bengal.
- Dalchar area, in and around the south of Char Fassion of Bhola in the confluence of the Shahbazpur river with the Bay of Bengal.
- Kalir char area, south of Sandwip at the confluence of the Sandwip and Hatia channel with the Bay of Bengal.

However, the results of the FRI study on this spawning areas does not allow a conclusion to be drawn as to whether Hilsha spawns at the mud flat or in the main river channel, which is of utmost importance to know considering the proposed interventions in the MES area.

Figure 3.20: Spawning and nursery areas of Hilsha in Bangladesh



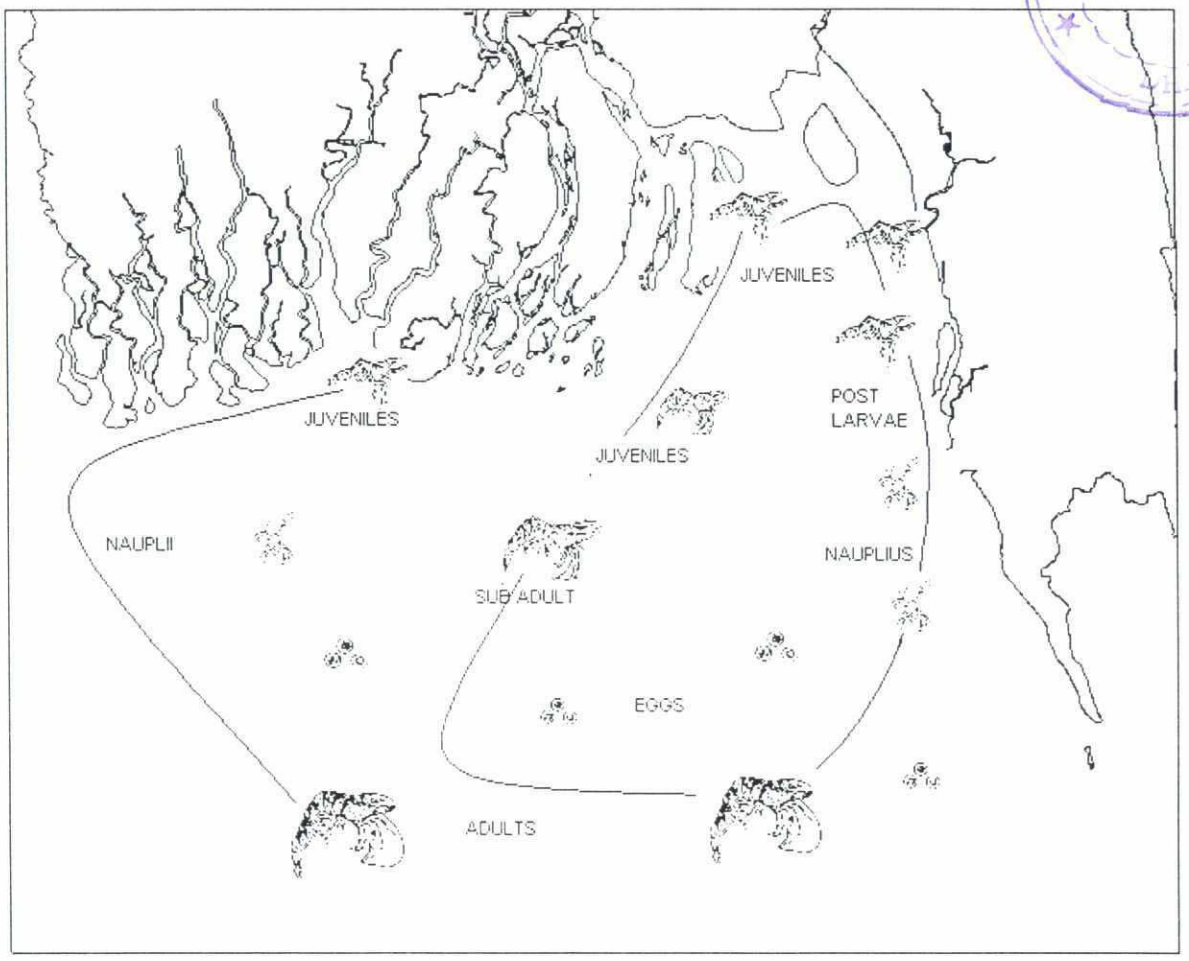
***Penaeid Shrimps***

In general marine shrimp follow a diadromous life cycle involving migration between the sea and the estuary. The most important species in Bangladesh are; Bagda (Tiger shrimp, *Penaeus Monodon*), Horina (Brown shrimp, *Metapenaeus monoceros*), and Chaga (White shrimp, *Penaeus indicus)*.

The life cycle of Bagda (*P. Monodon*) is presented in Figure 3.21.

Figure 3.21: The life cycle of Bagda in Bangladesh






There are three major spawning areas of Bagda in the Bay of Bengal:

- the offshore waters west of Teknaf/St. Martins Island
- the deep offshore waters south of Hatia
- the off shore waters south of Dubla Island

Penaeid shrimps reproduce in coastal waters, but after completion of the larval development, the post-larvae migrate into brackish waters. During low tide the shrimp stay near the bottom, but when the tide rises, they become active and are transported by the tidal current into the estuary. Juvenile shrimp remain 2-4 months in the brackish water environment, where they find food and shelter from predators. Towards sexual maturity, the shrimp will become less tolerant

to reduced salinities and migrate back to the sea. Migration is strongly influenced by lunar phases and the tides, being maximal during spring tide.

***Pangash or Catfish***

The major nursing areas for some catfish species (*Pangasius spp)* are the estuary of the Lower Meghna.

***Golda or fresh water prawn***

Golda (*Macrobrachium rosenbergii)* is caught in the inland water of Bangladesh and is a major export product. Golda is depending on the estuary for completion of their life cycle. During the reproduction period berried female migrate downstream towards the estuary (catadromous migration). Larvae of Macrobrachium can survive for five days in freshwater but brackish water is required for their development. After nursing in the estuary the juveniles migrate upstream against the river current and grow-out in the inland waters.

The annual catch and value of these "estuarine dependent" species in Bangladesh is presented inTable 3.13.

Table 3.13: Annual catch and value of some estuarine dependent fish species

| Species | Annual catch (mt.) | Value of catch (million US$) |
|---|---|---|
| Hilsha | 235,000 | 117.5 |
| Fresh water prawn | 405 | 1.62 |
| Tiger shrimp | 700 | 3.5 |
| Brown shrimp | 2,300 | 2.3 |
| White shrimp | 350 | 0.7 |
| TOTAL | 238,755 | 125.0 |

### 3.3.2 MES and estuarine dependent species

Within MES accelerated land reclamation through the construction of cross dams have been studied. In principle this is an "alteration of the habitat" as water changes to land and impacts on fisheries can be expected. Within the intertidal area, the estuary serves as a nursing and breeding area of a large number of economic important estuarine dependent fish and shrimp species such as: Hilsha, Bagda, Golda, Pangash etc. Reduction of this area will certainly have a negative impact on these species. However quantification of these impacts is difficult as data and knowledge of the system is lacking. The proposed accelerated land reclamation must be treated carefully. For the different feasibility studies of MES no quantification for this subject are given as;

- 25 per cent of the total fish catch of Bangladesh consists of Hilsha (*Tenualosa ilisha*) and according to FRI three major spawning areas are located in the MES area. Two of them located exactly in the area where accelerated land reclamation is proposed (Nijum Dwip and Char Montaz). The results of the FRI study however does not allow a conclusion to be drawn as to whether Hilsha spawns at the mud flat or in the main channel.

- One cross dam most likely does not have a significant impact. The cumulative impact of a number of cross dams could however have a impact similar to that of FCD/FCDI schemes on the inland fisheries, especially if Hilsha spawns at the mud flat. With the present knowledge we do not know if in the future the spawning places will move with the changing land/water patterns. Considering the economic importance of Hilsha (250,000 mt/year, 125 million US$/year) and the large number of households depending on it for its livelihood, and the fact that most interventions are irreversible, a very cautious approach is essential.

- The numerous creeks and mudflats in the intertidal area serves as nursing area for three other important economic important species; Bagda, Golda and Pangash. The studied interventions will reduce this specific habitat and will reduce the survival of the post-larvae or fry of these species, which are already under heavy pressure due to the earlier mentioned shrimp fry collection.

It is however strongly recommended that spawning of the major estuarine species is more studied in detail before major interventions in the MES are carried out, details of recommended studies are presented in 0.

### 3.3.3 Marine deep water stocks[18]

There is currently very little information available in Bangladesh on which to base an assessment of the status and potential of pelagic fish resources. The only pelagic species found in the fish catch statistics is Hilsha, which was discussed before.

In 1971 Alverson (1971) identified the Bay of Bengal as one of the priority programme areas for the undertaking of surveys of coastal pelagics and upwelling zones. Numerous resource surveys have been undertaken in the Bangladesh EEZ dating back to 1911 (see Table 3.14).

Table 3.14: Marine fisheries resources surveys in the Bangladesh EEZ, 1911 to 1988

| Name of Survey Vessel | Year | Country |
|---|---|---|
| Golden Crown | 1911 | United Kingdom |
| Chosi Maru | 1958 | Japan |
| Cagoa Maru | 1960 | Japan |
| Kinki Maru | 1961-1962 | Japan |
| Jalua | 1962-1970 | Bangladesh |
| Sagar Sandhani Meen Sandhani | 1968-1971 | Bangladesh |
| Lesnoi | 1969-70 | Soviet Union |
| Tamango Sartam-449 | 1972 | Japan |
| Santa Monika Orion-8 | 1976-77 | Japan |
| Fisheries Research Vessel-2 | 1979 | Thailand |
| Dr. Fridtjof Nansen | 1979-1980 | Norway |
| R V Anusandhani | 1981-87 | Bangladesh |
| R V Machhranga | 1987 | Bangladesh |

Of these, however, only the two surveys by the *Fridtjof Nansen* in 1979 and 1980 specifically targeted pelagic fish (Soetre[19] 1981). The *Fridtjof Nansen* undertook two surveys in the Bangladesh EEZ using acoustics and trawl methods to assess the standing stock of pelagic and demersal fish species.

The two acoustic surveys provided estimates of the standing stocks of pelagic fish of 60,000 tonnes and 120,000 tonnes respectively. Estimates of standing stocks of demersal fish from swept area calculations were 160,000 tonnes and 92,000 tonnes for the two surveys. The total shelf area of Bangladesh between 10 and 200m depth was estimated to be 42,440 $km^2$ (Table 3.15).

[18] A large part of this chapter comes from Third Fisheries Project (1995), Management Information Systems in the Fisheries Sector of Bangladesh Vol 2.

[19] Soetre, 1981, Surveys on the marine fish resources of Bangladesh, Nov-Dec, 1979 & May 1980. Reports on surveys with the R.V. Dr Fridtjof Nansen. Institute of Marine Research, Bergen, Norway: 67 p.

Table 3.15: Area of the shelf of Bangladesh

| Depth Zone (m) | Area ($km^2$) |
|---|---|
| 10-24 | 8400 |
| 25-49 | 4800 |
| 50-74 | 5580 |
| 75-99 | 13410 |
| 100-199 | 10250 |
| Total | 42440 |

All of the standing stocks estimates were considered to be under estimates because the area of the shelf shallower than 10 meters was not sampled, and fish occurring in the water column above the depth of the transducer were also not included.

The abundance and distribution of pelagic fish species varied significantly between the two surveys. This may have been linked to marked differences in hydrography resulting from the higher fresh water run off in November/December as compared to May. The species composition of catches of pelagic fish in both the bottom and pelagic trawls are shown in Table 3.16.

Table 3.16: Species composition of pelagic fish from bottom trawl catches

Unit: kg/haul

| Depth Zones (m) | 10-24 | | 25-49 | | 50-74 | | 75-99 | | 100-149 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Nov-Dec 1979 | May 1980 | Nov-Dec 1979 | May 1980 | Nov-Dec 1979 | May 1980 | Nov-Dec 1979 | May 1980 | Nov-Dec 1979 | May 1980 |
| Ariommidae Drift fish | | | | | 0.1 | 95.5 | 31.2 | 0.1 | | |
| Carangidae Jack/Scad | 4.0 | 14.9 | 7.0 | 16.8 | 10.4 | 288.3 | 56.1 | 12.1 | 0.1 | 0.6 |
| Clupeidae Herring/Scad | 37.9 | 43.4 | 4.1 | 3.9 | 22.4 | 1.1 | 0.6 | | | |
| Engraulidae Anchovy | 18.5 | 11.4 | 8.6 | 1.3 | 13.2 | 0.1 | 0 | | | |
| Leignathidae Ponyfish | 4.6 | 1.5 | 19.4 | 50.5 | 4.2 | 1 | 5 | | | |
| Scombridae Mackerel | 6.0 | 3.8 | 19.3 | 1.5 | 71.4 | 502.2 | 99.7 | | | |
| Sphyraenidae Barracuda | | | | 0.5 | 1.2 | 29.9 | 1.6 | 0.2 | | |

The average catch rates for the pelagics were very low. Fifty per cent of the hauls yielded less than 10 kg/h. The highest recorded catch rate was 170 kg/h, of which the major contribution was anchovy, *Stolephorus* spp.

Soetre (1981), used the standing stock estimates from the *Fridtjof Nansen* surveys as estimates of unexploited biomass ($B_0$) to calculate some very rough estimates of the potential yield of pelagic fish with Gulland's formula, $Y = 0.5 * M * B_0$.

Assuming a natural mortality (M) of 1, an estimated potential yield of about 100,000 tonnes was obtained. However using 0.5 for the constant of proportionality is likely to be an overestimate, the degree of overestimation being largely dependent on the degree of density dependence in the stock recruitment process. Yield taken as percentage of unexploited biomass, even in the case of very strong density dependence (recruitment constant regardless of mature stock size), is more likely to be around 0.3M rather than 0.5M. At lower levels of density dependence, the percentage yield is further reduced to between 0.1M and 0.15M. This is likely to be of significance for small pelagic species, which commonly display high levels of recruitment variability.

Estimates as calculated by DoF are presented in Table 3.17, and for the same reason they could be considered as rather optimistic estimates.

Table 3.17: Standing stocks and maximum sustainable yields of the Bangladesh EEZ

| Resource | Standing stock (mt) | MSY (mt per year) |
|---|---|---|
| Shrimps | 14,000 | 6,500 |
| Demersal fish | 150,000-160,000 | 50,000-85,000 |
| Pelagic fish | 90,000-120,000 | Unknown |

Source: DOF

The current potential for exploitation of pelagic resources in the Bangladesh EEZ is uncertain, but there is sufficient evidence of a substantial resource. It is however unlikely that commercial development of this sector will proceed without more reliable data becoming available from specially designed studies.

## 3.4 Fish Catch Assessment

### 3.4.1 The Bangladesh Fisheries Resources Survey System.

Information on fisheries in Bangladesh is collected by the Bangladesh Fisheries Resources Survey System (BFRSS) which became operational in 1983/84. The data on Inland fisheries are collected by district and in each district one FRSS-officer is stationed to collect all the statistical data. Data one Marine Industrial and Marine artisanal fisheries are compiled respectively by the Marine Production Officer and Statistical Officer of the Marine Fisheries Department of DoF in Chittagong. For marine fisheries the following catch data for the following gear categories is published annually:

**Industrial fishing**
- *Trawl fishing*
  - Shrimp Trawlers
  - Mixed Trawlers
  - Fish Trawlers

**Artisanal fishing**
- *Gill nets*
  - Mechanised boats
  - Non-Mechanised boats
- *Set bagnets*
  - Marine set bagnets (seasonal)
    - Mechanised
    - Non mechanised
  - Estuarine set bagnets (all season)
    - Mechanised
- *Longline*
  - Jewfish longline
    - Mechanised
    - Non mechanised
  - Other Longline
- *Trammel nets*
- *Other gear fishing*

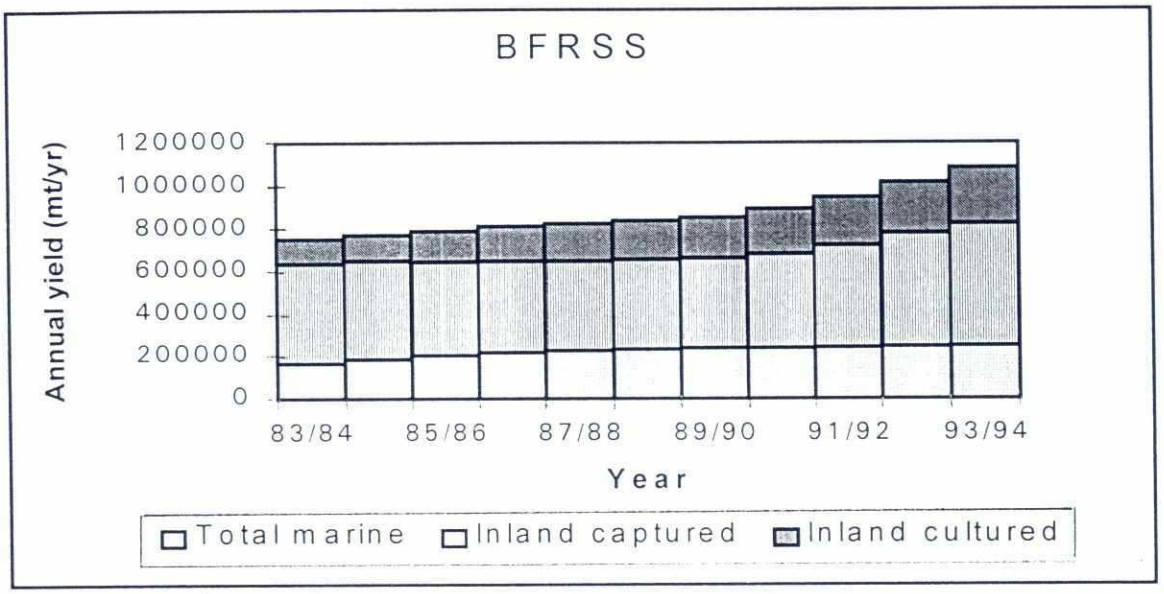
The catch data are further sub-divided over the following species: Hilsha, Bombay duck, Indian salmon, Pomfret, Jewfish, Catfish and Rays, Sharks, Shrimps and Other Fish.

### 3.4.2 Marine fisheries statistics

***Total catch***

In 1993/94 the total fish production of Bangladesh was estimated by BFRSS at 2.08 million mt, with 0.22 million mt obtained through marine fisheries (23 per cent), 0.57 million mt from inland fisheries (54 per cent) and 0.26 mt from aquaculture (24 per cent). Since 1983 the total fish production increased by 3per cent to 4per cent annually mainly due to an increased aquaculture production such as shrimp and carp culture and an increased marine catch (Figure 3.22).

Figure 3.22: Total fish production of Bangladesh, 1983 - 1995



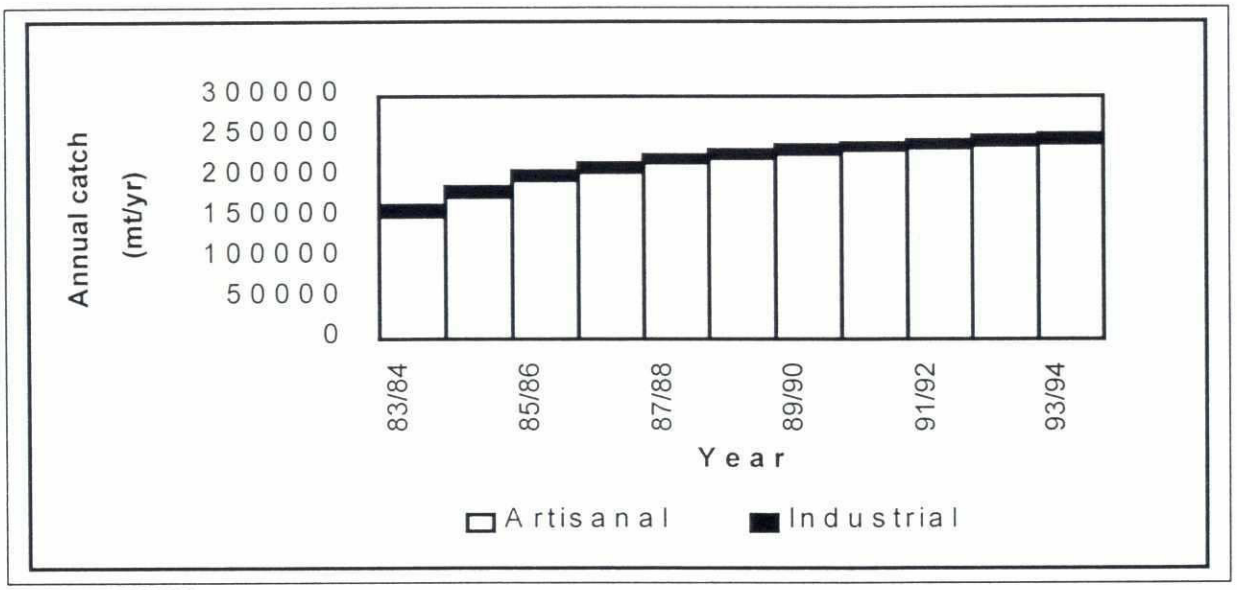

Source: BFRSS

A major problem of the FRSS data is that the "estuarine production" of the inland waters, which are in principle part of the "marine sector" can not be separated from the total inland production (except Hilsha catch). In the next paragraph the "estuarine catch consequently is not included.

*Industrial and artisanal catch*

The industrial catch remained more or less stable around 10,000 mt per year over the last decade and contribute for 5per cent of the total catch. Artisanal catch however increased from 150,000 mt per year in 1983/84 to 240,000 mt per year in 1993/94 (Figure 3.23).

Figure 3.23: Industrial and artisanal marine catch, 1983 - 1995




Source: BFRSS

*Catch per gear*

In Table 3.18 the annual catch for the different gear for the season 1994/95 is presented.

Table 3.18: Annual catch for the different gears used in the coastal area,1993/94

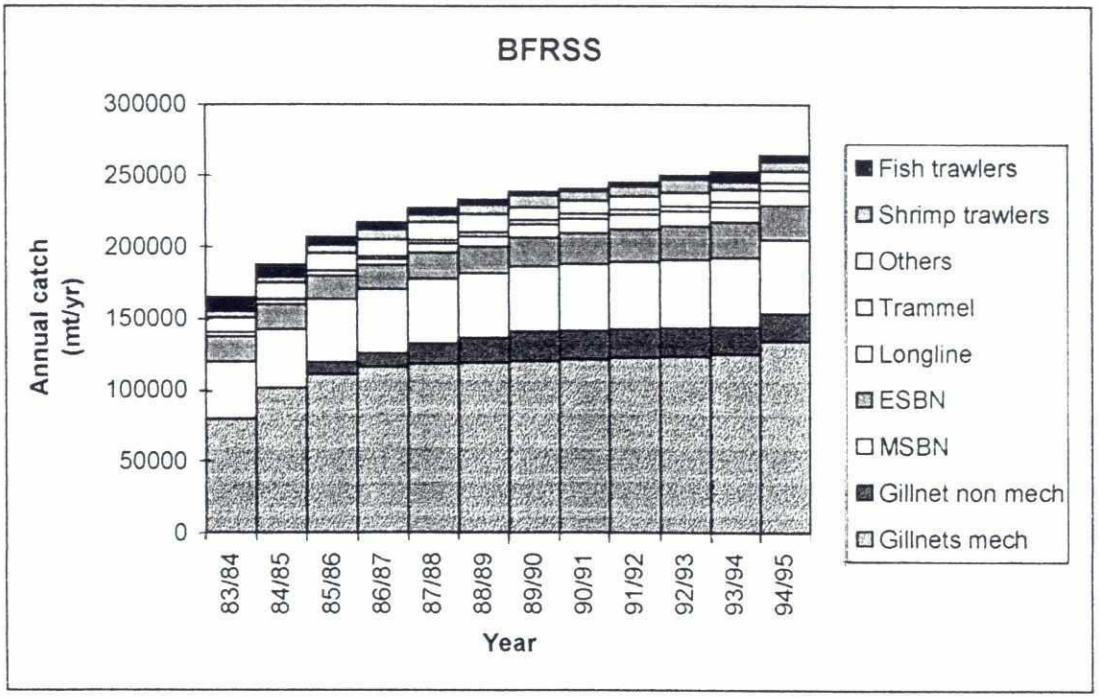
| Gear | Annual catch (mt per year) | Total catch (%) |
|---|---|---|
| Gillnets mechanical | 134308 | 51 |
| MSBN | 51245 | 19 |
| ESBN | 24665 | 9 |
| Gillnets non-mechanical | 19602 | 7 |
| Longline | 10368 | 4 |
| Others | 7435 | 3 |
| Shrimp trawlers | 7247 | 3 |
| Trammel | 5312 | 2 |
| Fish trawlers | 4468 | 2 |
| Total | 264650 | 100 |

Source: BFRSS
Note: Estuarine Hilsha catch excluded.

The majority of the catch (51per cent) is caught by gillnets operated from mechanised boats. These gears catch mainly Hilsha and it should be realised that the estuarine Hilsha catch is not included, which give an indication of the importance of the Hilsha catch in the Coastal area. The marine set bagnets contribute to 19per cent of the total catch followed by the Estuarine Set bagnets with 9per cent.

During the last decade no major changes were registered in the importance of the different gears as is indicated in Figure 3.24.

Figure 3.24: Distribution of the marine catch by gear used, 1983-95




Source: BFRSS

***Catch of main species***

In Table 3.19 the distribution of the marine catch among the main species is presented. The majority of the catch, 50per cent, consists Hilsha (estuarine catch excluded) followed by shrimp 8per cent and Bombay Duck (8per cent).

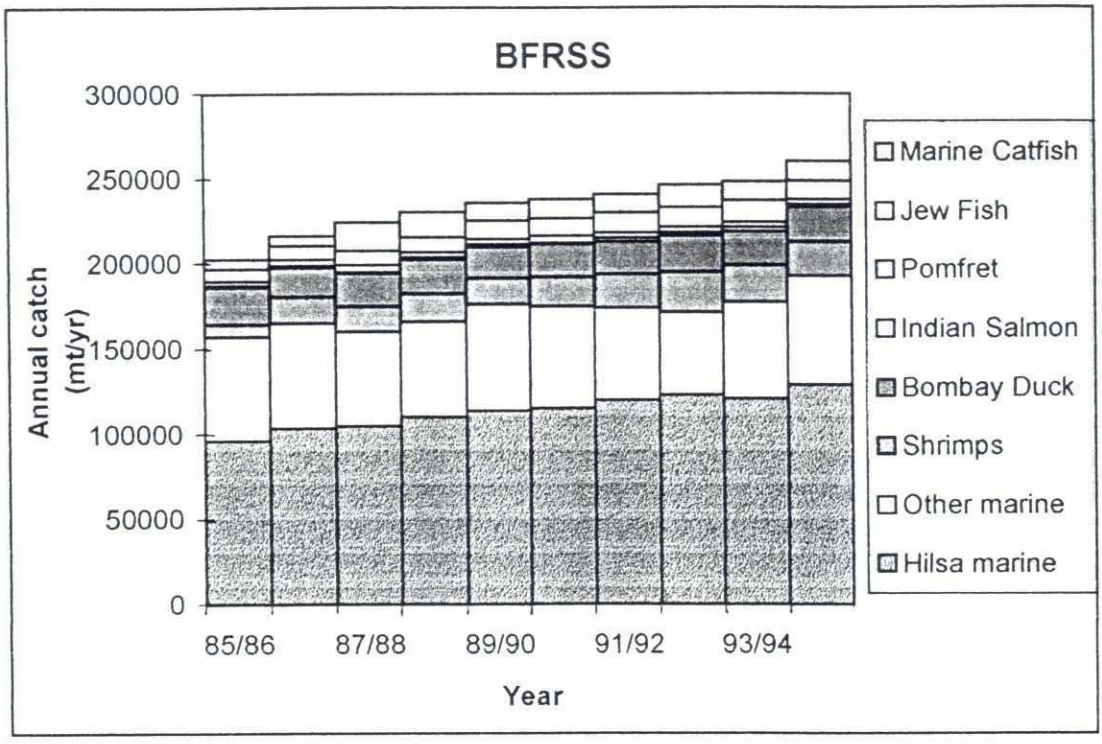
Table 3.19: Species distribution of the marine catch of 1994/95 in the coastal areas

| Species | Annual catch (mt per year) | Total catch (%) |
|---|---|---|
| Hilsha (marine) | 129115 | 50 |
| Other marine | 64009 | 25 |
| Shrimps | 20363 | 8 |
| Bombay Duck | 20117 | 8 |
| Marine Catfish | 11267 | 4 |
| Jew Fish | 10838 | 4 |
| Pomfret | 3393 | 1 |
| Indian Salmon | 1450 | 1 |
| Total | 260552 | 100 |

Source: BFRSS
Note: Estuarine Hilsha catch excluded

No major changes in the species composition of the marine catch were observed during the last decade (see Figure 3.25).

Figure 3.25: Species distribution of the registered marine catch, 1984 - 1995




Source: BFRSS

### 3.4.3 Gear used in the coastal areas

The major gear used in the coastal areas of Bangladesh are the estuarine set bagnet (ESBN), marine set bagnet (MSBN), gillnets, trammel nets and longlines. The number of gear operated in the coastal area are covered by the BFRSS and summarised data recorded since 1983/84 are presented in Table 3.20.

Table 3.20: Numbers of different gear operated in the coastal areas, 1984 - 1995

| Year | Gillnets | MSBN | ESBN | Longlines | Trammel | Others | Shrimp trawlers | Fish trawlers |
|---|---|---|---|---|---|---|---|---|
| 83/84 | 3347 | 4500 | 7410 | 743 | | | 27 | 46 |
| 84/85 | 3000 | 4775 | 7410 | 650 | 100 | 1000 | 30 | 37 |
| 85/86 | 6689 | 5320 | 7295 | 1357 | 200 | 1650 | 31 | 14 |
| 86/87 | 6682 | 5460 | 7155 | 1350 | 300 | 1561 | 31 | 18 |
| 87/88 | 6389 | 5400 | 7215 | 1382 | 500 | 1608 | 33 | 19 |
| 88/89 | 6389 | 5400 | 7215 | 1382 | 500 | 2222 | 35 | 17 |
| 89/90 | 6389 | 5400 | 7215 | 1382 | 500 | 2222 | 40 | 13 |
| 90/91 | 6389 | 5400 | 7215 | 1382 | 500 | 2222 | 41 | 15 |
| 91/92 | 6389 | 5400 | 7215 | 1382 | 500 | 2222 | 37 | 14 |
| 92/93 | 6389 | 5400 | 7215 | 1382 | 500 | 2222 | 37 | 14 |
| 93/94 | 6389 | 5400 | 7215 | 1382 | 500 | 2222 | 41 | 12 |
| 94/95 | 6389 | 5400 | 7215 | 1382 | 500 | 2222 | 41 | 12 |

Source: BFRSS, 1983-95

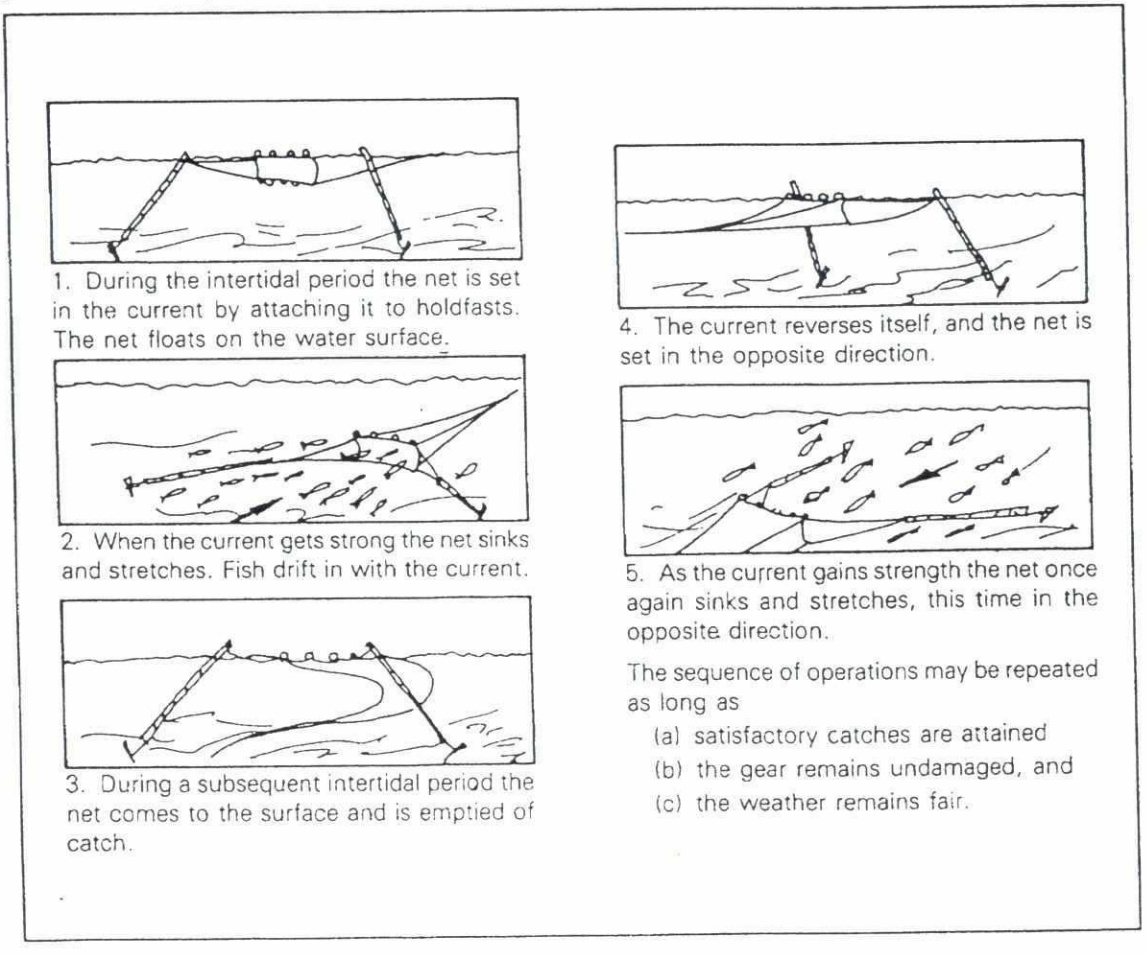
The data reflects one of the major problems of the BFRSS, a lack of regular updating of the frame survey as in spite of the rapid increase of the number of fishing households in the coastal area the number of different gears has almost not changed since the mid 80's. This has serious consequences as statistical data are not only collected in order to know how much fish is caught. They are also collected in order to provide resource information for the formulation of a fisheries management policy as trends observed in long term statistical data can give an indication of the status of the fish stocks and its level of exploitation.

*Estuarine set bagnet*

The estuarine set bagnet[20] is a fixed, tapering net, resembling a trawlnet, set in the tidal stream by attaching it to holdfasts. It has a rectangular mouth which is kept open by two vertical bamboo poles. The net is held in position, against the current, by linking the extended sides of the net (wings) to holdfasts by means of long bamboo poles or hollow drums and steel wires. The holdfasts are two wooden stakes embedded some distance apart in the seabed, so that the net is parallel to the direction of the tidal current (see Figure 3.26).

The set bagnet catches those species of fish which drift with the current or do not swim fast enough to stem the current. During each slack period the net rises to the surface (because of the bamboo poles used for opening of the net and the bamboos serving as sweep lines) and is emptied. It is then turned over to face the opposite direction and is made ready for fishing again (Figure 3.26)

Figure 3.26: The operation of a set bagnet (Behundi jal)




Source: from Islam *et al.*, 1993.

[20] Islam et al., 1993, The estuarine set bagnet fishery, BOBP/WP/89.

The net is made up of four panels. The mesh size decreases from 140-20 mm at the mouth to 22-5 mm at the codend. The length of the net varies from 8 to 40 metres and the height of the mouth opening is 2 to 7 metres.

According to the BFRSS there are about 7000 ESBN operated in the coastal area. However a survey carried out by the marine wing of the Department of Fisheries in Chittagong under the Development and Management project during 1989/91 found almost double, with 12,600 ESBN operated in the coastal area. The distribution of the ESBN over the different sampled strata (not districts) is presented in Table 3.21.

Table 3.21: Distribution of estuarine set bagnets in the coastal areas

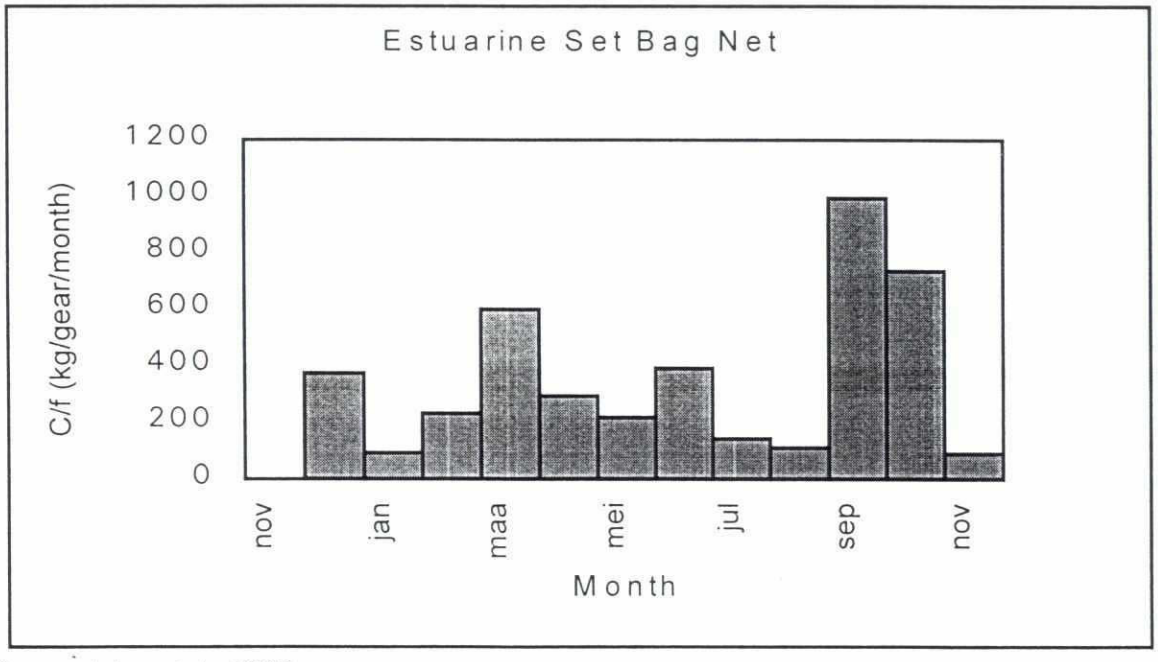
| Stratum | No of ESBN | Percentage of total ESBN |
|---|---|---|
| Cox's Bazar | 3232 | 26 |
| Chittagong | 3081 | 25 |
| Noakhali | 2029 | 16 |
| Pathuakhali | 2759 | 22 |
| Bagherhat | 413 | 3 |
| Satkhira | 1047 | 8 |
| Total | 12561 | 100 |

Source: Islam et al., 1993

The majority of the ESBN are operated by non-motorised boats. The annual catch of the ESBN was estimated at 54,000 mt by this study, which is substantially less than the annual catch as estimated by BFRSS. This again stresses the importance of reliable frame and catch and effort data.

The majority of the catch is caught in Cox's Bazar (65 per cent) followed by Patuakhali (21 per cent). Estuarine setback nets are used throughout the year, but there are two major peak seasons, one in September/October and another in March (Figure 3.27).

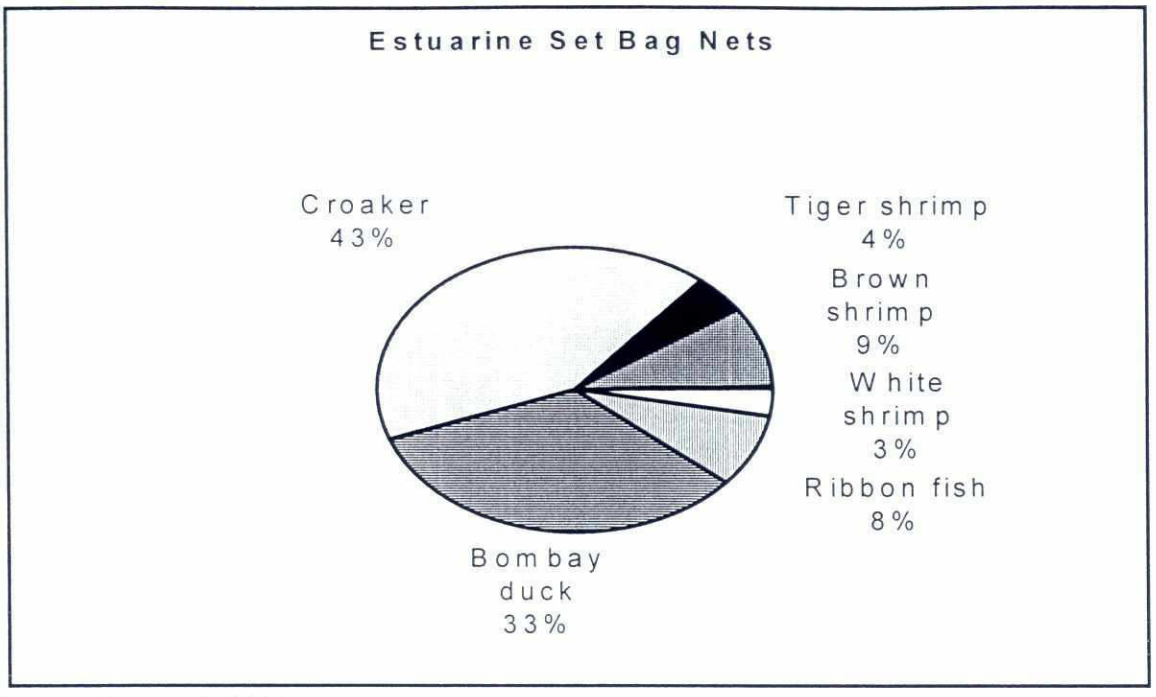
Figure 3.27: Monthly catch of the estuarine set bagnets in the coastal areas




Source: Islam et al., 1993

The estuarine set bagnets are mainly catching Croaker (*Johnius spp.)* (43 per cent), Bombay Duck (*H neherus*) (33 per cent) and shrimp (16 per cent), with 87 per cent of the shrimp being caught in the Cox's Bazar area (Figure 3.28).

Figure 3.28: Species composition of ESBN in the coastal area




Source: Islam et al., 1993

Estuarine set bagnets are considered to be a destructive gear as they catch mainly juveniles. First indications of this characteristic were obtained through a length based stock assessment programme[21] carried out in 1989/91 by DoF, Chittagong under the Bay of Bengal Programme. For the major species the exploitation rate of the ESBN is very high (0.6-0.85) and a yield per recruit curve made with available data (see Figure 3.38) for *P. Monodon* indicates that the exploitation rates are above the maximum yields of the ESBN. Furthermore for most species the ratio $L_c/L_\infty$ and clearly indicates that most species are caught to early by the ESBN (Table 3.22).

Table 3.22: Parameters from a length based stock assessment survey for ESBN

| Species | $L\infty$ | E | Lc | $Lc/L\infty$ |
|---|---|---|---|---|
| P. monodon | 31.4 | 0.85 | 13.8 | 0.43 |
| M. monoceros | 19.8 | 0.76 | 5.9 | 0.29 |
| H. neherus | 34.9 | 0.81 | 6.3 | 0.18 |
| P. stylifera | 15.4 | 0.67 | 2.8 | 0.17 |

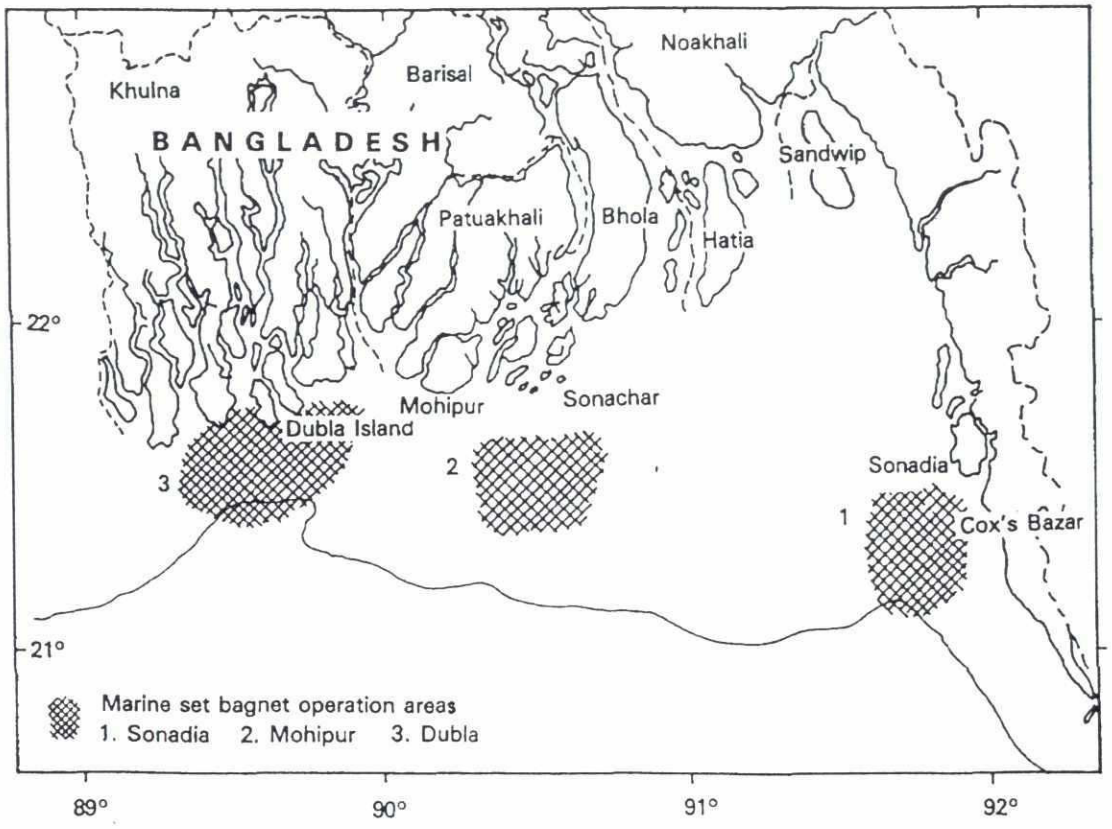
Source: Islam et al., 1993

*Marine set bagnets*

The Marine Set bagnet (MSBN) is more or less similar to the ESBN but they are operated further in sea in a depth range of 10-30m in areas where the salinity is 20-30 ppt. The main fishing grounds for the MSBN are located near Dubla Island, near Mohipur and near Sonadia (Figure 3.29).

[21] Length based stock assessment programmes will be discussed more in detail in Chapter 0

Figure 3.29: Fishing grounds of the marine set bagnets in the coastal areas




Source: Quayum et al., 1993

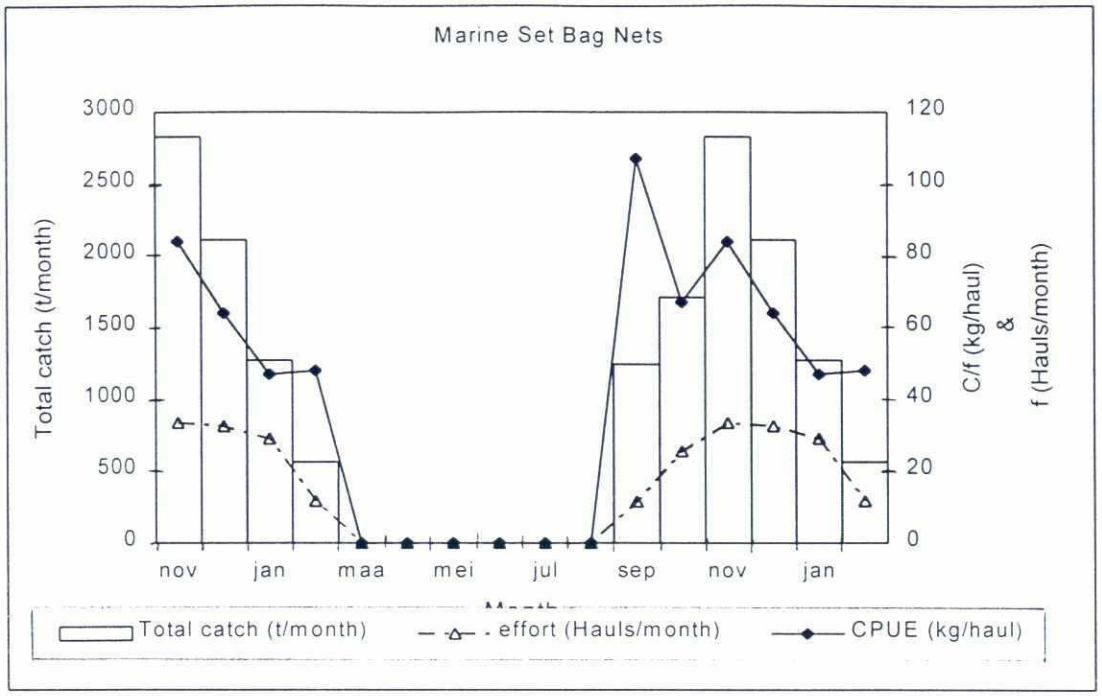
According to the BFRSS 5,400 marine set bagnets are operated in the coastal areas. However a survey carried out in 1991[22] found 3,850 MSBN, 65 per cent operated in Dubla, 21 per cent in Mohipur and only 11 per cent in Sonadia.

The MSBN is a seasonal gear (see Figure 3.30) which is mainly operated during the winter month when there is a lower fresh water run off into the Bay of Bengal and it is difficult to and dangerous operate the gear during the monsoon.

The MSBN are operated by motorised and non-motorised boats and mostly 3 to 12 units are operated by one boat. The catch rates are high if compared with the ESBN and varies from 40 to 80 kg/haul or 1,300 to 7,000 kg/gear/month (Figure 3.30) and the total catch of the MSBN was estimated to be 26,000 mt in 1991 (Quayum et al., 1993) which is almost half the estimate of BFRSS (51,200 mt).

[22] Quayum et al., 1993. The Marine Set bagnet fishery. BOBP/WP/89.

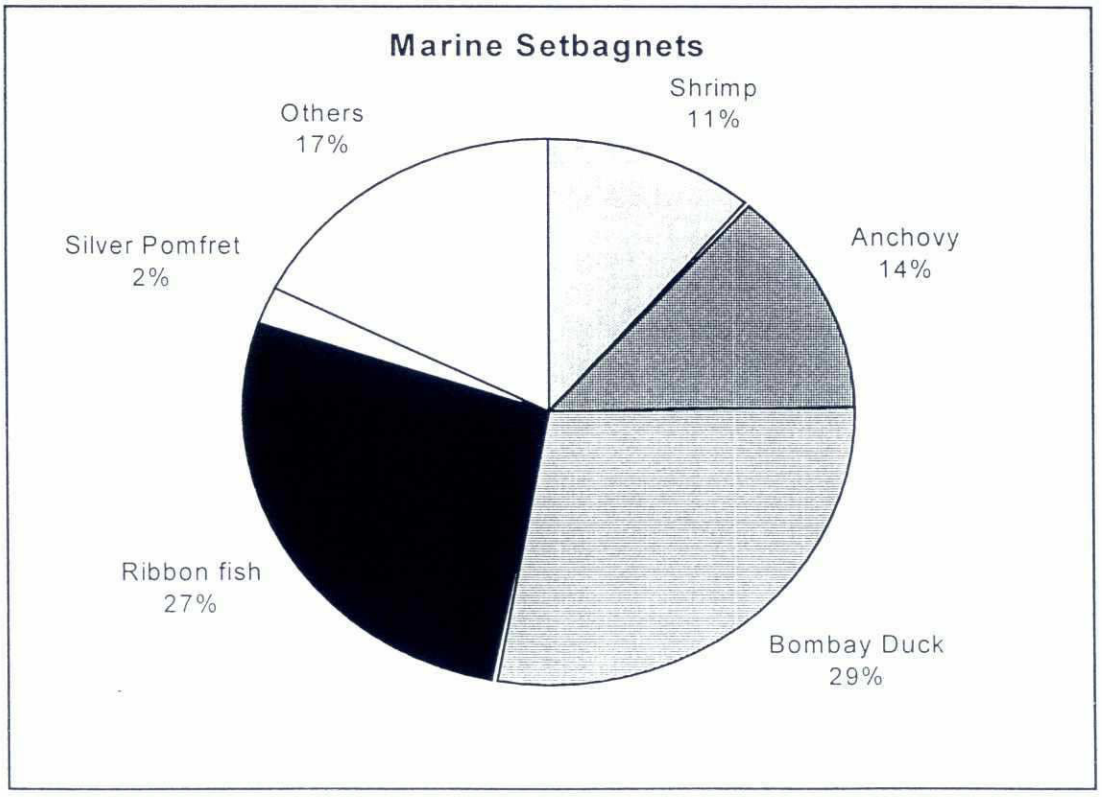
Figure 3.30: Monthly catch, effort and CPUE for MSBN at Sonadia,1990/91




Source: Quayum et al., 1993

The majority of the catch of MSBN consists of Bombay Duck, Ribbon fish and Anchovy (Figure 3.31).

Figure 3.31: Species composition of MSBN in the coastal areas




Source: Quayum et al., 1993

*Bottom trawling*

The scale of the industrial marine fisheries in Bangladesh is small. It started around 1978/79 and initially there was a rapid increase to about 130 trawlers in 1980/81 a result of a joint venture with Thailand. The fleet declined after a number of years and nowadays about 50 trawlers are officially operating in the coastal area. The number of illegal, foreign trawlers operating is not known.

The trawlers are operating in the deep water areas (30-80 m) and the principal species caught are Brown shrimp (*M. Monoceros*) and Tiger shrimp (*P. Monodon*). Among the fin fish, Silver and Black Pomfret (*Pampus argenteus* and *Formio niger*), Grunts (*Pomadasys spp*), Indian Salmon (*Polynemus spp*), Snapper (*Lutjanus spp*), Goatfish (*Mullidae*), Croaker (*Sciaenidae*), Mackerel (*Rastrelliger spp*) and Lizardfish (*Sauridae*) are of importance (Mustafa and Khan, 1993[23]).

The BFRSS reports annual catches in the order of 3,000 mt per year for shrimps and 7,000 mt per year for fin fish. However comparing these data with catches as registered by DoF under the Bay of Bengal programme (Mustafa and Khan, 1993) it seems that the BFRSS only reports the commercial important catch as during 1989/90, 56,000 mt was caught by the trawlers of which 2,700 mt was Penaeid shrimp, 6,900 mt was high valued fin fish, 26,500 mt was low valued by catch, 14,500 mt was trash fish and 5,400 mt were other discarded species such as cuttlefish, crab etc.

The small scale of the industrial fishing fleet makes data collection on catch and effort easier compared with the artisanal fisheries. Data for the trawl fisheries are provided on a haul by haul basis by the captains of the trawlers to DoF after each trip. The catch and effort data obtained from the trawlers allows to use the BFRSS for more then only publishing catch statistics, they also can be used to formulate fisheries management strategies for trawl fishing.

The traditional methods are the surplus production models of Schaefer[24] (1954) and Fox[25] (1970). Surplus production levels determine the optimum level of effort, that is the effort that produces the maximum yield that can be sustained without affecting long term productivity of the stock, the so-called maximum sustainable yield (MSY). The surplus production models can be applied when reasonable estimates are available by total catch (by species) and the Catch per unit of effort (CPUE) and the related fishing effort over a number of years. A prerequisite is that the effort must have undergone substantial changes over the period covered. This is the case for shrimp trawling in the coastal area of Bangladesh.

The Schaefer model plots the CPUE as a function of the fishing effort on a linear model;

$$CPUE = a + b^* \text{ fishing effort}$$

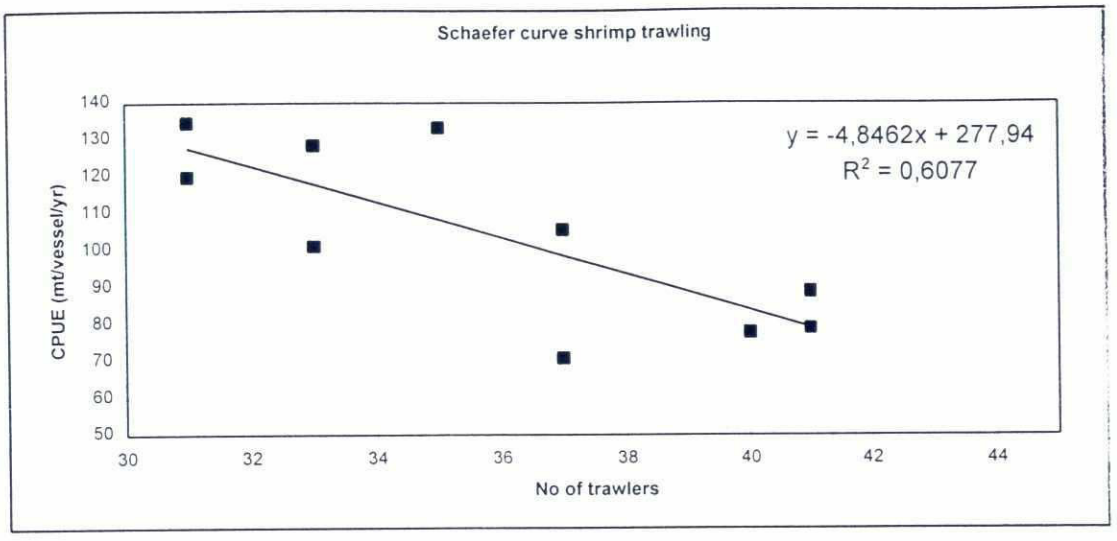
This plot for shrimp trawling is presented in Figure 3.32.

[23] Mustafa and Khan, 1993. The bottom trawl fishery, BOBP/WP/89

[24] Schaefer, M. Some aspects of the dynamics of populations important to the management of the commercial marine fisheries. Bull. 1-ATTC/Bol.CIAT. 1(2):27-56.

[25] Fox. W.W., 1970. An experimental surplus-yield model optimising exploited fish populations. Trans. Amer. Fish. Soc., 99(1): 80-88.

Figure 3.32: Schaefer curve for shrimp trawling in the coastal areas

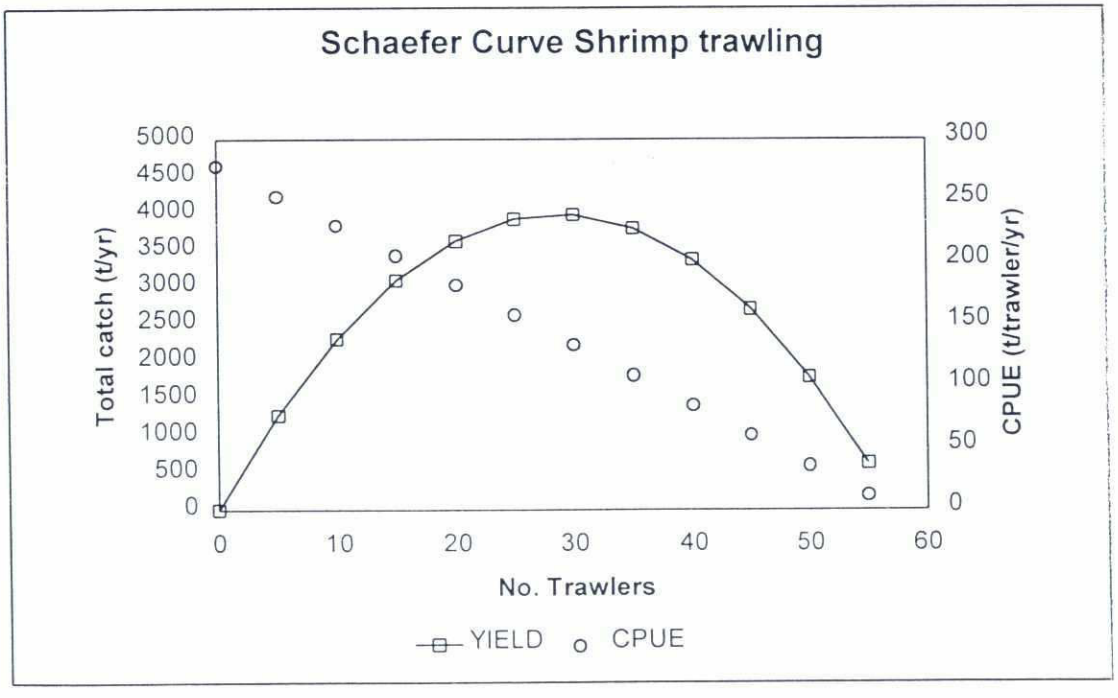



The maximum sustainable yield is then calculated by:

$$MSY = - 0.25 * a^2/b$$

A complete Schaefer plot with Yield and CPUE is shown in Figure 3.33.

Figure 3.33: Yield and CPUE derived from a Schaefer curve for shrimp trawling




The analysis indicates a MSY of about 3,900 mt of shrimp per year with a maximum fishing effort of 31 shrimp trawlers. Mustafa and Khan (1993) carried out a more sophisticate analysis based on trawling hours and boat days and arrived at MSY values for Penaeid shrimps of 4,145 mt per year and 4,329 mt per year.

It would mean that the present number of shrimp trawlers can not be increased and that the maximum exploitation level is reached or that fishing is carried out already above the maximum level. The latter is further supported by the exploitation rates and yield per recruit curves from the length based stock assessment data of Penaeid shrimps (see chapter 3.5)

The data of fin fish trawlers or the data of the artisanal fisheries could not be used this way, which clearly demonstrates the limitations and short comings of the BFRSS a lack of regular updating of the frame survey.

*Trammel nets*

The use of trammel nets in the Bay of Bengal started about a decade ago, spreading from Thailand to Malaysia, Indonesia, Sri Lanka and India in one direction and through Myanmar to the southeast coast of Bangladesh in the late 1982 (Islam[26] and Khan, 1993). Due to its relatively low investment and its effectiveness on catching shrimp in shallow water the trammel net the fishermen along the coast of Teknaf started to operate the gear and its use spread gradually along the coast of Cox's Bazar.

The trammel net is a kind of gillnet with three panels attached to the same head and ground ropes. The two outer panels have large mesh (150-265 mm) while the inner or middle panel has small meshes (40-45 mm). A complete trammel net consists of 16-25 pieces each with a length of around 28 m.

The trammel net is operated in shallow water at depth of 8-20 m and about 8-20 km from the shoreline. In the between Teknaf and Mohesskhali Island about 400 trammel nets are operated (Islam and Khan, 1993) which is in line with 500 operated in the whole of Bangladesh as estimated by BFRSS.

Trammel nets are used throughout the season but the intensity of use depends on tides, climate and season. The peak season for trammel nets is the winter when the sea is calm.

The total annual production (1989-90) was estimated at 1,750 mt, with a fishing effort of 35,000 boat-days and an average daily catch of 51 kg/boat. This production is almost one third of the estimates of BFRSS.

Islam and Khan (1993) made the following remarks on the trammel nets:

- the trammel nets now operated by country boats seem to be an efficient and economic gear for inshore fisheries
- most catches from trammel nets are pre-adult and adults of shrimp and fish; hence this type of artisanal fishery does not seem to be destructive to the stocks
- if motorised boats are used in this fishery, fishing may be extended to much deeper fishing ground for better catches and revenues.

Some of this will be discussed in chapter 3.5 on stock assessment.



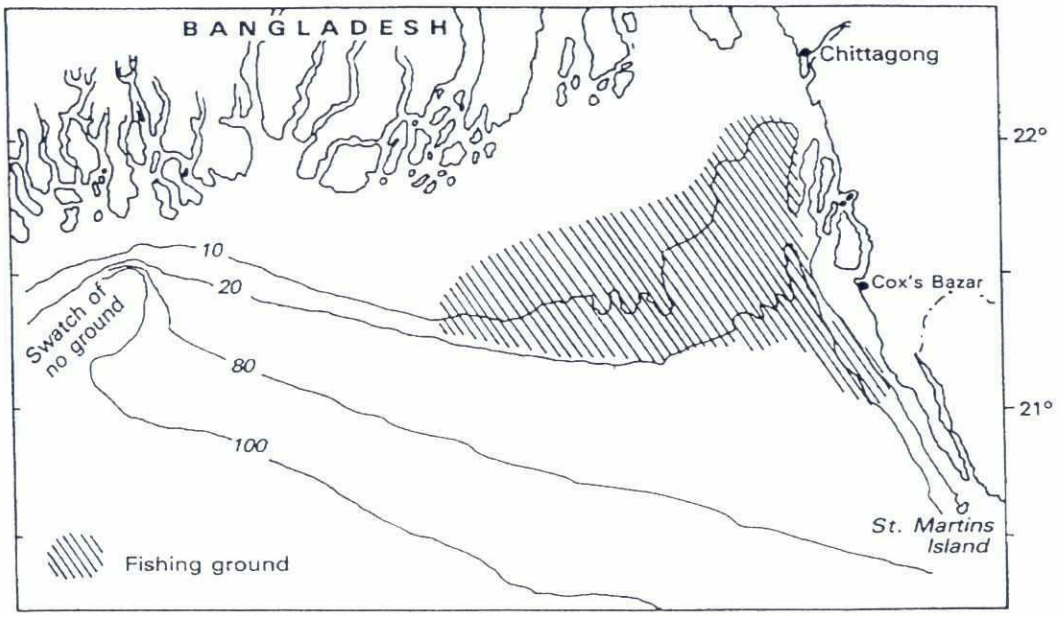
*Longlines*

Fishing with longlines has become more important the last decades as they catch Croakers for the export market. Longlining for Croakers is conducted in the areas south of Chittagong, Noakhali and Patuakhali and southwest of Cox's Bazar in areas with 10-30 metres of water depth[27]. The fishing grounds for longlines are shown in

[26] Islam and Khan, 1993. The trammel net fishery, BOBP/WP/89

[27] Huq et al., 1993. The bottom longline fishery for Croaker (Sciaenidae). BOBP/WP/89,

Figure 3.34: Fishing grounds for Croaker bottom longlining




Source: Huq et al., 1993

Longlines are operated from motorised boats and in 1991 their number was estimated at 280, this number however was estimated through production figures and not through a frame survey. BFRSS estimated that 1380 longline units are used in the coastal area.

Longlines are operated from mid August to mid February and fishing is only done during the neap tide period. At the beginning and the end of the season only day trips are made while during the peak season (October-January) the fishing trips can last 3-4 days.

The average daily catch of a longline unit is 175 kg of which about 100 kg is Croaker. The main targeted species for longlining are; Silver pennah Croaker (*Pennahia argentata*), Belanger's Croaker (*Johnius belangerii*), Spotted Croaker (*Protonibea diacanthus*) and Pama Croaker (*Otolithoides pama*). During the BOBP programme no estimate of the total annual catch of the longlines was not made due to the absence of frame survey data. But the production could be in the order of 20,000 mt per year if the frame data of BFRSS (1380 units) are combined with the BOBP data of an average effort of 90 days per unit and an average daily catch of 175 kg per unit (all species).

***Pushnets for Bagda fry catching***

Pushnets or fixed bagnets used for catching Bagda fry are not yet covered by the BFRSS. Due to the economic importance of this activity and its eventual impact on other gears catching Bagda (see chapter 3.5) available data are presented in this chapter.

Large number of shrimp post larvae are taken out from the shallow nursery areas in the estuarine waters by gears such as pushnets, fixed bagnets and dragnets in order to need the demand of the shrimp farming industry.

Shrimp fry collection was studied by DoF Chittagong under the Bay of Bengal Programme in 1989/90[28]. The survey indicated that about 300,000 Bagda fry gears are operated in the coastal area of Bangladesh (Table 3.23) with the highest number operated in Cox's Bazar.

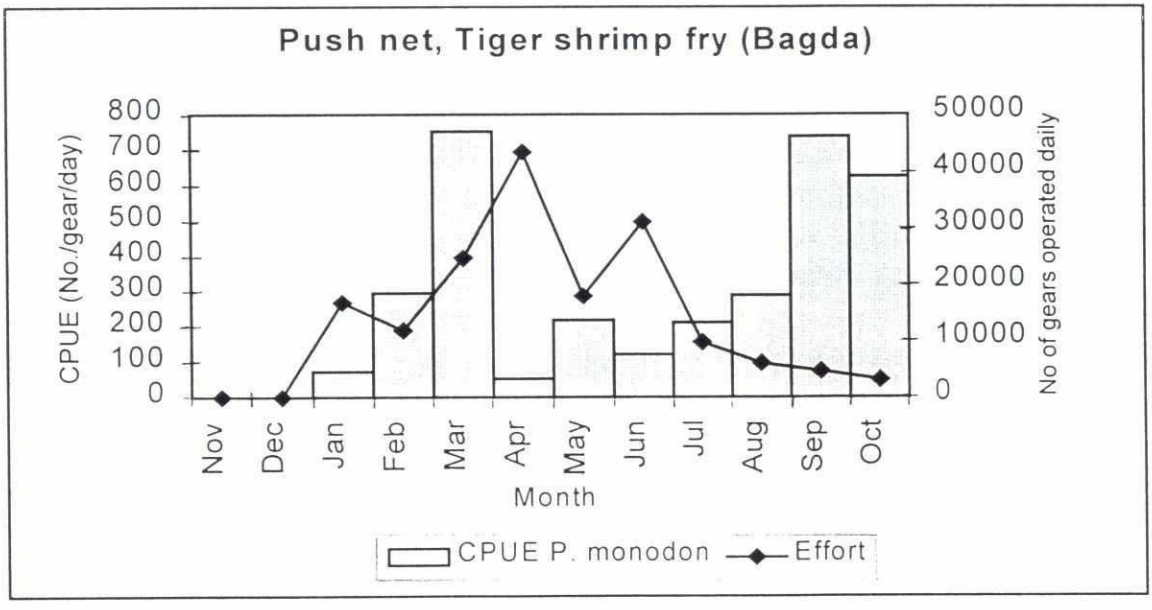
Table 3.23: Pushnets and fixed bagnets used for *P. Monodon* fry collection, 1989/90

| Month | TEKNAF | | COX BAZAR | | PATUAKHALI | | KHULNA | | SATKHIRA | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PN | FBN | PN | FBN | PN | FBN | DRAG | FBN | PN | FBN | |
| Nov | | | | | | | | | | 1631 | 1631 |
| Dec | | | | | | | | | | 1398 | 1398 |
| Jan | 646 | | 3110 | | | | 5925 | 5925 | 6990 | 46600 | 59096 |
| Feb | 950 | | 10885 | 6220 | | 2077 | | | | | 9247 |
| Mar | 1292 | | 23325 | 1710 | | 30054 | | 1185 | | 116500 | 150741 |
| Apr | 646 | | 31100 | 12440 | | 1385 | | 948 | 11650 | 17708 | 33127 |
| May | 760 | | 17105 | | | | | | | 11650 | 12410 |
| Jun | | | 10107 | | | | | | 20970 | 2796 | 2796 |
| Jul | 1140 | | 8553 | 6220 | | | | | | 1165 | 8525 |
| Aug | 2280 | | 2643 | | 1108 | | | | | 3728 | 7116 |
| Sep | 4636 | | | 1224 | | | | | | | 5860 |
| Oct | 646 | | 2021 | | | | | | 466 | | 646 |
| Total | | | | | | | | | | | 292593 |

Source: Paul et al., 1993

There are two peak seasons in the catch in Bagda fry, one around February/March and another around September (Figure 3.35). These peaks most likely coincide with two spawning periods of *P. Monodon*.

Figure 3.35: Catch per gear and monthly number of pushnets operated in coastal areas




During the peak season about 40,000 pushnets are operated each catching 500-700 Bagda fry per day. In 1989/90 the annual catch of Bagda fry was estimated at 2 billion, of which 64 per cent was caught by pushnets and 81 per cent was caught in Cox's Bazar. The same study estimated that only 1 per cent of the total catch, composed of all kinds of species, is Bagda fry,

[28] Paul et al., 1993. Shrimp fry collection. BOBP/WP/89

the remaining 99 per cent or 185 billion is wasted (Table 3.24) of which the highest wastes were occurring in the Satkhira area.

Table 3.24: Total pushnet and fixed bagnet catch and number of Bagda fry caught

| **Total catch** | **187** | **billion** |
|---|---|---|
| fish larvae | 20 | billion |
| Non Penaeid, plankton etc. | 100 | billion |
| Penaeid | 21 | billion |
| Bagda fry | 2 | billion |

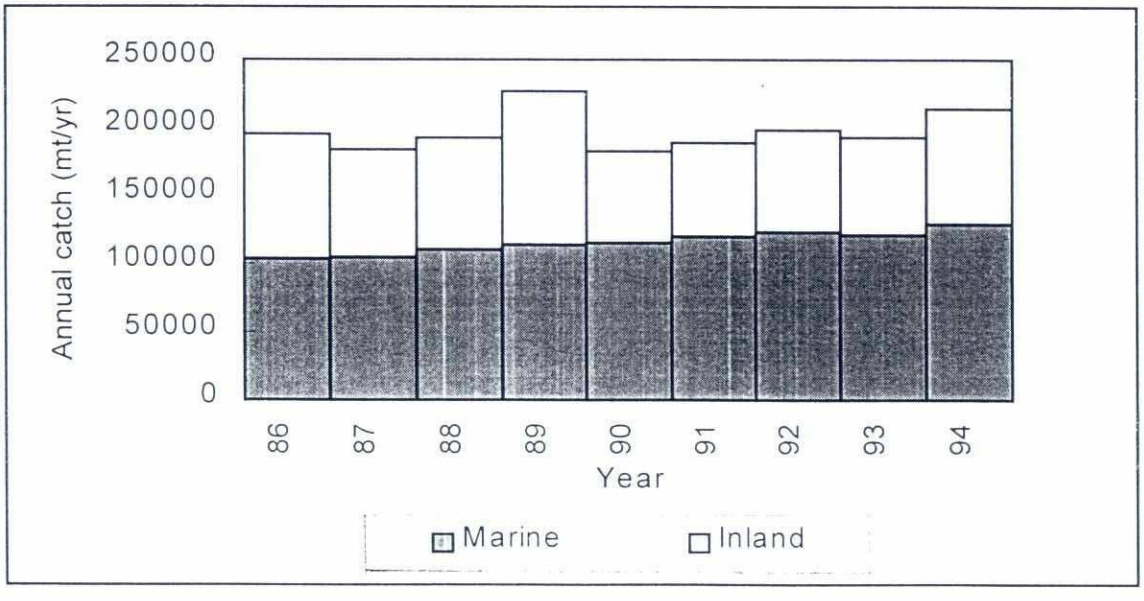
Source: Paul et al., 1993

***Hilsha Fishery***

Hilsha is one of the most important commercial fish species in Bangladesh as it contributes to about 20-25 per cent of the total fish production of Bangladesh. Hilsha is caught in the marine and estuarine waters of Bangladesh and during their migratory run they are caught all over the country in small quantities.

The majority of the Hilsha are caught with Hilsha gillnets which are mostly operated through motorised boats. The number of gillnets operated in the marine waters are published by the BFRSS (Table 3.20), however the number of gears operated more inland in the major rivers can not be extracted and the total fishing effort on Hilsha is therefore not known. The division of the annual Hilsha catch among marine and inland waters is presented in Figure 3.36.

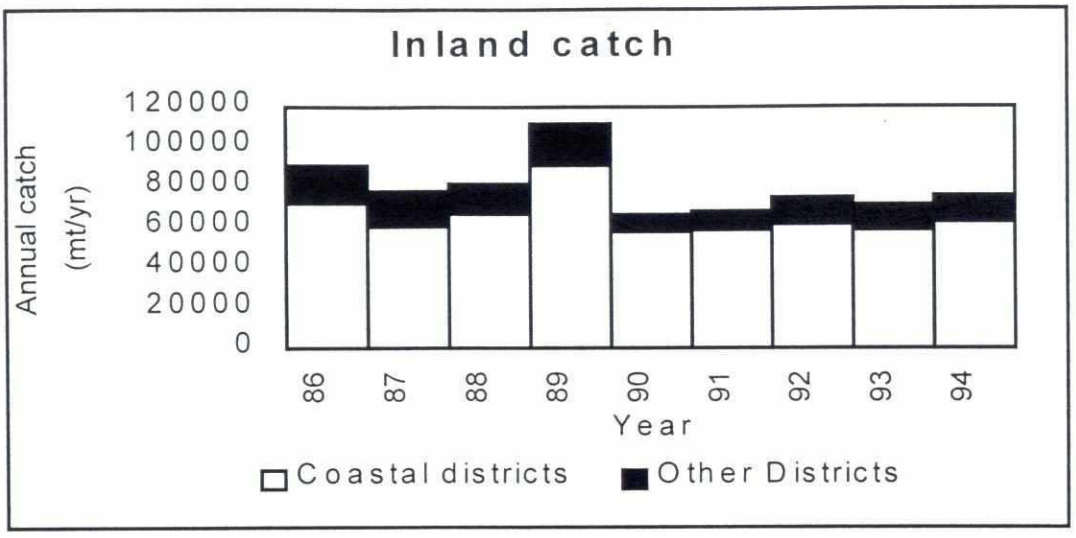
Figure 3.36: Inland and marine Hilsha catch of Bangladesh since 1986/87




Source: BFRSS

The catch statistics reveal that the annual catch fluctuates around 200,000 mt per year Furthermore it seems that the contribution of the marine Hilsha catch to the total Hilsha catch is slightly increasing over the years. The bulk (80 per cent) of the inland catch is still caught in the coastal districts with the Meghna river as the major inland fishing area for Hilsha (Figure 3.37).

Figure 3.37: Distribution of the inland Hilsha catch by district




Around Chandpur, the nursing grounds of Hilsha, every year from November to June "Jatka" or the catch of juvenile Hilsha (2-12 cm) fishing takes place. Officially there is a ban on this type of fishing activity but the practical reality is that still about 3500 mt is caught each year. The impact of this activity will be discussed in chapter 3.5.

## 3.5 Stock assessment

For the development of a fisheries management strategy, fisheries scientists and policy makers want to know what the present status of their fish stock is and what the impact of fishing on their fish stocks will be. Within the last century a number of tools, fish stock assessment programmes, have been developed which can visualise the interactive processes between fishing and fish stocks. Fish stock assessment programmes and their models can be grouped into:

- Holistic models, which use a limited number of parameters and consider the fish stock as a homogeneous biomass.
- Analytical models, which are based on a detailed description of the stock and take into account the length or age structure of the stock, mortality rates, growth rates etc.

### 3.5.1 Holistic models

The best known holistic models are "the swept area method production models" and "the surplus production models". Both types have been used to a limited extend in Bangladesh.

*Swept area models* are used in situations where almost no data are existing or in the case of unexploited resources. The method is based on research trawl catches per unit of area. From the densities observed and estimate of the biomass at sea is made from which finally the MSY is estimated. This method is rather imprecise and predicts only the order of magnitude of MSY. In Bangladesh this method was used for the estimation of the MSY of the marine offshore fish stocks (chapter 0).

*Surplus production models* such as the Schaefer or Fox models, use Catch per unit of effort in relation to the fishing effort as basic input. The models are based on the assumption that the biomass in the sea is proportional to the catch per unit of effort. Surplus production models use long-term data series as obtained from fisheries statistics, such as the BFRSS, but can only be used if substantial changes of the fishing effort has taken place over time. Surplus production models have been applied in Bangladesh for the estimation of the MSY of shrimp trawlers.

Unfortunately the models could not be used for all other type of fisheries due to the absence of reliable fishing effort data in the BFRSS.

Surplus production models are usually applied to time series of CPUE and effort. A modification of the surplus production model is to apply the model to a dataset collected in one year of different fishing grounds fished with different fishing levels.[29] For Bangladesh it should be studied if this adapted model can be applied for Bagda fry catching as the number of gear per km of shore length varies considerably.

### 3.5.2 Analytical models

Analytical models are based on a detailed description of the stock and require relatively more data and data of higher quality then Holistic models. But it is believed that they produce more reliable predictions. Analytical models looks at the structure of a certain fish stock and makes an analysis with the following basic concepts:

- if there are "too few old fish" the stock is over-fished and the fishing pressure on the stock should be reduced

- if there are "many old fish" the stock is under-fished and more fish could be caught in order to maximise the yield.

Analytical models have been used extensively in the western hemisphere, but it use in tropical waters was hampered due to the fact that most of the models were "aged-based". Age reading of fish is rather easy in the colder waters of the western hemisphere but is difficult or impossible in the tropical waters. The development of "length based" models and the growth of the computer industry since the early 80's made these tools available for tropical fisheries.

In Bangladesh analytical models have been used for inland fisheries by FAP 20 and by a research project of BAU/MRAG in the early 90's. For marine fisheries analytical models have been applied by the Marine wing of DoF Chittagong for the most important species and gears in used in the Bay of Bengal and by FRI for Hilsha fisheries. It should be acknowledged that DoF as well as FRI has started with this activities almost without external assistance. The quality of analytical models depends on the quality of the used data and requires continuous field sampling of length data, all over the season, which is not easily done in the Bay of Bengal. Both DoF and FRI made a primary attempt to apply Analytical models and the results were encouraging. However due to the relative inexperience with the different methods in some cases the analysis was not completed, or some procedural mistakes were made.

The use of analytical models was extensively discussed with DoF-staff, Chittagong and an attempt was made to carry out a complete analysis. Due to time constraints not all species could be analysed and in the next chapter the results of length based analysis of Tiger shrimp (*P. monodon*) is presented. During the seminar on Hilsha fisheries in Bangladesh (March 1998) a paper was presented on the population dynamics of Hilsha by Rahman et al[30], some of the results presented in this paper will be discussed briefly.

*Steps in length based stock assessment*

The theory and mathematics of length based stock assessment will not be discussed here as the are well presented in a number of handbooks on this subject. However the basic principles and steps to be followed will be briefly summarised below:

- A first step of the analysis is to determine growth and recruitment parameters of the selected species. The major parameters are $L_\infty$ the maximum length of the fish, K the

[29] Munro and Thompson, 1983. The Jamaican fishing industry. ICLARM Stud Rev., (7):15-25.

[30] Rahman, Mustafa and Rahman, 1998. Population Dynamics and Recruitment Pattern of Hilsha, *Tenualosa ilisha*. Paper presented at the seminar on Hilsha fisheries in Bangladesh. FRI, March 1998

growth parameter and $t_0$ the relative age at birth. The parameters are used in the von Bertalanffy growth curve. When growth of a species is considered in should cover the growth within the whole population. Here one of the major problems of length based models is encountered "how to estimate unbiased growth parameters". Fish samples are taken from gears in order to estimate the parameters, but most of the fishing gears are selective. A special problem of Bagda is its migration so different lengths of Bagda are caught by different gears at different location in the Bay of Bengal. These problem can be corrected by pooling the gears, or by using only data from non selective gears or by correcting the data for the selectivity of the gears.

- Once the growth parameters for the entire unit of stock have been estimated the impact of the different gears on the structure of the stock is studied. Length data obtained from the different gears, reflect the impact of the gear in terms of mortalities over the different length classes. For example in the catch of a large mesh size gillnet the number of small Bagda caught will be minimal as they swim through the gear, but the number of large Bagda will be high, i.e. the mortality rate of this gear on small Bagda is low and the mortality rate of this gear on large Bagda is high. The second step is to determine the mortality rates of the different gears on the selected species. This is mostly done with a "length converted catch curve" . The input parameters are the unbiased growth parameters and the length frequency data from gear we are studying. The length converted catch curves provides the total mortality rate (Z), the fishing mortality (F), the exploitation rate (E = F/Z) and information on first length at capture and on selectivity of the gear.

- The data obtained in step 1 and 2 can be used in to look at the Yield per Recruit model of Beverton and Holt, obtained for the different gears at different theoretical exploitation rates. An essential input is the length of first maturity of the selected species. This type of analysis gives us a first insight at the exploitation levels of the different gears on the selected species .

- A more sophisticated analysis is the Virtual Population Analysis (VPA) in combination with predictive Thompson and Bell models. Essential for this analysis is that the total catch of the selected species for each gear is known, as in the VPA the obtained length frequencies of a selected gear are raised by the total catch of the selected gear. A major bottleneck in Bangladesh, for this analysis, is the reliability of the total catch data.

A last step in the analysis is to use the VPA data in a multi-gear, multi-species Thompson and Bell predictive model in order to analyse the total fisheries in a certain area.

***Stock assessment of* P. monodon**

Growth parameters for *P. Monodon*, by using the data of all gears grouped, were estimated at $L\infty = 33.2$ cm and $K = 0.92$ year$^{-1}$ . A problem with the data was that all data were already raised with catch data and that this raising was done linear, without taking into consideration the changing body weights at the different length classes. The data should be fitted through the original LF data, further there is evidence of seasonal growth, which has not been taken into consideration yet.

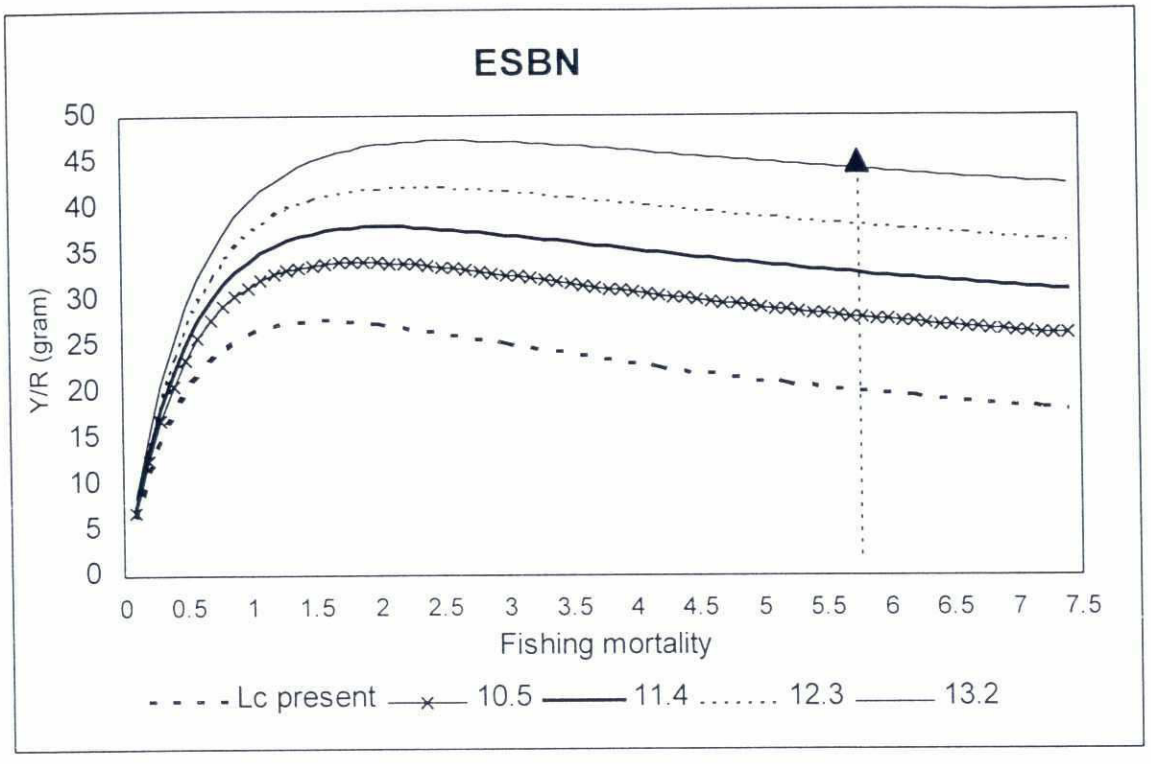
The growth parameters were used to determine mortality rates for the different gears and they are presented in Table 3.25.

Table 3.25: Mortality rates of *P. Monodon* for different gear used

| Parameter | ESBN | Trammel net | Trawler | Pushnet |
|---|---|---|---|---|
| Total mortality (Z) | 8.57 | 3.27 | 4.47 | not realistic |
| Fishing mortality (F) | 6.97 | 1.67 | 2.87 | not realistic |
| Natural mortality (M) | 1.6 | 1.6 | 1.6 | 1.6 |
| Exploitation rate (E) | 0.81 | 0.51 | 0.64 | not realistic |
| $Lc_{50\%}$ | 8.77 | 16.03 | 19.77 | not realistic |

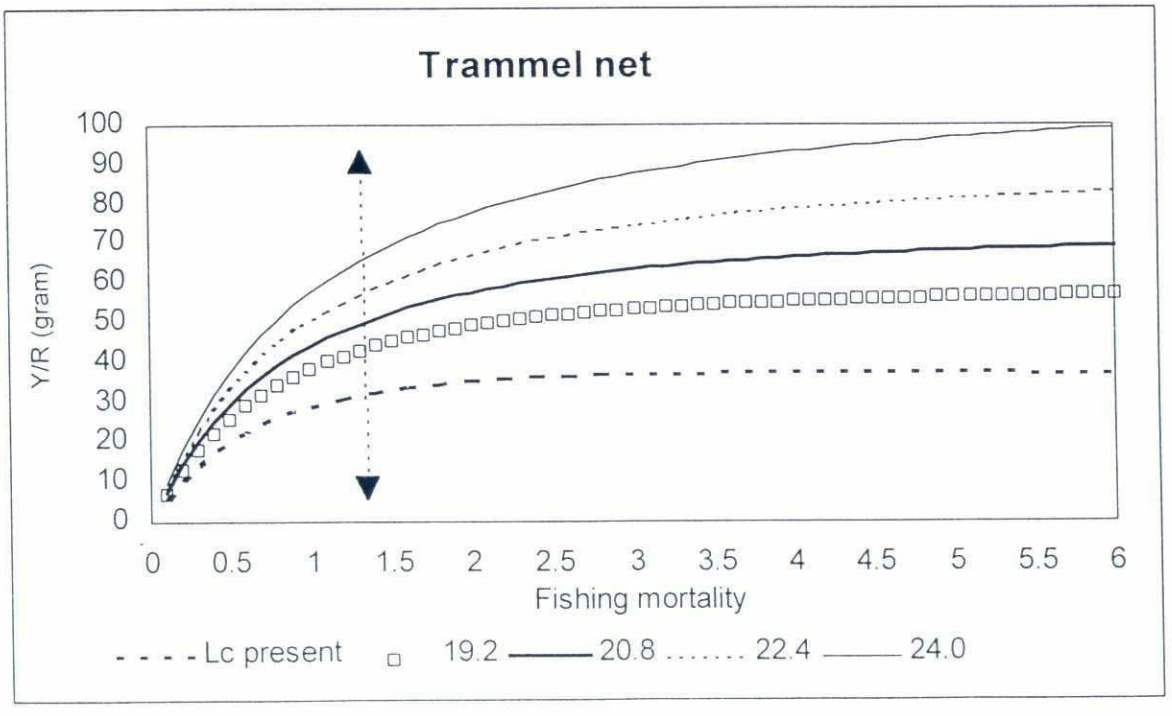
Yield per recruit curves, calculated with a length of first maturity of 16 cm, for ESBN, Trammel nets and Trawlers are presented in Figure 3.38, Figure 3.39 and Figure 3.40.

Figure 3.38: Yield per recruit of *P. Monodon* for estuarine set bagnets.



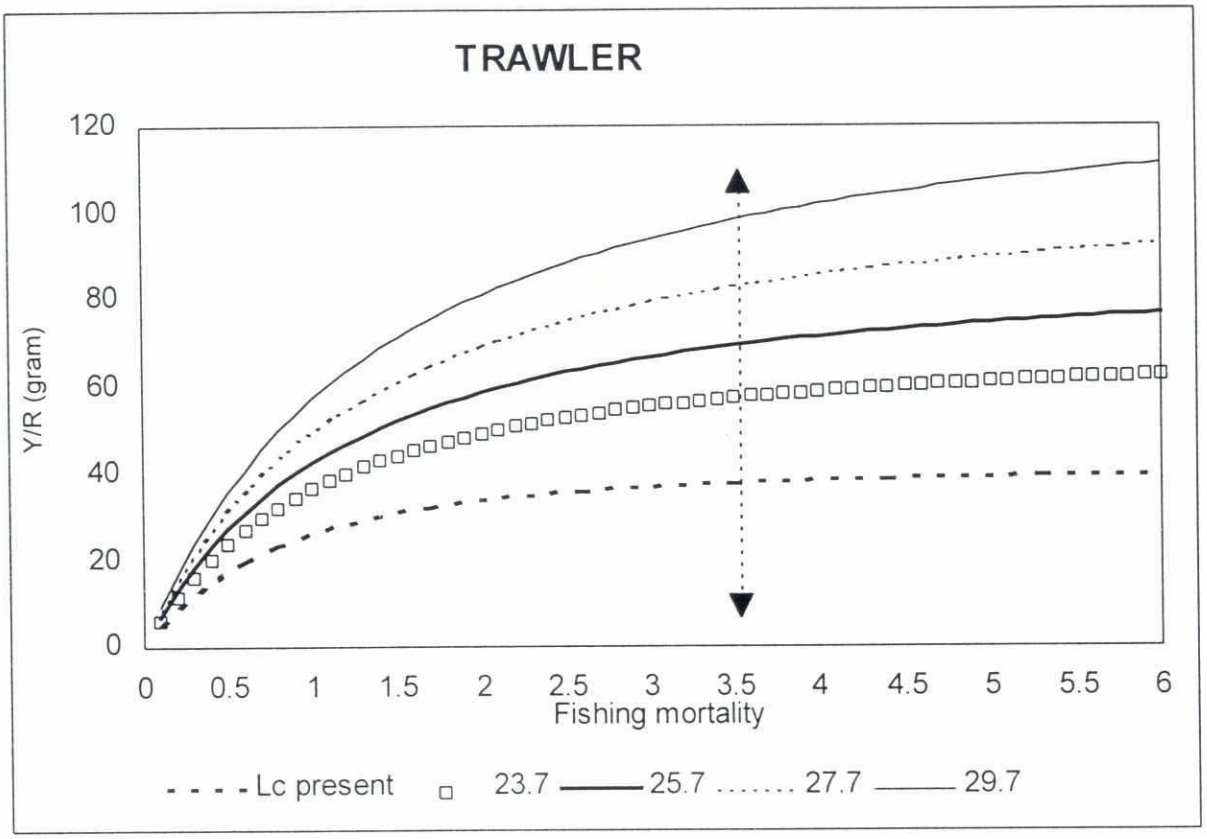

For ESBN it is clear that with the present fishing mortality of 6.97 (dotted arrow) over-exploitation takes places. Increasing the LC50 per cent by increasing the mesh size would improve the situation somewhat.

Figure 3.39: Yield per recruit of *P. Monodon* for trammel nets



For trammel nets with a fishing mortality of 1.67 the situation is reasonable as we are around the optimum/maximum fishing effort.

Figure 3.40: Yield per recruit of P. *Monodon* for trawlers




With a fishing mortality of 4.47 it seems that the trawlers are operating around or slightly below the optimum/maximum effort.

The VPA arrays were calculated for the different gears (Table 3.26) and used as input for a Thompson and Bell analysis.

Table 3.26: Results of virtual population analysis of *P. Monodon* for different gears used in the coastal areas

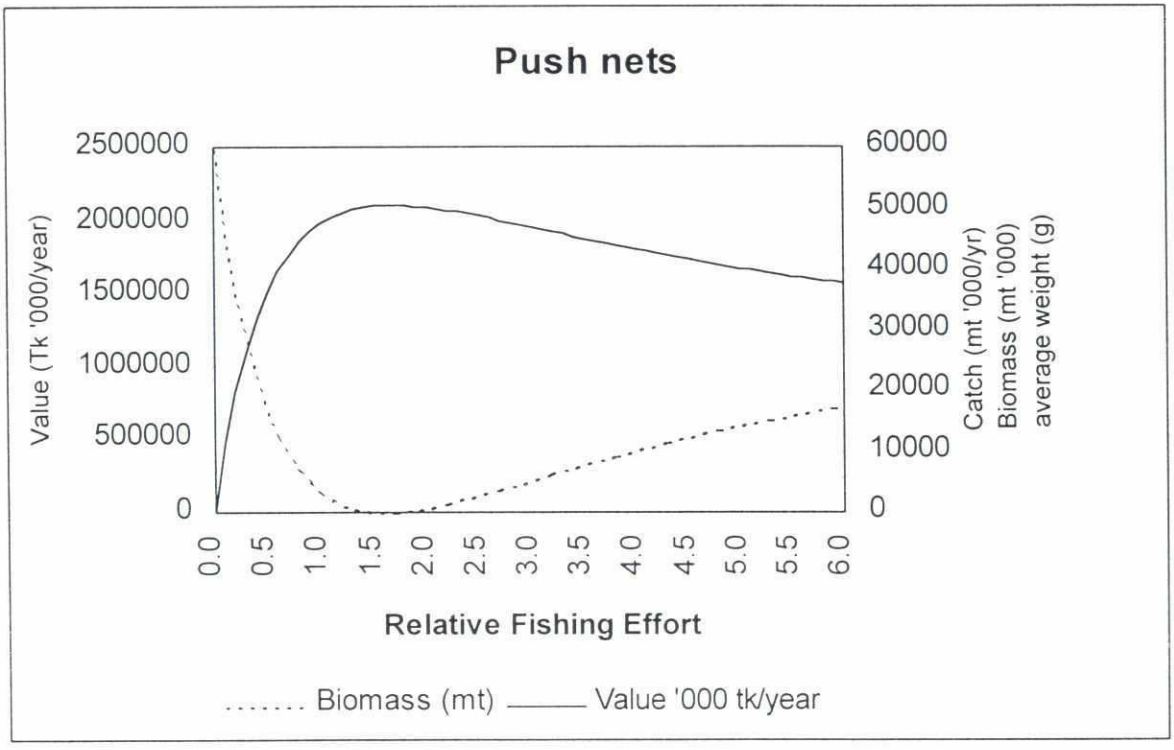
| Pushnet | | | | ESBN | | | Trawl | | | Trammel | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Class | Population | F-array | Catch (N) | Population | F-array | Catch (N) | Population | F-array | Catch (N) | Population | F-array | Catch (N) |
| 1 | 2152000000 | 41.28 | 1576194000 | 6922626 | 0 | 0 | 21000000 | 0 | 0 | 575347 | 0 | 0 |
| 2 | 513061000 | 44.5 | 394048000 | 6564012 | 0 | 0 | 24614898 | 0 | 0 | 544174 | 0 | 0 |
| 3 | 104422000 | 1 | 39404000 | 6213596 | 0 | 0 | 23300741 | 0 | 0 | 513773 | 0 | 0 |
| 4 | | 0 | | 5871356 | 0 | 0 | 22017355 | 0 | 0 | 485147 | 0 | 0 |
| 5 | | 0 | | 5537391 | 0 | 0 | 20765000 | 0 | 0 | 455303 | 0 | 0 |
| 6 | | 0 | | 5211775 | 0.04 | 7145 | 19543952 | 0 | 0 | 427245 | 0 | 0 |
| 7 | | 0 | | 4887660 | 0.20 | 38986 | 18354495 | 0 | 0 | 399980 | 0 | 0 |
| 8 | | 0 | | 4541682 | 0.41 | 75939 | 17196931 | 0 | 0 | 373513 | 0 | 0 |
| 9 | | 0 | | 4171084 | 0.48 | 83226 | 16071570 | 0.03 | 0 | 347850 | 0 | 0 |
| 10 | | 0 | | 3807139 | 0.33 | 55546 | 14978744 | 0.02 | 18660 | 323000 | 0.00 | 2 |
| 11 | | 0 | | 3484205 | 0.21 | 34276 | 13900814 | 0.15 | 13754 | 298965 | 0.02 | 32 |
| 12 | | 0 | | 3194219 | 0.47 | 70439 | 12862202 | 0.10 | 93485 | 275727 | 0.01 | 162 |
| 13 | | 0 | | 2880525 | 1.80 | 248951 | 11781645 | 0.19 | 58577 | 253201 | 0.03 | 458 |
| 14 | | 0 | | 2409879 | 4.28 | 485671 | 10775915 | 0.21 | 106652 | 231247 | 0.08 | 964 |
| 15 | | 0 | | 1742472 | 9.81 | 726638 | 9763200 | 0.35 | 115480 | 209699 | 0.20 | 2416 |
| 16 | | 0 | | 897368 | 37.09 | 780378 | 8785772 | 0.46 | 179342 | 187716 | 0.50 | 5636 |
| 17 | | 0 | | 83327 | 10.59 | 39667 | 7792721 | 0.38 | 216476 | 163778 | 1.08 | 10804 |
| 18 | | 0 | | 37669 | 9.14 | 16816 | 6816455 | 1.20 | 167884 | 136398 | 1.61 | 13990 |
| 19 | | 0 | | 17907 | 12.88 | 10469 | 5942753 | 1.37 | 474727 | 108046 | 2.16 | 15505 |
| 20 | | 0 | | 6136 | 1 | 2360 | 4832634 | 2.10 | 469676 | 80699 | 2.68 | 15006 |
| 21 | | 0 | | 0 | 0 | 0 | 3816288 | 4.49 | 586896 | 56468 | 3.31 | 13479 |
| 22 | | 0 | | 0 | 0 | 0 | 2781166 | 2.59 | 886989 | 36276 | 4.62 | 12186 |
| 23 | | 0 | | 0 | 0 | 0 | 1578377 | 2.55 | 338575 | 19736 | 4.66 | 7138 |
| 24 | | 0 | | 0 | 0 | 0 | 1030762 | 3.88 | 235620 | 10069 | 3.68 | 3214 |
| 25 | | 0 | | 0 | 0 | 0 | 647243 | 2.71 | 227344 | 5393 | 1 | 2035 |
| 26 | | 0 | | 0 | 0 | 0 | 326147 | 3.08 | 93679 | 0 | 0 | 0 |
| 27 | | 0 | | 0 | 0 | 0 | 177242 | 2.84 | 62005 | 0 | 0 | 0 |
| 28 | | 0 | | 0 | 0 | 0 | 82943 | 7.22 | 30365 | 0 | 0 | 0 |
| 29 | | 0 | | 0 | 0 | 0 | 35481 | 1 | 25300 | 0 | 0 | 0 |
| 30 | | 0 | | 0 | 0 | 0 | 4576 | 0 | 1760 | 0 | 0 | 0 |

The VPA for the different gears has been used as input data for a Thomson and Bell analysis. The analysis was carried out in an excel spreadsheet instead of the FISAT module.

The Thompson and Bell analysis provides the relation between the relative fishing effort which is 1 for the present situation and the total catch, total value of the catch, the average weight of the caught species and the total biomass..

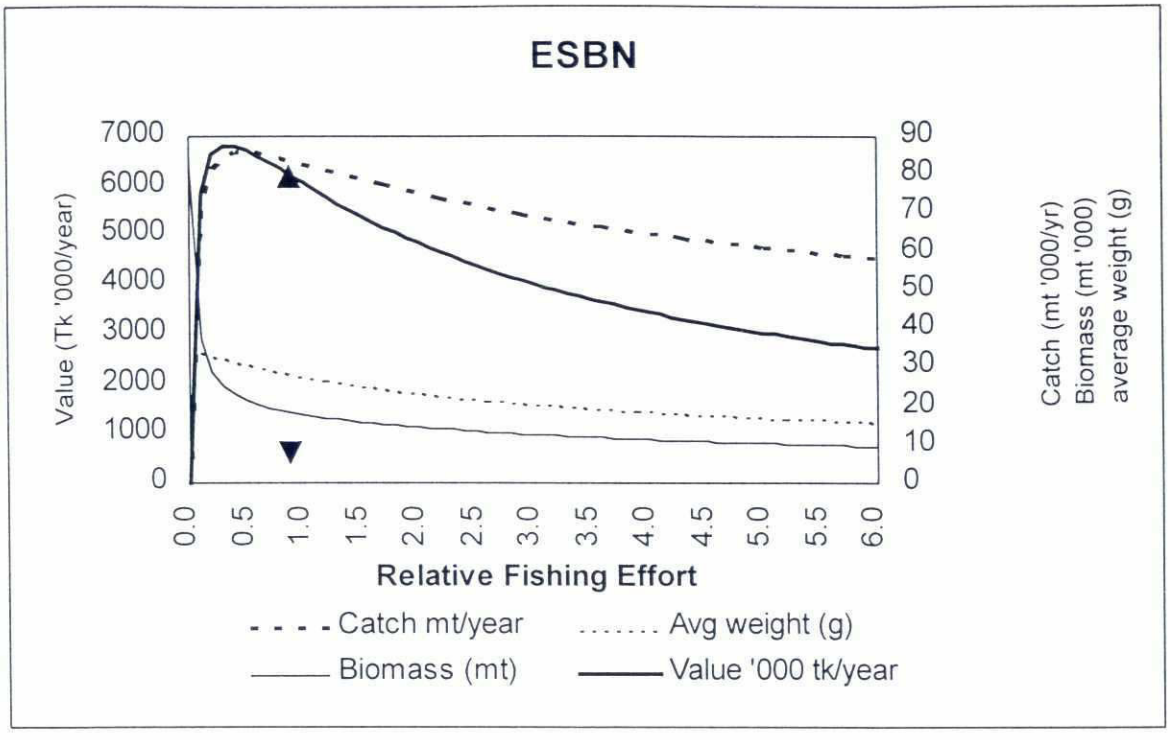
The results of the Thompson and Bell analysis for *P. Monodon* and the different gears are presented in Figure 3.41, Figure 3.42, Figure 3.43 and Figure 3.44.

Figure 3.41: Thompson and Bell analysis for *P. Monodon* caught by pushnets.



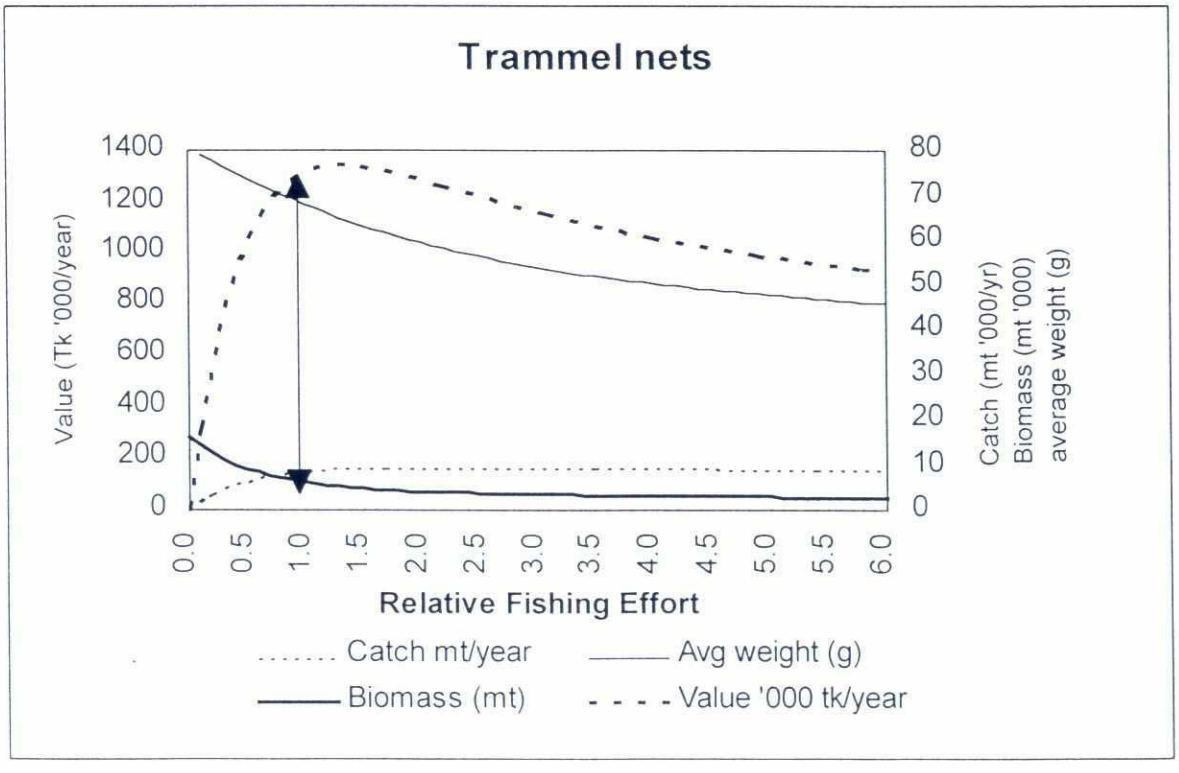

The Thompson and Bell analysis for pushnets does not give valid results. It more or less crashes.. The reason is the high fishing mortalities, with high values of F.Δt the VPA gives negative values and cannot be used.

Figure 3.42: Thompson and Bell analysis for *P. Monodon* caught with ESBN



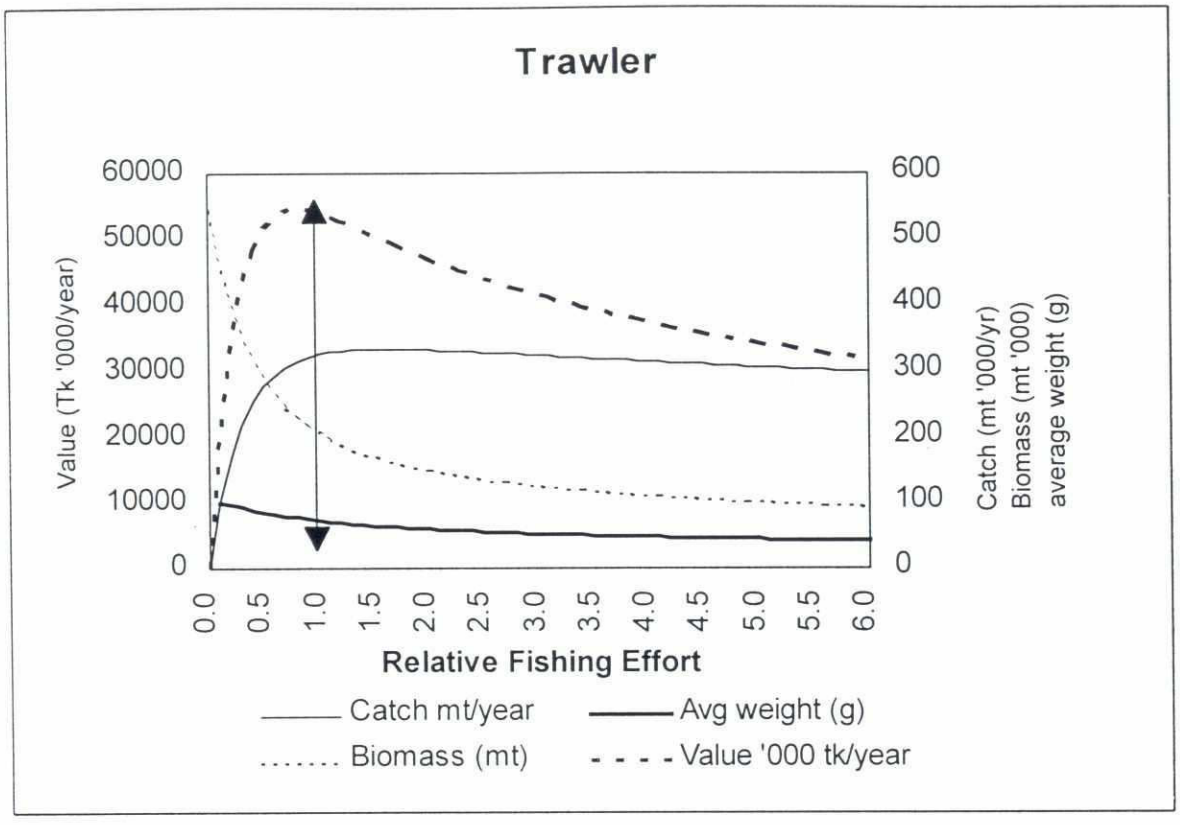

The Thompson and Bell analysis for ESBN indicates again over exploitation for the total catch and for the total value of the catch and the effort should be reduced to at least to 0.5, half of the present level.

Figure 3.43: Thompson and Bell analysis for *P. Monodon* caught by trammel nets




The situation for trammel net is relatively good as the present fishing effort is just below the maximum effort for total catch as well for total value of the catch.

Figure 3.44: Thompson and Bell analysis for *P. Monodon* caught by trawlers

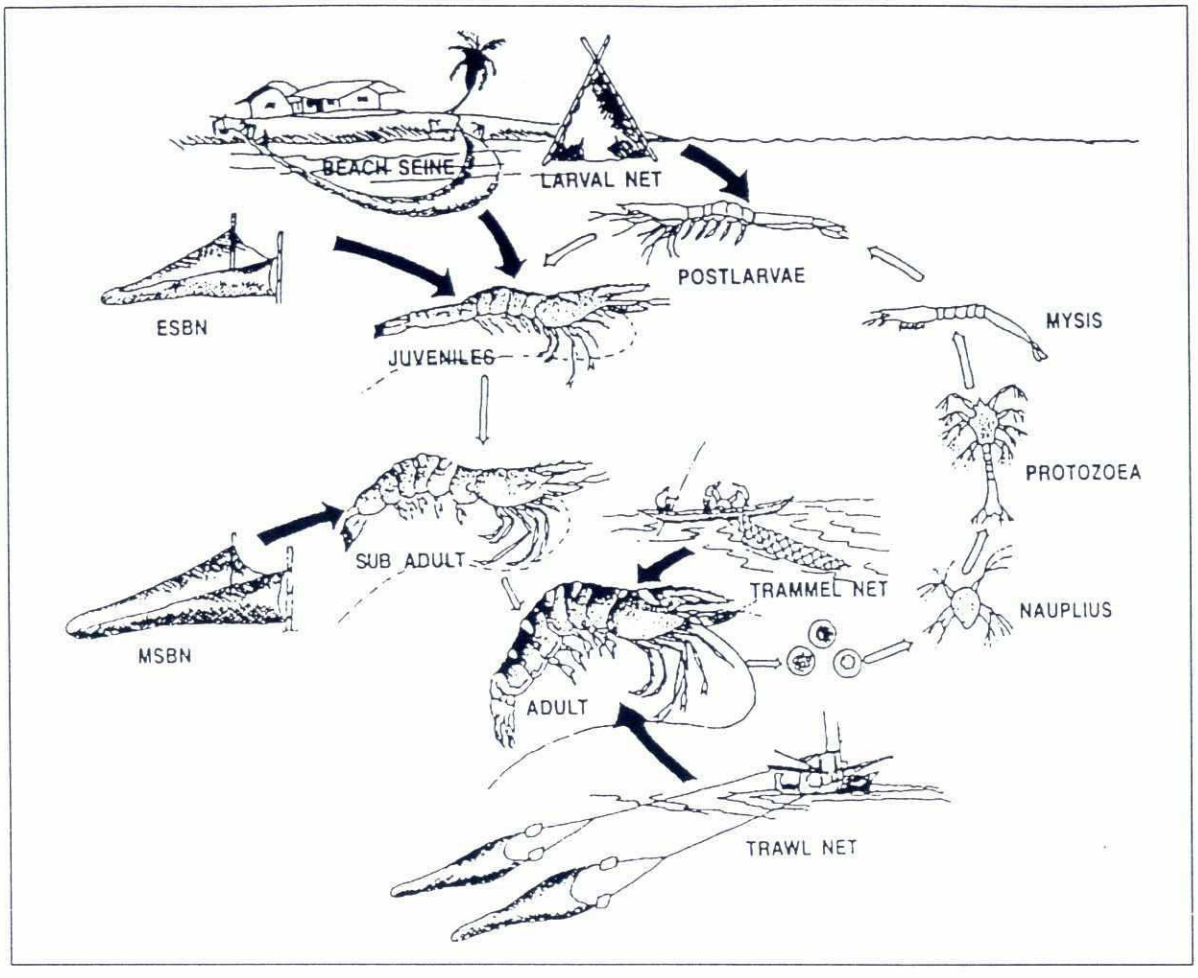



The situation of the trawlers is relatively good. Their is a slight over fishing for value. This as the size of the Bagda would increase by reducing the effort with 25 per cent. The present fishing effort is around the maximum if the annual catch is considered.

The above presented results of the Thompson and Bell analysis is a static one, it looks only at the impact of changing the effort of one gear upon the catch of that gear.

Shrimp fisheries in the Coastal area is a complex cycle as during different parts of its life cycle they are "hunted" with different gears (see Figure 3.45).

Figure 3.45: Different types of shrimp fisheries in the coastal area of Bangladesh




Adult shrimp are fished by the trawlers in the offshore areas. Their offspring are drifting towards the estuary/coastal waters were they are fished by thousands of pushnets and fixed bag nets. The juveniles are migrating back to sea and encounter numerous Estuarine Set bagnets and finally the sub adults are fished by the Marine Set bagnets.

In principle we would like to have a more interactive model which could simulate the impact of reducing the effort of one gear on the catch of the other gears. With the present available data such an interactive model can not be made for the four different gears. The impact of the pushnets would be too high.

This as Thompson and Bell models assume a constant natural mortality over the different length classes and over the different gears. For post-larvae and juveniles this is however not the case as high natural mortalities are occurring during the early life stages. Incorporating the pushnets in an interactive model and then reducing the effort of pushnets would lead to a tremendous over estimation of the resulting catch of the other three gears.

An interactive model (Thompson and Bell or BEAM4) could be made for three gears, ESBN, trammel nets and Trawlers. A major excercise is the calibration of such a model for the present fishing effort by manipulation of the data in the overlapping length classes of the different gears. Within the time frame of the present study such a model could not be made. But a small proposal has been written in order to finalise the model in co-operation with DoF and FRI staff members (see section 7.1.5).

*Hilsha stock assessment*

Due to the importance of Hilsha over the years a number of stock assessment studies have been carried out for this species. The results are encouraging, but at the same time it must be realised that it is just a start a Hilsha, due to its migratory behaviour, is difficult to study. A second problem that the major gear used in the fisheries is the "selective gillnet" This is clearly demonstrated in the length frequency data of the study of Rahman et al., 1998, as no fish below 19 cm are found. Fitting the growth curves through such samples is difficult. Real recruitment is not visible and two distinct recruitment patterns, as would be expected are not found. The VPA clearly indicates that the mortality rates for the Gillnets are starting around 30 cm, i.e. large fish are caught. Estimation of MSY was done by using the biomass estimates of the VPA and applying here the Gulland formula for swept area approach (see 0) continuation with a Thompsonad Bell analysis would most likely provided more reliable results for the Gillnets.

Stock assessment for Hilsha is a priority, especially if the scientific discussion on the ban of "Jatka fishing" is considered. A multi gear stock assessment programme which covers Jatka and adults, in combination with a multi gear interactive T&B model for juvenile and adult Hilsha could end this discussion and provide information for the formulation of a fisheries management policy. Due to the migratory behaviour of Hilsha stock assessment should be carried out with "matched sampled methods" in order to avoid bias.

# 4. AQUACULTURE

## 4.1 Carp rearing

The production of reared carp as indicated by the BFRSS in the coastal districts of Bangladesh is presented in

Table 4.1: Production statistics of reared carp in coastal districts

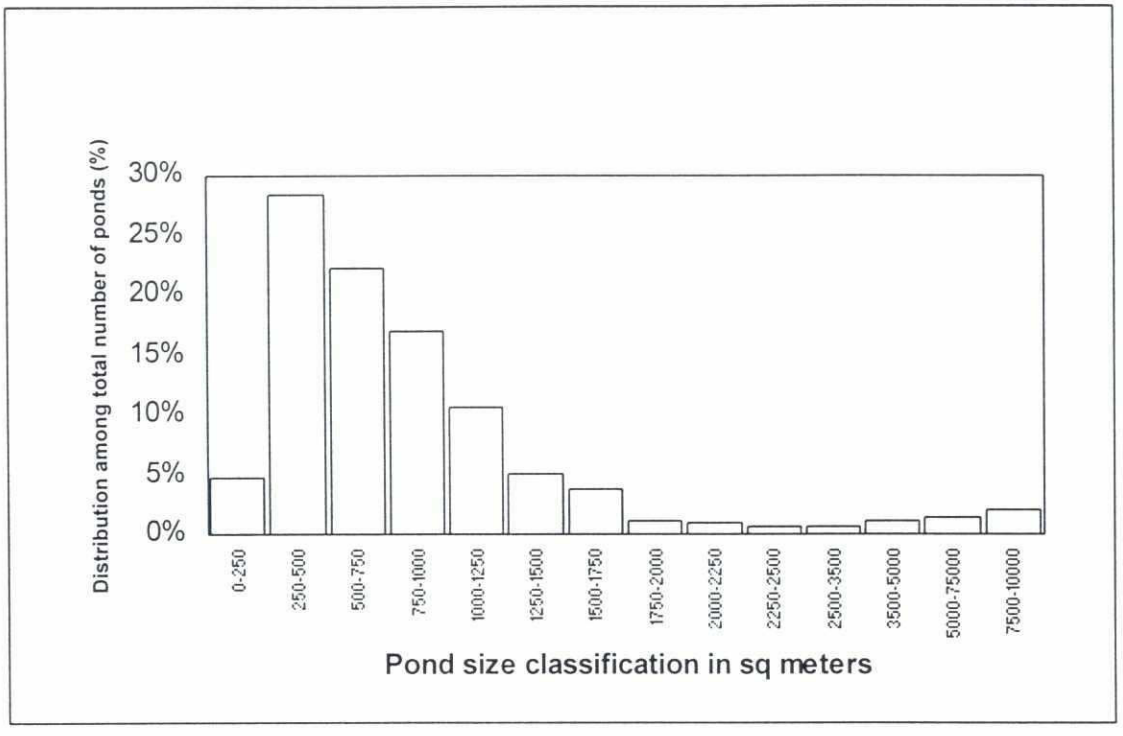
| District | Area (ha) | | | Production (mt/year) | | | Production (kg/ha/year) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Culture | Culturable | Derelict | Culture | Culturable | Derelict | Culture | Culturable | Derelict |
| Barguna | 1465 | 562 | 368 | 2059 | 165 | 58 | 1.41 | 0.29 | 0.16 |
| Barisal | 2454 | 941 | 615 | 3689 | 533 | 168 | 1.50 | 0.57 | 0.27 |
| Bhola | 2799 | 1073 | 702 | 4510 | 616 | 328 | 1.61 | 0.57 | 0.47 |
| Chittagong | 5200 | 4723 | 375 | 12944 | 7161 | 494 | 2.49 | 1.52 | 1.32 |
| Cox's Bazar | 2237 | 2032 | 162 | 3095 | 1833 | 44 | 1.38 | 0.90 | 0.27 |
| Feni | 1401 | 478 | 202 | 2607 | 216 | 65 | 1.86 | 0.45 | 0.32 |
| Khulna | 2108 | 345 | 275 | 3674 | 183 | 63 | 1.74 | 0.53 | 0.23 |
| Laksmipur | 2024 | 691 | 291 | 3013 | 641 | 187 | 1.49 | 0.93 | 0.64 |
| Noakhali | 4347 | 1484 | 625 | 8533 | 693 | 59 | 1.96 | 0.47 | 0.09 |
| Pathuakhali | 2693 | 1033 | 676 | 5328 | 580 | 153 | 1.98 | 0.56 | 0.23 |
| Pirojpur | 1397 | 535 | 350 | 4497 | 661 | 226 | 3.22 | 1.23 | 0.64 |
| Satkhira | 1158 | 190 | 151 | 1905 | 123 | 66 | 1.64 | 0.65 | 0.44 |
| TOTAL | 29284 | 14085 | 4792 | 55854 | 13405 | 1911 | 1.86 | 0.72 | 0.42 |

Source: BFRSS, 1993/94

The statistics indicate that about 43,000 ha is used or suitable (cultured and culturable ponds) for carp rearing. Furthermore the statistics indicate average production levels of 1,800 kg/ha/year for cultured pond, 720 kg/ha/yr. for culturable ponds and 420 kg/ha/yr. for derelict ponds.

The following remarks should be made concerning the statistics. The total area of ponds was calculated in 1988 with the use of satellite images by SPARSSO. This technique allowed only large ponds to be located. A survey of MES indicated that the majority of the fish ponds are smaller than 1,500 $m^2$ (see Figure 4.1) which means that the majority of the ponds are not covered.

Figure 4.1: Distribution and size of fish ponds in South Hatia




Source: MES survey, 1997

Further production figures of 1,800 kg/ha/year for cultured and 420 kg/ha/year is too high and it seems to be the target production. This as a number of aquaculture extension project in Bangladesh (MAEP, FAP 20, ODA) indicated that the average production in traditionally managed ponds is about 800 kg/ha/year Through aquaculture extension projects this production can be increased to 2,000 kg/ha/year

The rearing of carps in fresh water at present is not positively or negatively impacted by the proposed physical interventions of MES. Experiences elsewhere in Bangladesh(FAP 20, MAEP) indicated that a major bottleneck for the development of carp rearing and the relative low production rates is the not proper management techniques used. This is caused by lack of knowledge of the pond owners and operators.

A carp rearing development programme should include the existing ponds, the new ponds to be excavated in the accreted land and a carp culture extension programme.

Carp culture is a well known activity in Bangladesh and therefore the husbandry techniques are not further described.

The present production rate of 825 kg/ha/year can be increased to 2,000 kg/ha/year if proper husbandry techniques are applied. The production rate will be less then the average production rate of 2,200 kg/ha/year as obtained elsewhere in Bangladesh and is caused by physical properties of soil and water in the coastal area. Input and production parameters for optimal production levels of existing or newly excavated ponds are presented in Table 4.2.

Table 4.2: Production parameters for the rearing of carp in fresh water ponds.

| Inputs | Tk/ha | Outputs | |
|---|---|---|---|
| Fingerlings | 1500 | Production (kg/ha/crop) | 2000 |
| Feed | 2700 | Gross Benefit (Tk/ha/crop) | 100000 |
| Fertilisers/lime | 1640 | Net benefit (Tk/ha/crop) | 67000 |
| Rotenone/dewatering | 800 | | |
| Land lease/tax | 1200 | | |
| Manpower | 10640 | | |
| Miscellaneous (10 per cent) | 1848 | | |
| Total | 20328 | | |

Increasing the production of existing ponds and introduction of carp rearing in the newly accreted land can only be achieved if an aquaculture extension programme is carried out in the project area.

The basis of an aquaculture development programme is the transfer of knowledge through extension officer. Experience in FAP 20 indicated that availability of credit is not a prerequisite for a successful programme. Interested pond owners/operators are given a basic training after which the extension officer visited each pond operator once a month at the pond site and provides further on site training. Experience with similar programmes in Bangladesh (FAP 20, MAEP) indicated that one extension officer can cover 60 ponds per year and that it takes two year to bring the pond at the proposed production level of 2,000 kg/ha/year. The costs of a aquaculture extension programme are estimated at Tk 12,000 per ha of pond to be developed (See Table 4.3)

Table 4.3: The costs of an aquaculture extension project

| Area Development Parameters | | | |
|---|---|---|---|
| Average pond size | 2000 | m2 | |
| Total pond area | 200 | ha | |
| Development time | 5 | | |
| No of ponds covered per year | 200 | | |
| No of Ponds/extension officer | 60 | per year | |
| Operating costs per ha | 7027 | Tk/ha | Development of one pond takes two year |
| Total area developed in 5 years | 200 | ha | |
| Investment cost / ha | 4840 | Tk/ha | Investment replaced in 5 years |

| Operating Costs | | | Monthly costs Tk | Annual total Tk |
|---|---|---|---|---|
| Extension officers | 3 | No. | 9000 | 360000 |
| Supporting staff | 1 | No. | 7000 | 84000 |
| Administration | 1 | No. | 9000 | 72000 |
| Petrol | 35 | litre | 3675 | 44100 |
| Training | 60000 | lump sum | | 60000 |
| Logistic support/office | 125000 | lump sum | | 125000 |
| Office costs | 185000 | lump sum | | 185000 |
| annual fish fortnight | 10000 | lump sum | | 10000 |
| Miscellaneous + O&M (15 per cent) | | | | 141015 |
| Total | | | | 1081115 |

| Equipment | | | Costs (Tk./5 year) |
|---|---|---|---|
| Motorcycles | 4 | No. | 616000 |
| Training material | | lump sum | 44000 |
| Office equipment | | lump sum | 220000 |
| Miscellaneous (10 per cent) | | | 88000 |
| Total | | | 968000 |

## 4.2 Shrimp farming

### 4.2.1 Trends and current status

Brackish water shrimp farming in Bangladesh is an important economic activity. The total area under shrimp farming in 1994/95 was 130,000 ha and which constituted 43 per cent of the total aquaculture area. According to the BFRSS shrimp culture produced 34,000 mt in 1994-95 and constituted an estimated 85 per cent of all exported shrimp. In 1996-97 Shrimp export accounted for a foreign exchange earning of Tk 11,889 million. About half a million people are engaged in shrimp farming and related activities.

Shrimp farming is mostly carried out in the low lying polders in the coastal areas, whereby 77 per cent of all farms are located in Khulna, Bagherhat and Satkhira (Table 4.4).

Table 4.4: Distribution of shrimp farms in the coastal areas

| Division | No of farms | Shrimp area (ha) |
|---|---|---|
| Chittagong | 2128 | 29771 |
| Barisal | 59 | n.a |
| Khulna | 10291 | 99918 |

Source: Shrimp Resources Statistics, Department of Fisheries, Central Shrimp Cell, Dhaka, 1995

Shrimp farming in Bangladesh is mostly carried out extensively with low stocking rates (1-2 Pl/$m^2$ ) and low production rates of 100-200 kg/ha/yr. Shrimps are mostly farmed in rotation with agriculture. From February to July shrimp are farmed and once the salinity levels are low, transplanted aman is grown from August to January.

Shrimp farming development in Bangladesh however, lacked careful planning and design. It resulted in what happened in so many other countries: declining yields and massive losses. First in Taiwan (1988: 42,000 t loss), Thailand and Sri Lanka (1989: US$ 27 million loss), thereafter in China (1992/93: the production declined from 200,000 mt to 50,000 mt) and in 1994/95 massive losses were obtained in the semi-intensive shrimp farms in Chittagong. These massive losses are usually referred to as *"the shrimp disease"*, and are caused by a combination of poor planning and design, pond pollution, and outbreaks of viral diseases and finally leads to the fact that shrimp farming becomes an unsustainable activity.

***Non-sustainability of applied practices***

The main reason for the non-sustainability of shrimp farming is its non-planned development. The following factors play an important role.

- Poor pond design and siting. Most of the ponds are large and difficult to manage and depend completely on the tides for water supply. Most of the ponds are however located on relatively high land, which makes proper water management extremely difficult. Secondly, due to its uncontrolled development a proper supply and drainage network does not exist or does not function resulting in the practice that effluent water of one pond will re-enter a neighbouring pond, facilitating transmission of diseases and self pollution among the shrimp farms.

- Shrimp diseases. The development of shrimp farming in Bangladesh led in 1993/94 to the situation that the demand for post-larvae exceeded the supply and prices of post-larvae increased to 0.7-1 Tk/piece during the peak demand. As a result the shrimp farmers started with later stocking, shifted their rearing period and imported shrimp larvae from Thailand and Taiwan. The results were devastating as viral diseases joined the importation. First diseases started in 1994 during the second crop of semi-intensive shrimp farming in Cox's Bazar. The major agent causing the disease was the "China Virus" also know as White Spot disease. Next to the China Virus, heavy infections of Monodon Bacilli Virus (MBV), Type C Baculovirus (T-CBV) and Septic Hepatopancreas with bacterial sepsis was found in imported larvae and shrimps in grow-out ponds. The China Virus infects a wide range of shrimps species such as *P. monodon*, *P. indicus*, *P. Chinensis*, *P. merguensis*, *P. Japonicus* and *P. Vanamei* and it is suspected that planktonic shrimps may be the carriers and that natural stocks are infected. There is no treatment against the China Virus and intensive farms in Thailand and Malaysia changed there water management system and disinfect all their intake water nowadays. In 1994 and 1995 only semi-intensive farms in Cox's Bazar were affected. In 1996 and 1997, however the disease became more severe and affected both semi-intensive and extensive farming systems.

Disinfection of the intake water is not a viable economic option for the shrimp farmers in Bangladesh. All efforts should be concentration on the elimination of the roots of the problem; the unplanned development of shrimp farming and the import of infected post larvae.

## 4.3 Fresh water prawns

The rearing of the freshwater prawn Golda (*Macrobrachium rosenbergii*) increased rapidly from 1,000 ha in 1991 to about 12,000 ha in 1997. The Golda ponds are relatively small (2,500 - 5,000 $m^2$ ), operated by the landowners and often constructed in the low lying beel areas. The principle districts for Golda farming are Bagerhat, Khulna, Pirojpur, Narail, Jessore and Gopalganj. The freshwater prawn is mostly cultured in combination with Indian carps. The ponds are stocked with juveniles (4-6 cm) at a rate of 1-1.5 per $m^2$, fed with snail meat and

agriculture by products. Average production levels are about 700 kg/ha with 50 per cent consisting of Golda. Like shrimp farming, Golda depends almost entirely on the "wild fry" which are caught in the brackish water rivers in the coastal area. There are about 30 to 40 Golda hatcheries in operation producing an estimated 21 million post larvae annually. But the farmers still prefer "wild fry" as they believe that hatchery reared fry are of low quality and do not grow as well as natural fry. Golda farming at present seem to be more socially acceptable and causes fewer environmental conflicts compared with shrimp farming. The major reasons are the relatively small ponds, There are no problems with salinity intrusion and no serious disease problems till present. A point of concern however could be the massive disappearance of snails from the ecosystem and long term impact of the transformation of the low lying wetlands into fish ponds.

## 5. INSTITUTIONAL SETTING OF FISHERIES IN THE COASTAL AREAS

### 5.2 Department of Fisheries

The Ministry of Fisheries and Livestock (MOFL) has the overall responsibility for the fisheries sub-sector in Bangladesh. The specific role is assigned to the Department of Fisheries which acts as the executing branch of MOFL in implementing government policies in the sub-sector. In the field, DoF staff are deployed at Division, District and Thana level.

DoF functions are both regulatory and developmental. The regulatory functions involve policy advise, quality control and the enforcement of laws and regulations which affect the fisheries subsector. Developmental functions largely relate to fisheries resource management and conservation, extension services training and collection of statistical data.

In the coastal area data statistical data are collected by different programmes. Data on marine fisheries is collected by the Marine Production Officer of the Marine Fisheries Department. The former Marine Fisheries Survey Management and Development Project of DoF carries out a separate catch, stock assessment monitoring programme and has two research vessels under its control.. Data on inland waters and shrimp farming in the coastal area is obtained by the BFRSS, within each district one survey officers monitors the different types of fishing habitats, production units. Further data are collected by FRI and by the Thana Fisheries Officers, but this is not a part of FRSS.

Statistical data on fisheries are a major tool for the development of a fisheries management policy. However as discussed in chapter 0 using the collected data for fisheries management is seriously hampered by the lack of an updated frame. The available data most likely reflects the trends as occurring but the absolute values of the different catch categories can be discussed. This problem has been studied by a number of experts since the early 90's and different strategies and projects have been formulated in order to improve the situation. Until present date however, none of the projects have been financed and implemented in the field.

### 5.2 Fisheries Research Institute

FRI was established in 1984 as a semi-autonomous fisheries research institution under the Ministry of Fisheries and Livestock. FRI employees about 80 scientists and has headquarters in Mymensingh. Its primary research covers the following four areas:

- fresh water research at Mymensingh
- riverine research at Chandpur and Rangamati
- marine fisheries at Cox's Bazaar
- brackish water research at Paikgacha.

Its activities initially focused on establishing its physical facilities and developing scientific staff. Research has been conducted on genetic improvement of carp, fish diseases, culture techniques for fry and fingerlings, seasonal pond management practices, fish polyculture in inland culture fisheries, and improved methods of fish nutrition.

At present the assessment of the marine fisheries resources is covered both by FRI and DoF. Whereby, FRI is concentrating mainly on Hilsha, and DoF carries out catch and stock assessment on the remaining gears and species.

There is a serious shortage of manpower within FRI and experienced scientists in resource/fisheries management are limited. It is expected that this situation will improve in the near future as FRI will be supported by the Agriculture Research Project financed by the World Bank which will start somewhere in 1998.

### 5.3 Bangladesh Fisheries Development Corporation

The BFDC was created as an autonomous organisation in 1964. Its activities concern development of infrastructure for preservation, processing, distribution and marketing of fish and fisheries products; surveys of marine fish resources; training; credit; introduction of new fishing techniques; net making; quality control; etc. The BFDC operates a number of fish and shrimp trawlers in the bay of Bengal, manage some large water bodies such as Karnafuli Reservoir, FCDI projects in three areas, i.e. Dhaka, Narayanga and Demra, Gulshan lake, and markets fish in Dhaka by transporting them from Chittagong, Rangmati, Cox's Bazar, Jessore and other places. At present it is not clear what is the actual role of BFDC in fisheries development as it is engaged in a number of commercial activities.

### 5.4 Banking institutions and NGOs

Institutional credit for the fisheries sector is provided by two specialised government owned banks and by four commercial banks, one of the latter is co-operative bank. The specialised banks are Bangladesh Krishi Bank (BKB) and Rajshahi Krishi Unnanyan Bank (RAKUB), and the three nationalised commercial banks are Sonali Bank, Agrani Bank and Janata Bank. The private sector commercial bank with the government as majority shareholder is the Rupali Bank and the co-operative bank is the Bangladesh Samabaya Bank Ltd.

There are several non-governmental organisations which provide credit to landless rural people for fisheries related activities. The most important in terms of volume of lending is the Grameen bank providing short term working capital for activities such as net making, fish trading, aquaculture, etc.

It should however be realised that this is the picture for the whole of the country. Despite the good intentions of a number of NGOs and banks, the situation in the coastal area is somewhat different. As discussed before (see section 3.2.2), the major source of credit for the fishermen in the coastal area is the money lender. The number of banks and large NGOs operating in the coastal area, especially on the remote chars/islands, is limited or not existing at all. If available, they are not adapted to the needs of the fishermen or the lines are too complicated and procedures are too long.

# 6. FUTURE DEVELOPMENTS FOR FISHERIES

In principle development strategies for the fisheries sector are well defined in the Fifth Five Year Plan (1997-202) of the GOB (see Appendix 2).

However as in other countries in the region the policy of GOB is mainly focused on increasing production and income from fishing which seems to be in contradiction with the high exploitation levels of the fisheries. The major effort should concentrate on managing what we have at present before there is none left to manage.

Furthermore the plan does encompass the reality that marine fisheries is one of the few open common resources left in Bangladesh, providing employment or means of livelihood outlet for landless and other limited resource rural inhabitants as reflected by the relatively high growth of the number of fishermen. This movement of population reflects the existence of relatively worse conditions in other sectors and fisheries has become a refuge for people with nowhere else to turn for work. Which means that solutions and strategies for optimal resource management must also be sought outside fisheries and will be a long term and difficult process.

## 6.1 Development strategies

### 6.1.1 Marine fisheries

*Long term strategies*

At present there is a tremendous risk that the marine fisheries will collapse in the near future due to over exploitation of the stocks. From a fisheries management point of view only a reduction of the fishing effort or the use of large mesh sizes can be recommended. Such a recommendation fits well in the traditional sectoral basis of fisheries management, mainly concerned with issues and impacts within the fisheries sector. Traditional fisheries management presupposes that corrective action would be taken by other sectors to eliminate or modify externally generated impacts on the fisheries sector. However this is an illusion and fisheries management demands a more integrated approach within the context of integrated coastal area management and an overall rural enterprise development policy

Fisheries in the coastal areas of Bangladesh is poverty driven. The Bay of Bengal is one of the few open common resources left in Bangladesh, still attracting numerous labourers from the poorest segment of the population. This trend will continue till the moment the system collapse.

In principle there are two major basic problems to be covered in a long term strategy:

- how to encourage existing fishermen already in fisheries to leave the fisheries for good, this in terms of labour and capital
- how to stop the flow of new entrants into marine fisheries.

Both can only be tackled with integrated development projects creating investment opportunities and employment outside the fisheries sector with as basic aim to channel surplus labour to other sectors of the economy. Benefits of such an integrated system of development includes improved education, alternative employment generation, development of rural enterprises, improved communication and access to markets, accessible credit systems, diversification of income sources at household level, awareness building, etc. This will be a long-term and difficult task. There will be a high risk that the system will collapse beforehand as in the whole region only Malaysia[31] succeeded in reducing its fishing labour force, mainly due to its high economic growth and development of the industrial sector.

[31] Ahmad, H..B., 1994. Socio-economic issues in the management of coastal fisheries in Malaysia. In Socio economic issues in Coastal Fisheries Management. Proceedings of the IPFC Symposium, 23-26 November 1993, Bangkok, Thailand, pp 130-137.

*Short term strategies*

The long-term strategies should be covered on a national level and will be a long-term, gradual development process. However in order to try to slow down the process of degradation several actions, summarised below, should be undertaken immediately.

- In co-operation with NGOs an adapted credit programme should be developed for the fisherfolk community in order to reduce their indebtedness to the money lender.

- On a pilot basis a ESBN replacement programme should be executed, which encompasses the introduction of alternative gears, alternative income generation and introduction of credit facilities in order to guarantee a higher fish price The results can be used for the gradual replacement of all ESBN nets in the Coastal area.

- Set up a programme for the reduction of post harvest losses, and improvement of transport and storage fish. This programme should cover the fishermen as well as the fish traders.

- The capacity of fish stock and catch/effort monitoring should be improved immediately and institutionalised and a number of fisheries biologist should be trained in fisheries stock assessment, further development of fisheries management information system through updating of the existing frame. This programme should encompass the major economic species and used gears and special attention should be given to ESBN, pushnets and Jatka gears and would result in a more complete picture on a regular basis on the status of the marine and estuarine fisheries.

- There is a risk that accelerated land reclamation will affect several fish and shrimp stock. At present reliable data on this subject are lacking. Therefore a major research programme on the spawning and nursery of estuarine dependent fish and shrimp species should be carried out before major interventions in the MES area are carried out.

- There is a serious resource conflict between offshore shrimp trawling and the catching of Bagda fry for shrimp farming. In the long run this will most likely result in the collapse of both activities and complete collapse of the whole shrimp industry. Considering the social-economics of Bagda fry catching for the local communities. it should be investigated what will be the biological, social and economic impact of closing the shrimp trawling as a management measure.

- A further increase in the total marine catch can only be attained through exploitation of the under utilised pelagic resources. This resource can not be exploited by the artisanal fishermen and it should be investigated if this resource can be exploited through international joint ventures.

All fisheries related activities should be a part of an Integrated Coastal Management Strategy

### 6.1.2 Aquaculture

*Shrimp farming*

It is now generally recognised that shrimp farming must enter a new era. Compared to other sophisticated poultry, cattle or even fish production shrimp farming is primitive. In order to compete in the future and become a more sustainable activity shrimp farming should use a long term strategy as used by other livestock industries based on:

- proper planning of shrimp farming through coastal management plans, zoning of suitable shrimp farming sites, formulation of a land use policy, development of proper structures and marketing systems, etc.

- domestication and genetic improvement of stocking material
- further development of sustainable rearing techniques, disease diagnostics and treatment methods
- development of advanced feeding strategies
- development and implementation of sound environmental management plans.

Replanning and zoning of the shrimp farming industry within the context of a Coastal Area Management and Development Plan can be done in an early stage of further development as the past experiences made policy makers and shrimp farmers aware of the problems. A major bottleneck however is the remaining existence of the China virus in the environment. On the long run it will most likely disappear, but without changing the roots of the industry a new disease will certainly appear with similar impacts as the China virus. A major change would be the development of pathogen free, certified, hatchery reared post larvae, which is a long term process.

The following development strategies/projects are recommended for further development of aquaculture in the coastal area.

- Development of a shrimp farming master plan. The master plan should cover: present land use and cropping pattern, soil and topographic maps, indicate which areas are suitable for sustainable shrimp farming, redesign of the major water ways in such a way that all shrimp areas are supplied with separate inlet and outlets. Shrimp culture should be banned from areas where separate inlet and outlet structures can not be constructed and in areas where the tidal movement does not allow proper water exchange of the ponds. Geographical Information Systems will be a major tool within the master plan.

- Shrimp health management plan. Under this programme profound knowledge on shrimp diseases should be acquired. The programme should include the set up of a shrimp disease unit, rehabilitation of DoF/FRI hatcheries which can serve as research and training centres, testing of broomstick, post larvae, introduction of gene probing for shrimp viruses, dissemination of simple stress tests for post larvae and assistance to hatchery operators and grow-out farmers. This programme would provide the scientific basis for viable pathogen free hatchery industry.

- Development of a viable pathogen free hatchery industry. This programme would reduce the need for imported post-larvae and on the long run the use of wild caught larvae could be avoided. Assistance will provided to private hatchery operators, introduction of improved hatchery management, introduction of a testing and certification programme for disease free status for specific pathogens as well as for general quality standards (stress tests). The certification will be linked with the development of an independent certification control unit.

- The development of a hatchery industry will be a long term process. In the mean time wastage of larvae of shrimp and fish through the Bagda fry catchers should be reduced as much as possible through an awareness and assistance programme. The programme should introduce and propagate the use of non-destructive gears, proper handling and transport procedures. There is a serious resource conflict between offshore shrimp trawling and the catching of Bagda fry for shrimp farming. In the long run this will most likely result in the collapse of both activities and complete collapse of the whole shrimp industry. Considering the social-economics of Bagda fry catching for the local communities. it should be investigated what will be the biological, social and economic impact of closing the shrimp trawling as a management measure.

- Fresh water fish culture in the MES is well below the target level of 2,000 kg/ha/year and the production could be easily increased by an aquaculture extension programme.

- Improvement and assurance of the quality of exported shrimps and fish which could lead to an increased income for the shrimp farmers as it allows higher "farm gate" prices.

- Further diversification of the aquaculture industry should be studied i.e. sea-bass farming, mud crab farming, milkfish, etc.

## 7. PROJECTS

In the context of the development strategies a number of projects were formulated together with a preliminary costing. The projects could be used as a frame for donor assistance

### 7.1 Marine fisheries

#### 7.1.1 Adapted credit programmes for the fisherfolk community in coastal areas

*Objectives*

The major objective is to develop on a pilot scale an adaptive credit programme for the fisherfolk communities in the coastal areas. The programme would provide tools for the improvement of the livelihood of the fisherfolk as it would reduce the dependency on the money lender and would increase fish prices as obtained by the fisherfolk. The project has a high priority as future co-management, co-operation of fisherfolk communities in the implementation of fisheries management schemes can only be obtained if they and not the money lender will profit from the schemes.

*Project description*

The project will be mainly carried out by NGOs, preferable with experience with fisherfolk in the area. Two pilot areas, with high numbers of fishing households will be selected. The Marine Fisheries Management Information System could provide the basis for selection. On a initial stage an inventory will be made of the basic needs and constraints of the fisherfolk communities in the selected area. Credit/development systems, which have proofed to be successful in Bangladesh will be adapted to the needs of the fisherfolk communities or if necessary new credit systems will be developed. The project will have a duration of five years and will cover about 500 fisherfolk households. The programme will have to be very flexible, with an open approach and complete support by the majority of the community. Organisation of the local fishermen will be a major part of the programme as it is bound to face hostility from local vested interests groups.

*Preliminary costing*

The total costs of the project are estimated at US$ 1.96 million or Tk 90 million and details are presented in Table 7.1.

Table 7.1: Staffing and preliminary costs of a pilot credit programme

| | |
|---|---|
| **Title of Project** | **Development of adapted credit programmes for fisherfolk communities** |
| Duration | 5 years |
| Output | Adapted credit programme tested with 500 fisherfolk house holds |
| Exchange rate | 1 US$ = 46 Taka |

| Description | Unit description | Units | Unit costs | | Total US$ |
|---|---|---|---|---|---|
| | | | US$ | Taka | |
| *Personnel* | | | | | |
| Team leader | Person month | 60 | 1,739 | 80,000 | 104,348 |
| Field staff (8) | Person month | 480 | 652 | 30,000 | 313,043 |
| Office staff (6) | Person month | 360 | 543 | 25,000 | 195,652 |
| Technical Assistance | Person month | 15 | 20,000 | 920,000 | 300,000 |
| *Sub Total* | | | | | *913,043* |
| *Equipment* | | | | | |
| Cars | Number | 1 | 20,000 | 920,000 | 20,000 |
| Motor cycles | Number | 8 | 4,000 | 184,000 | 32,000 |
| Office equipment | Lump sum | | 25,000 | 1,150,000 | 25,000 |
| Revolving credit fund | | | 500,000 | 23,000,000 | 500,000 |
| *Sub Total* | | | | | 577,000 |
| *Running costs* | | | | | |
| Office Rental (2) | Month | 120 | 652 | 30,000 | 78,261 |
| O&M cars | Month | 60 | 435 | 20,000 | 26,087 |
| O&M motor cycles | Month | 480 | 152 | 7,000 | 73,043 |
| Training | Lump sum | | 20,000 | 920,000 | 20,000 |
| Office costs | month | 120 | 326 | 15,000 | 39,130 |
| Local DSA | person days | 2,000 | 15 | 700 | 30,435 |
| Workshops | Lump sum | 5 | 500 | 23,000 | 2,500 |
| Miscellaneous | 10 per cent | | | | 26,946 |
| *Sub-Total* | | | | | *296,402* |
| Total | | | | 82,176,500 | 1,786,446 |
| Contingency, 10 per cent | | | | 8,217,650 | 178,645 |
| Grand Total | | | | 90,394,150 | 1,965,090 |

### 7.1.2 ESBN Replacement project

*Objectives*

The major objective of the project is to develop an acceptable methodology to reduce the number of estuarine set bagnets in the Coastal area of Bangladesh.

*Project description*

This pilot project has a duration of 5 years and will be carried out by DoF in co-operation with local NGOs and the BOBP. Through an awareness programme the fishermen will informed on the present situation of fisheries and the impact of the ESBN. In full consensus with the fishermen,

alternatives will be developed and introduced. Alternatives could be different gears, different design of ESBN, alternative employment, income diversification of the households. The project has to flexible and open as it aims to find alternatives with the fishermen involved. This as experiences elsewhere have indicated that banning ESBN by law and enforcement of the laws does not work and is socially not acceptable. The project includes experimental gear design and fishing and will require a substantial input on Technical assistance.

***Preliminary costing***

The total costs of the project are estimated at US$ 1.77 million or Tk 82 million and details are presented in Table 7.2.

Table 7.2: Staffing and preliminary costs of a pilot programme for the reduction of ESBN in the Bay of Bengal

| | |
|---|---|
| **Title of Project** | **ESBN replacement programme** |
| Duration | 5 years |
| Output | An acceptable method for the replacement/reduction of ESBN |
| Exchange rate | 1 US$ = 46 Taka |

| Description | Unit description | Units | Unit costs | | Total US$ |
|---|---|---|---|---|---|
| | | | US$ | Taka | |
| *Personnel* | | | | | |
| Team leader | Person month | 60 | 1,739 | 80,000 | 104,348 |
| Field staff (6) | Person month | 360 | 652 | 30,000 | 234,783 |
| Office staff (3) | Person month | 180 | 543 | 25,000 | 97,826 |
| Project fishermen (8) | Person month | 480 | 326 | 15,000 | 156,522 |
| Technical Assistance | Person month | 25 | 20,000 | 920,000 | 500,000 |
| *Sub Total* | | | | | *1,093,478* |
| | | | | | |
| *Equipment* | | | | | |
| Cars | Number | 1 | 20,000 | 920,000 | 20,000 |
| Motor cycles | Number | 8 | 4,000 | 184,000 | 32,000 |
| Boat | Number | 1 | 10,000 | 460,000 | 10,000 |
| Office equipment | Lump sum | | 25,000 | 1,150,000 | 25,000 |
| Fishing gears | Lump sum | | 50,000 | 2,300,000 | 50,000 |
| Credit fund | Lump sum | | 50,000 | 2,300,000 | 50,000 |
| *Sub Total* | | | | | *187,000* |
| | | | | | |
| *Running costs* | | | | | |
| Office Rental | Month | 60 | 652 | 30,000 | 39,130 |
| O&M cars | Month | 60 | 435 | 20,000 | 26,087 |
| O&M motor cycles | Month | 360 | 152 | 7,000 | 54,783 |
| O&M boat | Month | 60 | 761 | 35,000 | 45,652 |
| Training | Lump sum | | 25,000 | 1,150,000 | 25,000 |
| Office costs | month | 120 | 652 | 30,000 | 78,261 |
| Local DSA | person days | 2,000 | 15 | 700 | 30,000 |
| Workshops | Lump sum | 5 | 750 | 34,500 | 3,750 |
| Miscellaneous | 10 per cent | | | | 30,266 |
| *Sub-Total* | | | | | *332,929* |
| | | | | | |
| Total | | | | 74,216,750 | 1,613,408 |
| Contingency, 10 per cent | | | | 7,421,675 | 161,341 |
| Grand Total | | | | 81,638,425 | 1,774,748 |

### 7.1.3 Study on the spawning areas of estuarine dependent species

*Objectives*

The major objective of the study is to determine where the major spawning and nursing areas of estuarine species, especially Hilsha, are located in the Bay of Bengal.

*Project description*

The project has a duration of three years and will be carried out by FRI in co-operation with DoF. The different ecological zones (mud flats, channels, etc.) will be sampled systematically for eggs, larvae and mature stocks. This will be combined with determination of physical and water quality parameters. Distribution area and migration patterns will be followed by tagging and recapture and telemetrics. Final analysis and linking of data will be done in a GIS environment

*Preliminary costing*

The total costs of the project are estimated at US$ 1.1 million or Tk 49 million and details are presented in Table 7.3.

Table 7.3: Staffing and preliminary costs of a study of spawning and nursing areas of Hilsha in the Bay of Bengal

| | |
|---|---|
| **Title of Project** | **Spawning areas of Hilsha** |
| Duration | 3 years |
| Output | Location of the major spawning and nursing areas of estuarine species |
| Exchange rate | 1 US$ = 46 Taka |

| Description | Unit description | Units | Unit costs | | Total US$ |
|---|---|---|---|---|---|
| | | | US$ | Taka | |
| *Personnel* | | | | | |
| Team leader | Person month | 36 | 1,739 | 80,000 | 62,609 |
| Fisheries biologists (2) | Person month | 72 | 1,087 | 50,000 | 78,261 |
| Field staff (4) | Person month | 144 | 652 | 30,000 | 93,913 |
| Office/Laboratory staff (3) | Person month | 108 | 543 | 25,000 | 58,696 |
| Project fishermen (8) | Person month | 288 | 326 | 15,000 | 93,913 |
| Technical Assistance | Person month | 15 | 20,000 | 920,000 | 300,000 |
| *Sub Total* | | | | | *687,391* |
| *Equipment* | | | | | |
| Cars | Number | 1 | 20,000 | 920,000 | 20,000 |
| Motor cycles | Number | 4 | 4,000 | 184,000 | 16,000 |
| Boat | Number | 1 | 15,000 | 690,000 | 15,000 |
| Laboratory/Experimental equipment | Lump sum | | 30,000 | 1,380,000 | 30,000 |
| Office equipment | Lump sum | | 5,000 | 230,000 | 5,000 |
| Field equipment/ telemetrics | Lump sum | | 50,000 | 2,300,000 | 50,000 |
| *Sub Total* | | | | | *136,000* |
| *Running costs* | | | | | |
| Office Rental | Month | 36 | 652 | 30,000 | 23,478 |
| O&M cars | Month | 36 | 435 | 20,000 | 15,652 |
| O&M motor cycles | Month | 144 | 152 | 7,000 | 21,913 |
| O&M boat | Month | 36 | 761 | 35,000 | 27,391 |
| Fish samples | kg | 6,000 | 1 | 50 | 6,522 |
| Office costs | month | 36 | 652 | 30,000 | 23,478 |
| Local DSA | person days | 1,500 | 15 | 700 | 22,500 |
| Workshops | Lump sum | 4 | 1,000 | 46,000 | 4,000 |
| Miscellaneous | 10per cent | | | | 14,493 |
| *Sub-Total* | | | | | *159,428* |
| Total | | | | 45,209,700 | 982,820 |
| Contingency, 10 per cent | | | | 4,520,970 | 98,282 |
| Grand Total | | | | 49,730,670 | 1,081,102 |

### 7.1.4 Development of a Marine Fisheries Management Information System

***Objectives***

The objective of the project is to update the knowledge on the fisheries in the Coastal area of Bangladesh and development of a Marine Fisheries Management Information System.

***Project description***

The project will be carried out by DoF and FRI and will have a duration of three years. The preliminary Marine Fisheries Information system as developed by MES will be used to indicate present gaps in knowledge available. Updating of the present knowledge is essential as no fisheries management policy can be formulated or results of a fish stock assessment programme can be completely analysed if total catch for the different species and the different number of gears are not known. During inception the needed biological and socio economic data will be formulated by the different partners and stakeholders. The frame will be updated through a sub-sample, stratified frame survey. Fisheries biologist will be initially trained in catch and effort monitoring and length based stock assessment programmes. A two years monitoring programme covering fish stock assessment and socio economics will be designed and implemented. The results of the updated frame and the different monitoring programmes will be used for the development of a Marine Fisheries Management Information System in GIS. Staff members of DoF, FRI and NGOs will be trained in the use and updating of this system. Due to the innovative character of the project and the relative inexperience of the partners with new stock assessment programmes and GIS a substantial input as TA will be required.

***Preliminary costing***

The total costs of the project are estimated at US$ 1.4 million or Tk 65 million and details are presented in Table 7.4.

Table 7.4: Staffing and preliminary costs for the development of a marine fisheries management and information system

| Title of Project | Marine Fisheries Information System | | | | |
|---|---|---|---|---|---|
| Duration | 3 years | | | | |
| Output | Updated knowledge of the status of fisheries and stocks in the coastal area | | | | |
| Exchange rate | 1 US$ = 46 Taka | | | | |
| **Description** | **Unit description** | **Units** | **Unit costs** | | **Total US$** |
| | | | **US$** | **Taka** | |
| *Personnel* | | | | | |
| Team leader | Person month | 36 | 1,739 | 80,000 | 62,609 |
| Fisheries biologist (3) | Person month | 108 | 1,087 | 50,000 | 117,391 |
| Sociologist (3) | Person month | 108 | 1,087 | 50,000 | 117,391 |
| Field staff (8) | Person month | 384 | 652 | 30,000 | 250,435 |
| Project fishermen (8) | Person month | 288 | 326 | 15,000 | 93,913 |
| Data processor/GIS (2) | Person month | 72 | 1,304 | 60,000 | 93,913 |
| *Sub Total* | | | | | *735,652* |
| *Technical assistance* | | | | | |
| Team leader | Person month | 36 | 15,000 | 690,000 | 540,000 |
| Fish Stock Assessment Specialist | Person month | 9 | 20,000 | 920,000 | 180,000 |
| Sociologist | Person month | 9 | 20,000 | 920,000 | 180,000 |
| Unallocated | Person month | 6 | 20,000 | 920,000 | 120,000 |
| Sub total | | | | | *1,020,000* |
| *Equipment* | | | | | |
| Cars | Number | 2 | 20,000 | 920,000 | 40,000 |
| Motor cycles | Number | 8 | 4,000 | 184,000 | 32,000 |
| Boat | Number | 2 | 15,000 | 690,000 | 30,000 |
| Computers/software | Lump sum | | 30,000 | 1,380,000 | 30,000 |
| Office equipment | Lump sum | | 10,000 | 460,000 | 10,000 |
| Update frame survey | Lump sum | | 15,000 | 690,000 | 15,000 |
| *Sub total* | | | | | *142,000* |
| *Running costs* | | | | | |
| Office Rental | Month | 36 | 652 | 30,000 | 23,478 |
| O&M cars | Month | 72 | 652 | 30,000 | 46,957 |
| O&M motor cycles | Month | 288 | 152 | 7,000 | 43,826 |
| O&M boat | Month | 36 | 1,739 | 80,000 | 62,609 |
| Fish samples | kg | 10,000 | 1 | 50 | 10,870 |
| Office costs | month | 36 | 1,087 | 50,000 | 39,130 |
| Local DSA | person days | 2,500 | 15 | 700 | 37,500 |
| Update Frame | Lump sum | | 100,000 | 4,600,000 | 100,000 |
| Workshops | Lump sum | 2 | 1,000 | 46,000 | 2,000 |
| Miscellaneous | 10per cent | | | | 36,637 |
| *Sub-Total* | | | | | *403,007* |
| Total | | | | 58,910,300 | 1,280,659 |
| Contingency, 10 per cent | | | | 5,891,030 | 128,066 |
| Grand Total | | | | 64,801,330 | 1,408,725 |

### 7.1.5 Analysis of Bagda fry catching vs shrimp trawling

***Objectives, project description and costing***

The main objective is to model the impact of different shrimp fisheries management scenarios, i.e. what will be the impact of reducing the Bagda fry catching if compared with a reduction of the number of shrimp trawlers or other gears. The model will encompass biological and socio-economic parameters. The outcome of the model would provide objective criteria for future decision making processes and designing the model can be considered as a in house training of some staff members of DoF and FRI. The model will be based on available data obtained during the stock assessment survey carried out in the early 90's. Using this data will allow to discover the bias and flaws of the data set which could be used for better design future monitoring programmes. The model will be made by staff members of DoF and FRI and technical assistance and training will be provided by an international fisheries consultant.

The total costs are estimated at 2 million Taka or US$ 43,000 and details are provided in Table 7.5.

Table 7.5: Estimated costs and staffing for the development of an interactive shrimp fisheries model

| **Title of Project** | **Comparison of Bagda fry catching and shrimp trawling** | | | | |
|---|---|---|---|---|---|
| Duration | 3 months | | | | |
| Output | Simulation model which predicts the impact of different management options | | | | |
| Exchange rate | 1 US$ = 46 Taka | | | | |
| **Description** | **Unit description** | **Units** | **Unit costs** | | **Total US$** |
| | | | US$ | Taka | |
| Fisheries biologist DoF/FRI (2) | Person month | 3 | 1,739 | 80,000 | 5,217 |
| International Fisheries Biologist | Person month | 1.5 | 20,000 | 920,000 | 30,000 |
| Computer & software | Lump sum | | 4,000 | 184,000 | 4,000 |
| Miscellaneous 10 per cent | | | | | 3,922 |
| **Grand total** | | | | **1984400** | **43,139** |

## 7.2 Aquaculture

For aquaculture development four projects are formulated. All of them for shrimps as this can be considered as a priority area. Basic inputs for the project was taken from the formulation mission of the Fourth Fisheries Project[32] The different projects are summarised in the next chapters.

### 7.2.1 Shrimp farming master plan

***Objectives***

The major objective is to develop a frame for the shrimp farming industry within the context of an integrated coastal development plan.

***Project description***

The project has a duration of 1 year and will be carried out by the Shrimp Planning Cell of DoF in co-operation EGIS-II. The different farming systems and cropping patterns (including shrimps) in the Coastal area will be mapped and classified through Remote Sensing techniques and field

[32] Karim, M. and Stellwagen, J., 1998. Shrimp farming, Fourth Fisheries Project. Preparatory Phase for National Fisheries sector Development Programme, Final report, Volume 6.

visits. In GIS these data will be linked with data on hydrology, salinity, topography, drainage, water quality, infrastructure, socio economics, economics, environmental parameters, etc. This analysis in GIS will finally lead to the zoning of the coastal area indicating the most suitable land use patterns for the different zones. The second step will be the formulation of a shrimp farming development plan for the areas suitable for shrimp farming. The plan will include; development of major infrastructure, production planning, institutional development, marketing and processing.

***Preliminary costing***

The total costs are estimated at Tk 23 million or US$ 483,000 and details are provided in Table 7.6.

Table 7.6: Preliminary costing and staffing for the development of a shrimp farming master plan.

| | |
|---|---|
| Title of Project | Shrimp farming master plan |
| Duration | 1 year |
| Output | Zoning of land use in the coastal area and formulation of a shrimp farming development plan |
| Exchange rate | 1 US$ = 46 Taka |

| Description | Unit description | Units | Unit costs | | Total US$ |
|---|---|---|---|---|---|
| | | | US$ | Taka | |
| *Personnel* | | | | | |
| Team leader | Person month | 12 | 2,174 | 100,000 | 26,087 |
| Aquaculturist (2) | Person month | 24 | 1,304 | 60,000 | 31,304 |
| Agriculture expert (2) | Person month | 24 | 1,304 | 60,000 | 31,304 |
| RS-GIS experts (1) | Person month | 12 | 1,304 | 60,000 | 15,652 |
| RS-GIS-cartographers (4) | Person month | 48 | 870 | 40,000 | 41,739 |
| Socio economist | Person month | 12 | 1,304 | 60,000 | 15,652 |
| Environmentalist | Person month | 12 | 1,304 | 60,000 | 15,652 |
| Hydrologist | person month | 12 | 1,304 | 60,000 | 15,652 |
| Field staff (4) | Person month | 24 | 652 | 30,000 | 15,652 |
| *Sub Total* | | | | | *208,696* |
| *Technical assistance* | | | | | |
| Aquaculturist | Person month | 1.5 | 20,000 | 920,000 | 30,000 |
| RS-GIS expert | Person month | 2 | 20,000 | 920,000 | 40,000 |
| *Sub Total* | | | | | *70,000* |
| *Equipment* | | | | | |
| Computers/software Arcview | Lump sum | | 35,000 | 1,610,000 | 35,000 |
| Satellite images | Lump sum | | 50,000 | 2,300,000 | 50,000 |
| Office equipment | Lump sum | | 10,000 | 460,000 | 10,000 |
| *Sub Total* | | | | | *95,000* |
| *Running costs* | | | | | |
| Office costs | month | 12 | 1,087 | 50,000 | 13,043 |
| Local DSA | person days | 500 | 15 | 700 | 7,500 |
| Field visits-transport etc. | Lump sum | | 10,000 | 460,000 | 100,000 |
| Workshops | Lump sum | 2 | 1,000 | 46,000 | 2,000 |
| Miscellaneous | 10 per cent | | | | 12,254 |
| *Sub-Total* | | | | | *134,798* |
| Total | | | | 20,170,700 | 438,493 |
| Contingency, 10 per cent | | | | 2,017,070 | 43,849 |
| Grand Total | | | | 22,187,770 | 482,343 |

### 7.2.2 Shrimp health management plan

*Objectives*

The long-term objective is to assists hatchery operators with the production of disease free post larvae and to develop a shrimp diseases monitoring centre.

*Project description*

This pilot project has a duration of three years and will be carried out by FRI. Existing facilities of FRI in Cox's bazar and Khulna will be upgraded. A shrimp disease laboratory and shrimp hatchery will be equipped and operated by FRI staff. The FRI staff will be trained in disease diagnostics, laboratory techniques, disease prevention, hatchery operations, brood stock management, larval feeding, simple stress tests, etc. Research will be carried out on adaptive production methods for Bangladesh. Once the centres are established an in operation the private hatchery operators will be assisted and trained in appropriated hatchery techniques. The centre will have a major role in the development, implementation and control of shrimp hatchery certification.

*Preliminary costing*

The total costs are estimated at 56 million taka or 1.2 million US$ and details are provided in Table 7.7.

Table 7.7: Preliminary costing and staffing for the development of a shrimp health management plan

| Title of Project | Shrimp health programme | | | | |
|---|---|---|---|---|---|
| Duration | 3 years | | | | |
| Output | Production technology of healthy post larvae and certification of hatcheries | | | | |
| Exchange rate | 1 US$ = 46 Taka | | | | |
| **Description** | **Unit description** | **Units** | **Unit costs** | | **Total US$** |
| | | | **US$** | **Tk** | |
| *Personnel* | | | | | |
| Team leader | Person month | 36 | 1,739 | 80,000 | 62,609 |
| Fish pathologist (2) | Person month | 72 | 1,087 | 50,000 | 78,261 |
| Hatchery operators (2) | Person month | 72 | 870 | 40,000 | 62,609 |
| Laboratory assistants (4) | Person month | 144 | 870 | 40,000 | 125,217 |
| Hatchery assistants (4) | Person month | 144 | 870 | 40,000 | 125,217 |
| *Sub Total* | | | | | *453,913* |
| *Technical assistance* | | | | | |
| Hatchery expert | Person month | 24 | 15,000 | 690,000 | 360,000 |
| Shrimp pathologist | Person month | 6 | 20,000 | 920,000 | 120,000 |
| Unallocated | Person month | 6 | 20,000 | 920,000 | 120,000 |
| *Sub Total* | | | | | *600,000* |
| *Equipment* | | | | | |
| Cars | Number | 2 | 20,000 | 920,000 | 40,000 |
| Upgrading Laboratory | Number | 2 | 15,000 | 690,000 | 30,000 |
| Histopathology equipment | Lump sum | | 80,000 | 3,680,000 | 80,000 |
| Micro biological equipment | Lump sum | | 40,000 | 1,840,000 | 40,000 |
| Upgrading Hatchery | Lump sum | | 80,000 | 3,680,000 | 80,000 |
| Equipment Hatchery | Lump sum | | 25,000 | 1,150,000 | 25,000 |
| Office equipment | Lump sum | | 20,000 | 920,000 | 20,000 |
| *Sub Total* | | | | | *315,000* |
| *Running costs* | | | | | |
| Office Rental | Month | 36 | 652 | 30,000 | 23,478 |
| O&M cars | Month | 72 | 652 | 30,000 | 46,957 |
| Office costs | Month | 36 | 1,087 | 50,000 | 39,130 |
| Hatchery costs | Month | 72 | 652 | 30,000 | 46,957 |
| Local DSA | Person days | 750 | 15 | 700 | 11,250 |
| Overseas training (3) | Month | 18 | 5,000 | 230,000 | 90,000 |
| Training for private operators | Lump sum | | 35,000 | 1,610,000 | 35,000 |
| Workshops | Lump sum | 2 | 1,000 | 46,000 | 2,000 |
| Miscellaneous | 10 per cent | | | | 29,477 |
| *Sub-Total* | | | | | *324,249* |
| Total | | | | 50,285,450 | 1,093,162 |
| Contingency, 10 per cent | | | | 5,028,545 | 109,316 |
| Grand Total | | | | 55,313,995 | 1,202,478 |

### 7.2.3 Awareness programme for Bagda and Golda fry catching

*Objectives*

This project was formulated before by the Fourth Fisheries Project preparatory phase. The major objective is to secure sufficient and sustainable recruitment of species of fish and crustacean from the coastal and fresh water areas of Bangladesh by introducing non destructive collection procedures for wild shrimp fry and its scientific transportation to farming areas.

*Project description*

The project will be carried out by DoF in co-operation with local NGOs. The project will organise fry collectors, will train them in the use of improved methods and will organise central fry holding facilities. The project will improve the transportation methods and will train fry traders. Furthermore the project will demonstrate to farmers the techniques of nursery rearing/holding of shrimp post larvae, including late season (pre-winter) post larvae rearing through the winter season.

*Preliminary costing*

The total costs are estimated at million taka or million US$ and details are provided in Table 7.8.

Table 7.8: Preliminary costing and staffing for shrimp fry catching awareness programme

| **Title of Project** | **Shrimp fry catching awareness programme** | | | | |
|---|---|---|---|---|---|
| Duration | 5 years | | | | |
| Exchange rate | 1 US$ = 46 Taka | | | | |
| **Description** | **Unit description** | **Units** | **Unit costs** | | **Total US$** |
| | | | **US$** | **Taka** | |
| *Personnel* | | | | | |
| Team leader | Person month | 60 | 3,478 | 160,000 | 208,696 |
| Fry training experts (4) | Person month | 192 | 1,413 | 65,000 | 271,304 |
| Transport development experts (2) | Person month | 12 | 1,413 | 65,000 | 16,957 |
| NGOs | Person month | 510 | 217 | 10,000 | 110,870 |
| Supporting staff | Lump sum | | 500,000 | 23,000,000 | 500,000 |
| *Sub Total* | | | | | *1,107,826* |
| *Equipment* | | | | | |
| Cars | Number | 3 | 18,000 | 828,000 | 54,000 |
| speedboat | Number | 3 | 8,800 | 404,800 | 26,400 |
| Prototype fry boat | Number | 10 | 6,522 | 300,000 | 65,217 |
| Demonstration equipment | Lump sum | | 15,000 | 690,000 | 15,000 |
| Office equipment | Lump sum | | 15,000 | 690,000 | 15,000 |
| *Sub Total* | | | | | *175,617* |
| *Running costs* | | | | | |
| Office Rental | Month | 60 | 652 | 30,000 | 39,130 |
| O&M cars | Month | 180 | 326 | 15,000 | 58,696 |
| O&M boats | Month | 180 | 326 | 15,000 | 58,696 |
| Communication | Month | 60 | 130 | 6,000 | 7,826 |
| Training material | Lump sum | | 60,000 | 2,760,000 | 60,000 |
| Local DSA | Person days | 2,000 | 15 | 700 | 30,000 |
| Subsistence collectors | Days | 50,000 | 1 | 46 | 50,000 |
| Miscellaneous | Lump sum | 40,000 | | | 40,000 |
| *Sub-Total* | | | | | *344,348* |
| Total | | | | 74,878,400 | 1,627,791 |
| Contingency, 10 per cent | | | | 7,487,840 | 162,779 |
| Grand Total | | | | 82,366,240 | 1,790,570 |

# APPENDICES

## MARINE FISHERIES MANAGEMENT INFORMATION SYSTEM

The preliminary Marine Fisheries Management Information system as made by the Meghna Estuary Study is in principle a system which links data obtained from a certain place with the exact georeference of this place in GIS. All data of the frame survey were entered in a Dbase system together with the georeferences and BBS codes of all the villages. Georeferenced district and thana maps were provided by EGIS-II and in ARCVIEW the frame data can put as a layer over these maps and the data can be analysed for spatial differences.

For the present study only a small number of data were analysed. The system however allows for a more profound data analysis and due to the set-up of the system other data such as: BBS, hydrology, salinity, or updated frame survey data, etc. can be easily linked and this would result in a more detailed and robust Management Information System.

In order to facilitate this process MES decided to make the system available for future users. The basic data of DoF, the georeferenced village codes and basic GIS maps were put on CD-ROM. The CD-ROM can be obtained from the Land Accretion Estuary Division of the BWDB and can be used after their permission.

Appendix-2


## FISHERIES IN THE FIFTH FIVE YEAR PLAN

### Fisheries 1997-2002

***Past Performance***

Fisheries play a major role in nutrition, employment, foreign exchange earning and other areas of the economy of Bangladesh. About 60 percent of animal protein is supplied by fish alone and about 1.2 million people are directly employed by this sub-sector. Another 11 million people indirectly earn their livelihood out of activities related to fisheries. The production of fish has been estimated to be 1,373 thousand tons during 1996/97 as against the production of 847 thousand tons in 1989/90. It is estimated that inland fish production will be 1,079 thousand tons and that of marine will be about 294 thousand tons. The growth rate of fish production during last seven years averaged at 6.5 percent which is lower than increase in demand. However, the present rate of fish production has improved to 8 per cent. Over the last decade price of fish has increased at 2.5 percent.

There are various impediments to fisheries development, some of which are particular sources of fisheries. In case of capture fishery, inadequate knowledge, over fishing and indiscriminate killing of juveniles and destruction of spawning ground, obstruction of migration routes due to unplanned construction of dams and embankments under the flood control, drainage and irrigation projects, degradation of water quality, fish diseases, defective fish conservation laws and inadequacy of proper processing, marketing and other facilities are some of the major factors affecting the desired development. The major constraints of fish culture relate to problems of trained manpower and quality fish seed etc. In case of marine fishery, inadequate knowledge and information of fisheries resources, lack of proper management policy , inadequate know how to, use of inefficient fishing equipment, inadequacy of harbour and landing facilities as well as credit are important.

### Fifth Five Year Plan

Objectives: The major thrust for fisheries development will be on culture and capture fisheries, promotion of rice-fish farming system in the vast flood plains, conservation and management along with institutional and manpower development for equitable distribution of benefits from common property water resources through research on social engineering with NGOs. Some major specific objectives of fisheries sub-sector development during the Fifth Five Year Plan are as follows:

- to generate additional employment opportunities in fisheries and ancillary industries help poverty alleviation;
- to increase fish production and improve nutritional level;
- to improve the socio-economic conditions of the fishermen, fish farmers and others engaged in the fishery sub-sector;
- to increase export earning from shrimp, fish and fish products;
- to improve environmental conditions and public health;
- to improve the biological and institutional management mechanisms for judicious use of fisheries resources;
- to strengthen research, extension and management and co-ordination in order to transfer technology and encourage production activities in the private sector and to ensure sustainable development of fisheries resources, particularly utilising the water resources of the vast flood plains.

**Policies/Strategies**

Semi-intensive poly-culture of fish will be ensured in all ponds dighis and other closed and semi-closed water bodies.

Stocking of fish fry in flood plains and semi-closed water and FCDI project areas will be continued to halt the declining trend of open water capture fisheries.

Sanctuaries will be established to conserve fish spawning grounds at different areas of the country. Necessary measures will be taken to stop indiscriminate fishing of gravid female and undersized fish. Spawning grounds of the main fish species like Rui, Catla, Hilsha, Pangas, Golda Chingri etc. will be identified to establish fish sanctuary.

Enough credit facilities for the fish farmers will be created through easy credit system and NGOs credit guarantee fund scheme will be introduced for marginal farmers. Import of machinery and equipment for private sector hatchery, feeds and feed ingredients will be further liberalised and duties and taxes thereon will be reduced.

Training facilities for development of suitable manpower and entrepreneur groups will be extended both in the public and private sectors and multi-sectoral development approach will be followed.

Biotechnological aspects will be applied in conservation of fisheries resources in all big, water bodies viz. boars, haors, beels, rives, canals, and lakes.

New Fisheries Management Policy will be implemented to develop socio-economic condition of fishermen.

All precautionary and mitigation measures will be taken so that fishing grounds may not be affected during the development works of other sectors like flood control, drainage and irrigation project, agriculture, industries and urban development programmes.

Physical facilities like electricity, road, transports, fresh water etc. will be created and made available to develop brackish water fish and shrimp resources.

- Traditional methods of shrimp culture will be improved by introducing modern technology for increased production. Shrimp culture extension service will be strengthened to take necessary steps for the establishment of shrimp hatchery at private level.

- Marine fisheries resources survey will be strengthened to ascertain the exact stock of resources in the interest of fish harvest at maximum sustainable yield. marine fish harvest will be increased by ensuring new fishing groups of the Exclusive Economic Zone (EEZ) of the sea.

- Programmes will be undertaken to improve the socio-economic condition of the coastal fishermen communities.

- Quality of fish & shrimp will be ensured for the export of fish and shrimp through creation of facilities and modern quality certification system.

- Khas ponds, dighis, canals, road-side ditches etc. will be excavated/re-excavated/developed for fish culture through participation of the rural unemployed youths marginal farmers and distressed women which will also help poverty alleviation.

- All water bodies owned by the government will be transferred to the Fisheries and Livestock Ministry for leasing out to the fishermen/fish farmers groups and NGOs for long-term (10 years).

**Major Programme Areas**

Open Water Capture Fisheries: A 2.8 million ha fish habitat in the Flood plains remains as an initialised resources of fish production. In order to **increase** production in open water fisheries, programme will be undertaken to (I) conserve resources through rigorous implementation of the Fish Acts and motivation of fishermen, (ii) establish fish sanctuaries (iii) increase production by massive stocking of fast growing carp fingerlings in the natural depression and flood, drainage and irrigation projects, road and high ways projects, township and housing projects. Observing the declining trend of the stock of open water fisheries in the recent past, efforts have been made to augment this stock though release of fish fry in the flood plains. But these programmes were not satisfactory. Appropriate procedural and management system will be evolved to ensure accountability and transparency in the execution of programmes for open water fisheries.

Closed Water Culture Fisheries: There are over 1.3 million ponds covering an estimated area of 147,000 ha, some 6000 ha of ox-bow lakes and over 130,000 ha of shrimps farms. Currently, the average production in fresh water ponds is 1.4 Mt./ha. and that of brackish water shrimp farm is only 160 kg/ha. Programme will be taken to bring all the 1.3 million ponds under extension programme of DoF, BFDC, FRI and NGOs during the plan period to raise the present total production of 331900 tons to at least 450,000 tons of fish.

**Brackish Water Aquaculture**

An estimated 0.143 million ha of coastal land is under brackish water shrimp farming. The method is largely traditional or only improved traditional where an average production of 160 kg/ha is currently obtained. Recently, farmers specially from Bagerhat and Pirojpur areas have started shrimp farming in their paddy field. Farming area is rapidly expanding. Development of brackish water fisheries will be contingent upon the provision of infrastructure, supply of seed, feed and other inputs, security, technical advice, disease control and training of the farmers on improved scientific farming system. With more support from DoF, BFDC, FRI and other extension agencies, it will be possible to raise production in shrimp farms to a level of 400 kg/ha which means a total incremental production of at least 60,000 tons by the terminal year of the Plan. Semi-intensive farming, suitable sites for establishment of shrimp hatcheries. Private entrepreneurs will be encouraged to invest in hatchery operation. Government will support development of suitable land with road, electricity and other infrastructure and make them available to entrepreneurs, feed production and other related activities will be encouraged.

**Marine Fisheries**

With the declaration of 200 nautical miles as Exclusive Economic Zone (EEZ) in 1974, Bangladesh felt the responsibility for exploitation and management of its living and non-living resources within its 1,64,000 sq. km. sea area. Since fish is renewable living resources, unlike the mineral resources, only judicious exploitation and scientific management and development can ensure maximum benefit out of it. Over the last two decades, the share of marine fisheries in total national landing rose from 10.6 percent in 1970 to about 22 percent in 1996. If appropriate technology can be adopted, there is much scope of increasing the marine fisheries resources. In the past, marine fisheries survey was conducted with UNDP assistance through which some basic information/data on fish and shrimp stocks in the Bay of Bengal were collected and used for planning, development and other related purpose.

The marine fish and shrimp are being exploited using as number of gears, such as, trawl net, gill net, estuarine set bagnet (ESBN), beach seine net, trammel net, hook and lines, shrimp fry net etc. There are some under-exploited and unexploited resources in the Bay of Bengal like tuna, sharks, sardines, herring, squid, cattle fish, lobster etc. which have potential for development. These fisheries may be developed by proper resources assessment and introduction of appropriate technology. Beach seine nets and estuarine set bagnets have been identified by several studies by ODA/BOBP/FAO as the most destructive fishing method of shrimp collection. So these methods of fishing need to be stopped gradually.

The increasing pressure on the coastal resources in Bangladesh has caused decline of many marine fishes and shell fishes in the Bay of Bengal. The artisanal fishing which contributing about 95 percent of the total marine landing is largely composed of post larvae and juveniles which are seriously damaging the stock due to use of crude traditional technology. The number of artisanal fishing gears including estuarine set bagnets, beach seine and shrimp seed pushnets are increasing alarmingly causing serious over exploitation of stocks. So, the following measures/programmes will be taken to improve the marine fisheries resources during the Fifth Plan Period:

- Assessment of pelagic, demersal and other marine resources and their development;
- Studying and monitoring of oceanographic parameters of the Exclusive Economic Zone of Bangladesh;
- Imparting training to the coastal fishermen and providing support services to improve the socio-economic conditions of coastal fishermen community;
- Issuance of licenses to mechanised and non-mechanised boats and identify cards to fishermen;
- Continuous supervision and monitoring of fishing by the Marine Fisheries Department Officials of Chittagong;
- Ensuring replacement of destructive gears like ESBN and beach seine nets by other appropriate fishing gears and rehabilitation of those fishermen;
- Reduction of mortality of fish and shrimp larvae during shrimp seed collection; Conservation of marine fisheries resources in the mangrove reserve forest;
- Conservation of marine fisheries resources in the mangrove reserve forest;
- Stopping sea piracy by trawl fishing of neighbouring countries with the help of Coast Guards/ Naval Forces;
- Pollution control and environmental conservation through strict enforcement of marine fisheries laws:
- Proper utilisation of trash fish thrown by the trawlers.

Ministry of Fisheries and Livestock has already taken up one investment project (Strengthening of coastal fisheries management) and one TAPP (Coastal fisheries management of the Bay of Bengal) to implement some of the programmes as identified above.

To develop under-exploited or unexploited pelagic and other resources, appropriate technology and equipment will be necessary which are not locally available. The Government may encourage local entrepreneurs joint venture to undertake activities for exploitation of pelagic resources in order to obtain increased harvest from the sea. The exact marine fisheries resources identification is also urgently needed.

Post-Harvest Technology and Marketing: Fish marketing carried out at four different stages largely in the in the hands of the private sector, is managed, financed and controlled by a group of intermediaries known as "aratders" and "mahajans". The "aratders" provide advances to fish traders who in turn are required to bring fish to them for sale. The fish marketing system is thus traditional, complex and not very competitive. However, if faces serious problems including heavy losses and waste and poor fish quality. It is believed that in Bangladesh 30 percent to 33 percent of all fish caught gets spoilt and unsuitable for human consumption. This economic waste will be reduced through provision of cold-storage facilities, insulated and refrigerated transport systems and adequate supplies of ice. The marketing system will also adjust to (a)

expanding export demand for quality frozen sea food, (b) expanding domestic demand for quality fresh and frozen fish and (c) large seasonal fish catches in areas far from the main markets and fish landing centres.

Peoples' Participation in Fisheries: Fisheries sector is considered to be the thrust sector for sustainable development and socio-economic advancement of rural fishermen and fish farmers. Almost all the activities of fish breeding, nursing, feeding, fisheries training, harvesting, transportation, marketing, exporting and other ancillary activities are done by the private sector. Twenty five technology packages have already been developed and are being implemented on experimental basis from 1996-97. Recently, some NGOs and private development organisations are involved in group formation, motivation, training and income generating activities of fishing community and marginal farmers. A strong and effective linkage system will be developed between the Government specially, Local Government, Non-Government and Private organisations in respect of planning, implementation and monitoring of the fisheries development programme. About 10,000 entrepreneurs will be developed in different fields of fisheries in next five year. Job opportunities for 42,500 poor people will be created under this sub-sector.

**Fisheries Research**

Fish production in all areas of fresh water, riverine, brackish and marine is quite low. Lack of technical knowledge, fish seed, proper management, disease control and suitable manpower accounts for the present low level fish production Bangladesh. Appropriate research support will help to find out remedies for the above weaknesses. Following specific area-wise research priority and programmes are envisaged during the Fifth Plan.

***Freshwater Fisheries***

- Collection, screening and evaluation of germplasm of important fishes and their stock improvement and conservation of endangered species.
- Studies on productivity increase under interacted livestock, fish-crop farming system and to evolve suitable models of integrated farming system.
- Development of improved culture technology for carp, cat fish, prawn, tilapia, rajputi and indigenous species.
- Development of cost effective feeds for brood stock and fingerlings.
- Improvement and maintenance of the soil and water quality and overall management of water body in order to control fish diseases.
- Development of appropriate institutional mechanism for equitable distribution of benefits fish production of flood plains.

***Riverine Fisheries***

- Determination of exact stock of Hilsha fish in Bangladesh, their migration behaviour, spawning ground and timing of spawning in order to enforce restrictions on fishing during spawning time in spawning area.
- Studies of the commonly used agro-industrial chemicals on aquatic biota.
- Assessment of biological productivity and management of fisheries under different conditions.

**Brackish Water Fisheries**

- Adoption of appropriate culture technology, water and soil quality management and disease control measures.
- Local production, transportation of shrimp fry and their nursery management.
- Management of brood-stock and mass seed production of P. Monodon and P. Merguensis Mono and poly-culture of shrimp, prawn and fish.
- Development of shrimp diet from locally available ingredients.
- Studies on the effect of shrimp farming on mangrove, estuarine and environment.

***Marine Fisheries***

Survey and studies on stock, catch monitoring, assessment of stock and productivity of marine fisheries resources of Bangladesh.

Breeding, seed production and culture of sea bass & mullet.

Development of improved methods of handling, transportation and preservation of shrimp & Hilsha fish.

An economic study of production and marketing of small scale marine fisheries in Bangladesh. Utilisation of trash fish with joint effort of private and public sectors.

**Production and Export Targets during Fifth Plan**

The current level of per capita daily fish consumption is about 26.6 gm. In order to raise the level of consumption to about 34.43 gm per capita per day at the end of the Plan period, the required production of fish will be 1965 million tons. This is based on estimated projection of 132.5 million population by the terminal year of the Plan. In addition, it is assumed that during 2001-2002, the export of shrimp and fish and fish products will be 95,000 tons and another 15,000 tons of fish will be required for industrial and other uses. In view of this demand, the fish production target at the terminal year of the Fifth Plan has been set at 2.075 million tons. The following Table 13.6 gives the details of fish production target in the terminal year of the Fifth Plan.

Fish Production Target at the Terminal Year of Fifth Plan

(In "000" metric tons)

| | Source of production | 1996/97 (Estimated) | 2001/2002 (Target) |
|---|---|---|---|
| | 1 | 2 | 3 |
| 1. | Inland Fisheries | 1079.00 | 1675.00 |
| | Ponds | 331.90 | 450.00 |
| | Baors | 3.50 | 27.00 |
| | Coastal Aquaculture | 85.00 | 100.00 |
| | Rivers and estuaries | 165.00 | 180.00 |
| | Beels & Haors | 70.00 | 95.00 |
| | Kaptia Lake | 7.60 | 9.00 |
| | Flood Plain | 395.00 | 751.00 |
| | Irrigation canals, road side ditches, fresh water polders and enclosures etc. | 21.00 | 63.00 |
| 2. | Marine Fisheries | 294.00 | 400.00 |
| | Total (1 + 2) | 1373.00 | 2075.00 |

13.27.2 Export earnings from shrimp, fish and fish products and other aquatic organisms during 2001/2002 are expected to be Tk 23,028.00 million as against estimated Tk 16,000.00 million in 1996/97. The export target set for the Fifth Plan is shown in Table 13.7.

Export Target of Fish and Fish Products in 2001/2002

Quantity in '000 mt
Value in million Taka

| Items | 1996/97 | benchmark | 2001/2002 | target |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| Shrimp | 28.00 | 13,150.00 | 70.00 | 18,438.00 |
| Fish and fish products | 9.80 | 2,250.00 | 20.00 | 4,080.00 |
| Others | 5.50 | 600.00 | 5.00 | 510.00 |
| Total | 43.30 | 16,000.00 | 95.00 | 23,028.00 |

Financial Outlay: In order to implement the fisheries development programmes Tk 5861.80 million has been earmarked for the public sector during the Fifth Plan. Programme wise allocation is shown in Table 13.8. In addition to the public sector allocation of Tk 5,861.80 million, an amount of Tk 21,847.00 million is expected to be invested for implementation of the programmes for fisheries development in the private sector. For this purpose, programmes/ projects will be developed for implementation in the private sector will support and services from the public sector. Fish hatchery, feed mill, fish culture, fish processing, fish preservation fish production and export are some of the major areas for private sector's participation in this sector.

Programme-wise Allocation during the Fifth Plan
(at 1996-97 prices)

(in million Taka)

| Programme | Allocation |
|---|---|
| 1 | 2 |
| Survey, investigation, feasibility study, research etc. | 400.00 |
| Fisheries education, training, extension and community development | 890.00 |
| Culture and capture fisheries development (including inputs and water bodies development ) | 4,360.00 |
| Fish landing, storage, processing, marketing, transportation, distribution etc. | 211.80 |
| Total | 5,861.80 |