Government of the People's Republic of Bangladesh
Bangladesh Water Development Board
Flood Plan Coordination Organisation

FLOOD ACTION PLAN

NORTHEAST REGIONAL WATER MANAGEMENT PROJECT (FAP 6)

DRAFT THEMATIC STUDY

FISHERIES IN THE NORTHEAST REGION OF BANGLADESH

Shawinigan Lavalin (1991) Inc.
Northwest Hydraulic Consultants

in association with

Engineering and Planning Consultants Ltd.
Bangladesh Engineering and Technological Services
Institute For Development Education and Action
Nature Conservation Movement

Canadian International Development Agency

Government of the People's Republic of Bangladesh
Bangladesh Water Development Board
Flood Plan Coordination Organisation

FLOOD ACTION PLAN

NORTHEAST REGIONAL WATER MANAGEMENT PROJECT (FAP 6)

CIDA Project No. 170/13339

April 1992

DRAFT THEMATIC STUDY

FISHERIES IN THE NORTHEAST REGION OF BANGLADESH

Shawinigan Lavalin (1991) Inc.
Northwest Hydraulic Consultants

in association with

Engineering and Planning Consultants Ltd.
Bangladesh Engineering and Technological Services
Institute For Development Education and Action
Nature Conservation Movement

Canadian International Development Agency

ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
BFRSS	Bangladesh Fisheries Resources Survey System, a DOF service responsible for collecting fish production statistics
BWDB	Bangladesh Water Development Board
CAS	Catch assessment survey
CBM	Community-based management (in fisheries)
CIDA	Canadian International Development Agency
DFO	District Fisheries Officer, of the DOF
DOF	Department of Fisheries (of MFL)
DOR	Department of Revenue (of the Ministry of Finance)
DRH	Department of Roads and Highways (of MOC)
FAD	Fish aggregating device, including katha and similar brush parks
FAO	Food and Agriculture Organization of the United Nations
FAP 6	Flood Action Plan component no 6 (= NERP)
FCDI	Flood control, drainage and irrigation project (ie as used in this report, any water management project which contains one or more of these three elements)
FRI	Fisheries Research Institute (of MFL)
GDP	Gross domestic product
GRP	Gross regional product
MFL	Ministry of Fisheries and Livestock
MIWDFC	Ministry of Irrigation, Water Development and Flood Control
MLGRDC	Ministry of Local Government, Rural Development and Co-operatives
MOC	Ministry of Communication
MOL	Ministry of Land
MSY	Maximum sustainable yield
MWRM	Multipurpose water resources management (an alternative concept to FCDI)
NERP	Northeast Regional Project (= FAP 6)
NFS	National Fishermen's Society
NFMP	New Fisheries Management Policy
WFP	World Food Programme (of the United Nations)

GLOSSARY

aratdar	Fish wholesaler.
beel	Floodplain lake, which may hold water permanently or dry up during the dry season.
crore	10 million unit of measurement.
borak kal	Ice plant.
dharma jal	Small portable lift net.
donga	Dugout canoe.
flan jal	Dip or push net.
ghat	Fish landing or assembly place.
goola	Turbulence in rivers, as over a deep hole (KOOM).
haor	Depression on the floodplain located between two or more rivers, which functions as a small internal drainage basin.
himagar	Cold store (freezer).
hizal gus	A tree species (Barringtonia racemosa) which is water tolerant and grows in haors. Its branches are used for katha.
jalmohal	A beel, river section, khal or other water body which is registered for revenue collection purposes as a 'fishery'.
jalmohan	A wealthy middleman who leases jalmohals from the government and then subleases to fishermen.
katha	Brush park type (= acadja) fish production system. Also known as pile fishery. Consists of piles of brush (usually hizal gus or bamboo) set in a beel, often covered with a mat of water hyacinth held in position with bamboo stakes.
kachuri pana	A noxious floating aquatic plant, water hyacinth (Eichhornia crassipes), which infests many waters in Bangladesh
khal	Drainage channel running across a haor, connecting a beel to a river.
khara jal	Large fixed lift net.
khas	Government owned land and water bodies.
kola	Temporary dry season fishing camp, situated near a beel in a haor or deeply flooded area.
koom	Deep hole in river channel.
lakh	100,000 unit of measurement.
lentic	Stagnant water bodies such as beels and ponds.
lotic	Flowing water bodies such as rivers, streams and khals.

management	In the context of 'fisheries management', the control and regulation of fishing effort on fish stocks. Revenue collection by government for leases or licenses does not constitute fisheries management per se.
mohajan	Money lender, middleman and fish collector.
nadi	River.
pile	see katha.
shawla	Algae.
sisu	Gangetic dolphin (Platanista gangetica).

TABLE OF CONTENTS

Preface

This study is one of a series of sectoral studies being produced by the Northeast Regional Project (FAP6) as one component of a larger water resource management and development planning process. It is intended to constitute a preparatory benchmark of the fisheries sector of the region, and does not represent a definitive planning output of NERP. Its 'draft' nature is emphasized.

Much use has been made of the following key source documents (although citations and quotations are not always specified): Ali (1991), Azadi (1985), BCAS (1989), CIDA (1989,1990), Chong et al (1991), Rahman (1989), Tsai and Ali (1985), World Bank (1991).

This report also draws on three field trip reports and a short NERP technical report (entitled: Fisheries and FCDI in the Northeast Region: are they compatible?), all written by the senior author.

1. INTRODUCTION

1.1 Scope

This report has as its objectives the compilation and evaluation of available information on fisheries in the Northeast Region of Bangladesh, and the impacts of FCDI projects on these fisheries. The focus is on openwater floodplain capture fisheries. The intent is to provide a substantive benchmark from which to plan the future activities of NERP within the fisheries sector. The report is based on available literature, nominal fisheries statistics of BFRSS, and findings to date of NERP fieldwork. All conclusions and recommendations contained in this report are preliminary in nature, and will be used as guidelines subject to review and adjustment during the planning phase of the NERP project cycle. A final fisheries study report will be included as an appendix to the Northeast Region Water Management Plan, scheduled to appear in draft form by August 1993.

1.2 Regional social and economic context

About 11% of the Bangladesh population lives in the Northeast Region. The middle projection estimate of the 1990 population of the Northeast Region is 12.5 million (low-high range of 12.0 and 12.7 million). This is expected to grow to 16.1 million (range 15.0-16.7 million) by the year 2000, and could reach 20.8 million (range 18.6-22.0 million) by the year 2010. These projections envisage a population growth rate of 2.6% (range 2.2% and 2.8%). The labor force (employed, self-employed, and unemployed persons actively seeking work) is 41% of the total regional population (5.1 million). Employed/self-employed persons constituted about 68% (3.5 million), and unemployed about 32% (1.6 million) of the labor force.

About 25% of the regional population (3.1 million) is occupied with household duties. These are mainly women who also participate in agricultural employment, in the home and in the field. 4% of the population (0.5 million) are enrolled in educational institutions.

Employment by principal economic sectors is as follows:

Agriculture	68.5%	2.4 million
cultivation	65.6%	2.3 million
other	2.9%	0.1 million
Manufacturing	3.6%	0.1 million
Business	8.2%	0.3 million
Other	19.7%	0.7 million
TOTALS	**100.0%**	**3.5 million**

Agriculture dominates the employment base. Seasonal changes in employment rates in agriculture lead to labor shortages during the harvest period. Gender plays a role in employment: in some areas, less than 2% of males over 10 years of age were fully employed, and only 2% of women were openly unemployed.

Land use in the Northeast Region is mainly oriented towards agriculture. Net cultivable area is 72% of the region (1.45 million ha). The remainder is 14% uncultivable hills, homesteads and infrastructure and 7% rivers and permanent water bodies. About three quarters of cultivable land is prone to flooding. Flooding and scarcity of surface water during the dry season restrict cultivation to a single crop in most areas. Absentee landlords prevent full utilization of existing potential of agricultural lands in some areas (including land which has benefitted from expensive full flood protection investment). The inundated part of cultivable land (9,800 km sq) supports an important

floodplain fishery. There are numerous ponds, but only 42% of pond hectarage is in active use for aquaculture production. Tree resources of the region are located on high land: homesteads, embankment sideslopes and forest reserves in hills. Hizal gus is grown in some haors for its branches which are used in the katha fish production system.

The gross regional product (GRP) in 1985-6 for the Northeast Region was a nominal 50 billion Taka (approximately 11% of GDP), although it is recognized that the contribution of the fisheries sector is undervalued and therefore the true GRP is higher. Given a medium population estimate of 11.0 million, the nominal per caput GRP is estimated as 4,500 Taka. In recent years a rapid improvement has been taking place in the participation of women in income earning activities, including civil construction works, manufacturing and government employment.

1.3 History of fisheries in the Northeast

Because the largest area of deeply flooded land occurring anywhere in Bangladesh is located in the Northeast Region (ie Sylhet Depression), and because Bangladeshis in general prefer the taste of freshwater fish, the Northeast Region has received much attention within the nation as 'the fish mine' of Bangladesh. During the present century, Northeast fisheries have undergone a major change in ethnic and tenure structure. At about mid-century, de-colonization and partition almost eradicated the previous monopolistic hold of the Hindu community on the fisheries sector. Muslim capital interests supported by the new national government took over the sector and introduced the system of leaseholding of beels (jalmohal leasing). Physical labor (ie fishing) also came to be dominated by Muslim fishermen, although certain Hindu castes of professional fishermen continue to exist today, partly in response to a certain demand for highly skilled fishing labor.

The change from Hindu to Muslim ethnic predominance within the fisheries sector has also apparently had an impact on stock levels. Currently there is little user group management and conservation of fish stocks, and a general prevalence of resource mining. It has been said that under the previous Hindu predominance there was greater effort to conserve stocks and respect customary/traditional fishery management practices.

2. FISHERIES ENVIRONMENTS

2.1 Physiography

The topography of the Northeast Region consists of a large central depression (Sylhet Depression) flanked by floodplains, then gently sloping piedmont plains, and bordered distally by piedmont hills extending into India (see fig.). The minimal elevation is 1.5 m asl in the Sylhet Depression, and the maximum is 30 m asl in the piedmont hills. The areas occupied by different physiographic zones are as follows:

Floodplains	73%	14,600 km sq
Piedmont plains	14%	2,800 km sq
Piedmont hills	6%	1,200 km sq
Permanent water bodies	4%	800 km sq
River channels (dry season)	3%	600 km sq
TOTALS	**100%**	**20,000 km sq**

There are some discrepancies in numbers and surface area data reported by various authors for water bodies (beels, rivers).

2.2 Climate

Two monsoons govern the climate of the Northeast Region. The *wet southwest monsoon* extends from May to late September. It originates over the Indian Ocean and carries warm, moisture laden, connectively unstable air. It provides most of the annual rainfall. The *dry northeast monsoon* extends from November through to mid-March. It originates over snow and ice-covered land masses, and carries dry, cool air during the winter months.

The abundant rainfall ranges from annual means of 2,200 mm to 5,800 mm (the latter in the Sylhet District area). It is quite concentrated during the wet season (95%). The dry winter months receive only 5% of annual rainfall and hence experience relative drought from November to February.

Maximum monthly mean air temperatures at Sylhet range from 30.9 to 33.4 degC during the wet season to 25.8 to 29.0 degC during the dry season, while the minimum monthly means are 21.0-24.5 degC and 8.5-16.6 degC, respectively. Mean relative humidity varies between 83% in the wet season and 64% in the dry season. Annual evapotranspiration is about 1,200 mm, and peaks during March, April and May. Evaporation exceeds rainfall during the dry season.

2.3 River systems and hydrology

The Northeast Region is 'water-rich.' Because of its special topographical and hydrological conditions it can be regarded as 'unique' in Bangladesh. Most of the region is a self-contained drainage basin (with catchment extending into India) separate and distinct from the other large river systems of Bangladesh (Jamuna, Padma). The region is drained by a single major river channel in the southwest: the Upper Meghna River. This river receives inflow from two large tributaries, the Baulai River coming from the north, and the Kushiyara River from the northeast. The Baulai itself is formed by the confluence of the Kangsha River (which flows from west to east) and the Surma river (which flows east to west). The Surma and Kushiyara share a common origin at the bifurcation of the Barak River which flow into Bangladesh from India at the extreme eastern part of the Northeast Region (at Amalshid). The Kangsha, Surma and Kushiyara receive lower order tributary inflows from numerous small rivers and streams draining the Meghalaya and

Tripura Hills, such as the Luba, Jhalukhali, Manu and Khowai Rivers. The western boundary of the Northeast Region is defined by the Old Brahmaputra River channel, which no longer conducts major discharge volumes due to siltation at its origin. The current meager bank overspill of the Old Brahmaputra River has reduced the water supply of rivers to the east (such as the Mogra River, which passes through Netrakona) which discharge into the Sylhet Depression. The Northeast Region is crisscrossed by numerous khals and silted up old river beds which conduct drainage flows rather than mainstream discharges.

The annual flood pattern has two distinct phases in the Northeast Region (see figure at end of chapter):

The early flood phase occurs during the early monsoon season when river and beel water levels are relatively low. It can begin as early as April and extend as late as June. Flash floods occurring in the piedmont rivers flowing from India spill water into haors through khals and as river overbank spill. Unembanked haors thus act to attenuate flood conditions in rivers (conversely, embanking of haors accentuates flooding further downstream). When the flood recedes water stored in the haors drains back into the rivers.

The deeply flooded phase begins when backwater from the Meghna system causes deep flooding throughout the Sylhet depression and extends into the haor areas of the Surma-Kushiyara floodplain. The haor areas remain as a large deeply flooded 'lake' until the Meghna levels recede at the end of the monsoon season.

All external streamflow into the Northeast Region comes from 21 catchments that extend into India. Mean monthly streamflow entering from India varies from over 7,000 cu m/sec in July to a low of about 220 cu m/sec in February. Streamflow generated directly within the Northeast Region from rainfall and groundwater discharge constitutes a significant part of total streamflow (between 30% and 80% of the inflow from India during the February to April dry season months).

The total surface area of water in river channels during the dry season is 832 km sq: the Upper Meghna River surface area is 336 km sq and other rivers in greater Sylhet and Mymensingh Districts cover 496 km sq.

During the rainy season, all rivers overflow on to the lateral floodplain, except for portions of the Surma, Kushiyara, Khowai and Kangsha Rivers which have full flood embankments. Low order affluent tributaries flowing into Bangladesh from the Indian hills, such as the Luba River, become spate streams, and attract spawning migrations of carp and other species.

During the dry season the upper parts of the Surma (upstream from Chatak), Kushiyara and Kangsha conduct little discharge and can be navigated only by country boats as the water level is very low (m). However the Upper Meghna River, the Baulai, the Surma as far as Chatak and much of the Kushiyara have good water levels (although discharge is minimal) and are used by large metal hulled transport boats which come up from Bhairab Bazar. This is due to tidal backing-up of the Upper Meghna River. The good water levels in these rivers during the dry season, and the existence of deep holes (KOOM) with turbulence (GOOLA), make them important dry season overwintering habitats for the brood stock of some commercially important species, particularly major carps and large catfish. It is therefore important to distinguish between tidally-influenced and non-tidally-influenced section of major rivers. Parts of the former's river beds are below sea level, especially the KOOMs, and can be thought of as arms of the sea.

Preliminary computer simulations indicate that even without affluent discharge from the catchments and without direct rainfall on the region, approximately one-third of the region would still be inundated annually due to tidal backing-up of the Upper Meghna River into the Sylhet Depression. This has major implications for the long term economic prospects the region as a whole - particularly, that it may never be possible to achieve a full cereal-based rural economy, and that fish (ie protein) production would appear to have an assured and substantial role in the region's long term development potential.

2.4 Floodlands, haors and beels

Of the total area of the Northeast Region of 20,000 km sq, approximately 73% (14,600 km sq) is occupied by floodplain , or flood lands. Flood land elevation variations are typically very small, and the very flat river gradients have led to the formation of a dominant morphological feature in the region called HAORS. These are depressions located between two or more rivers, and function as small internal drainage basins. One or more small lakes, called BEELS, are situated at the lowest points of the haor. The beels are usually connected to the rivers surrounding the haor by one or more drainage channels called KHALS.

The total number of beels in the Northeast Region have been variously reported between 3,440 (covering 585 km sq, 17 ha mean size) and 6,149 (covering 635 km sq, 10 ha mean size) (CIDA, 1989). Some 58% of the beels in the Northeast Region are permanent, while 42% are seasonal, or temporary.

Total numbers and areas of beels by district are:

Habiganj	1,003	49.3 km sq
Moulvi Bazar	413	65.9 km sq
Sunamganj	1,641	171.9 km sq
Sylhet	1,084	118.7 km sq
Kishorganj	821	117.8 km sq
Netrakona	987	111.1 km sq
Mymensingh	85	64.0 km sq

Sunamganj District has the largest number of beels of any district in the Northeast Region and in Bangladesh. About half are large (over 20 acres in area). About 400 are permanent. Of the remainder, 500 are likely to desiccate completely each year, and 500 might still retain some water at the end of the dry season.

The most important fish producing haors in the Northeast Region are:

- Hakaluki Haor (Moulvi Bazar District), 364 km sq.
- Hail Haor (Moulvi Bazar District), 244 km sq.
- Tangor Haor (Sunamganj District).
- Dekker Haor (Sunamganj District).
- Matian Haor (Sunamganj District), 63.8 km sq.
- Sunamoral Haor (Sunamganj District), 37.3 km sq.
- Gurmar Haor (Sunamganj District), 53.6 km sq.
- Khaliajuri Haor (Netrakona District), 150 km sq.

- Gangajuri Haor (Habiganj District), 159 km sq.
- Humaipur Haor (Kishorganj District), 62.6 km sq.

During the rainy season, the entire floodplain (with haors and beels), rivers and khals become a single sheet of water. Fish are widely dispersed, and access is freely open to the public. During the dry season individual beels emerge and are an overwintering refuge habitat for brood stock of most commercial and subsistence fish species. Thus, important and valuable fisheries (JALMOHAL) operate in the beels during the dry season, and large landings of both broodstock and juveniles are realized.

Over the last few decades a major change has occurred in the quality of the haor environment, as many typical wetland areas (marshy bogs and shallow beels) as well as grazing pasture lands have been converted into rice fields. This represents a serious (but perhaps not as yet irreversible) loss of biodiversity in the Northeast Region.

2.5 Ponds and borrow pits

There are 374,922 ponds in the Northeast Region with a total area of 19,173 ha (0.05 ha mean size). Most are borrow pits resulting from home construction site preparation.

An important microfishery real estate are the borrow pits running along road embankments. These are owned by the DRH and leased out for fishery purposes. Water supply is dependent on river overspill flooding and rainfall, while their fish resource is dependent on movement of fish on to the floodplain during the monsoon season. The stocks of mainly miscellaneous species are exploited for subsistence and minor commercial sale. During the early dry season katha are installed to harvest the larger species. They are often subdivided by fish fences with basket traps or bunds. Later the entire pit may be drained to remove all fish. Borrow pits are vulnerable to water deficits. As many are only 2 - 3 ft deep, they are prone to desiccation by the end of the dry season (if they have not previously been artificially drained, which is the usual practice when harvesting the fish). A constraint on improving the water storage capacity is that borrow pits cannot be excavated to deepen them because this might endanger the road embankment.

Borrow pits created during the course of FCDI construction works are owned by the BWDB and are also leased out for fish production by auction to the highest bidder.

2.6 Sedimentation

Because of their steep gradients the piedmont affluent rivers arising in the Indian catchment area carry large quantities of sand, gravel and stone. Sedimentation of some haors and beels has become a problem for both fisheries and agriculture, especially in the deeply flooded haors of Sunamganj District. Infilling of beels reduces mean depth and cubic meter months of dry season aquatic habitat, and converts some beels from permanent to seasonal status. Stone and gravel is deposited in the upper parts of most tributaries (ie Luba and Rokti Rivers).

Peat deposits in the form of lenses are fairly common. They are usually exposed along river banks, or may be uncovered during FCDI excavations or roadbuilding in haors. Peat is the object of a cottage mining industry. The dried peat is used for fuel.

2.7 Limnology

Although high turbidity due to silt and clay loads characterizes flood waters during the monsoon, river water gradually clears during flood recession. This allows good growth of algae and aquatic macrophytes in beels and some river stretches during the dry season. Apart from providing a source of food to secondary trophic producers, algae (SHAWLA) in the form of pheriphyton also constitute the most important pathway for fixing of atmospheric nitrogen, upon which good yields of rice in the haors are dependent (Catling, 1981). In shallow rivers during the dry season (such as the Surma River near Kanairghat), algae grows directly on the sandy river bed, as well on the brush and bamboo used in kathas. Sometimes algal growth is excessive. In Halir Haor fishermen complain that it forms large mats at the bottom of beels which interfere with fish movement (?) and nets.

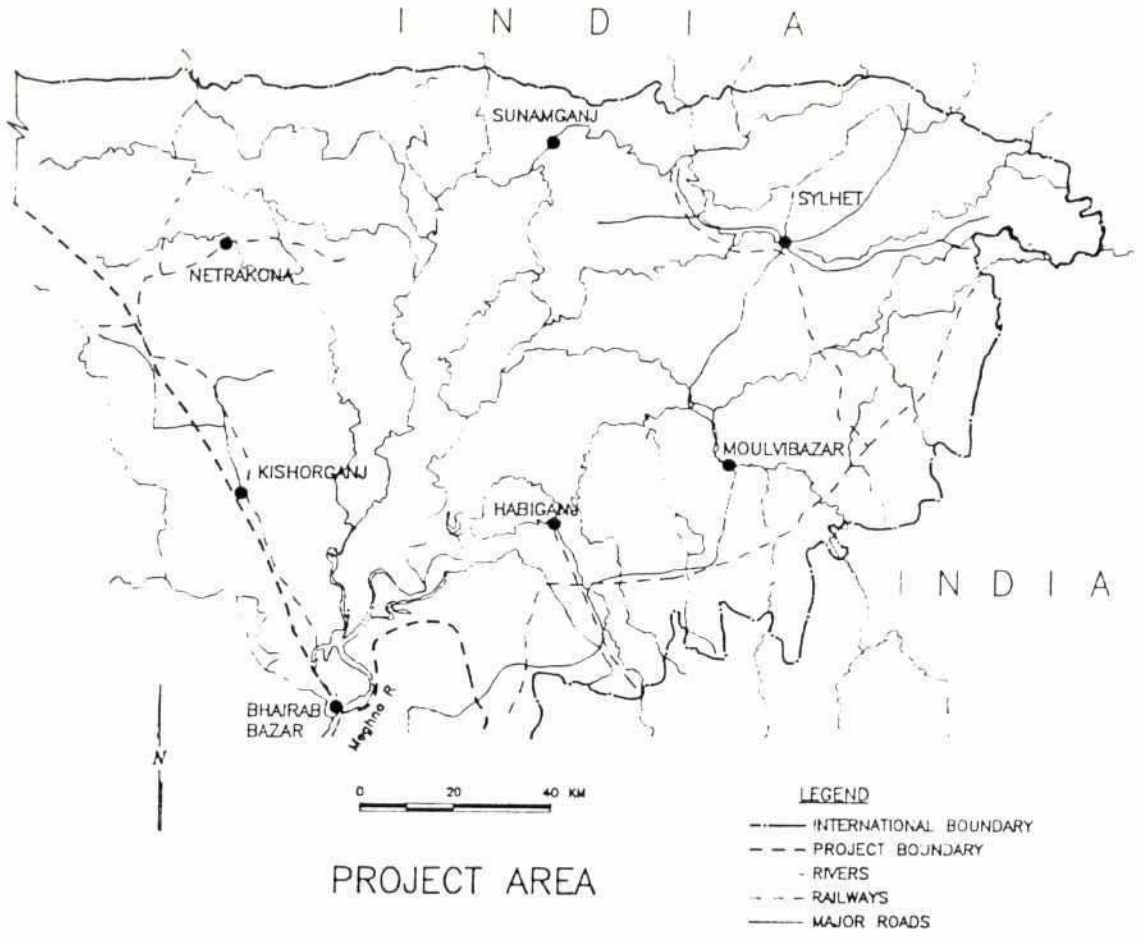
Infestation and overgrowth of smaller water bodies with KACHURI PANA (Water hyacinth, *Eichhornia crassipes*) appears to be a problem almost everywhere. Some domestic uses (fertilizer, fuel, cattle feed) and fisheries (covering mat for katha) are made of kachuri pana, but extensive overgrowth depresses fish production. It lowers water quality, plankton production and dissolved oxygen content (which many species cannot tolerate), and interferes with fishnets, thus reducing catchability of the stocks. Water lettuce (*Pistia stratoides*) also occurs in the region but is not particularly abundant, and therefore not a pest.

Water buffalo are plentiful in some areas and spend a lot of time wallowing in borrow pits. Their dung undoubtedly directly contributes to fertility of water bodies. Cattle graze on fallow rice fields and pasturelands of haors during the dry season and cattle fattening is an important economic activity. Cattle dung increases the productivity of floodlands when they are inundated (although much of this dung is collected and dried in the form of 'pizzas' for fuel).

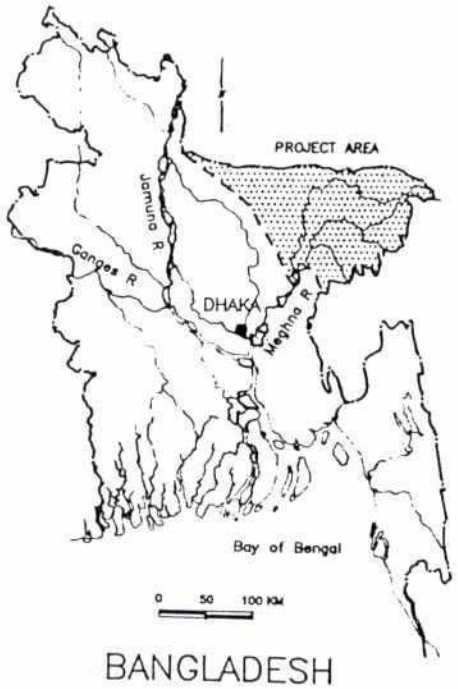
Hizal gus *(Barringtonia racemosa)* grows in many seasonal beels (especially in Sunamganj District), sometimes in small 'plantations'. The tree/bush becomes submerged during the monsoon and apparently acts like a natural katha. Beels with hizal gus are known to have much more fish present than beels without. Hizal gus can grow into a large tree, but most examples seen are short with a thick trunk. This is because the branches are removed periodically for use in pile fisheries. A large hizal gus plantation was established near Ajmiriganj several decades ago on the grounds of the Bithalong Hindu Temple. Apart from serving the local demand for branches for katha, the plantation was also intended to provide shade from the sun for worshipers.

The Gangetic dolphin, *Platanista gangetica* (SISU) is common in the Surma and Kushiyara Rivers, as far upstream as their origin from the bifurcation of the Barak River at the Indian border (at Amalshid). They are especially abundant in the rivers during the rainy season, when they also move on to the floodplain. During the dry season they stay in deep holes in the larger rivers. Their food consists of all varieties of fish species.

Serious problems of water pollution exist in the Surma River due to discharge of effluent from the pulp and paper mill and cement plant at Chatak, and in the Kushiyara River due to the fertilizer plant at Fenchuganj (although the latter is now scheduled to be shut down). Increasing use of insecticides may be reducing environmental quality and affecting fish catches. The use of fertilizers probably has a beneficial effect on fish production. Moreover, the roots and cut stems of rice plants also contribute after decomposition to the bioproductivity of the floodplain.

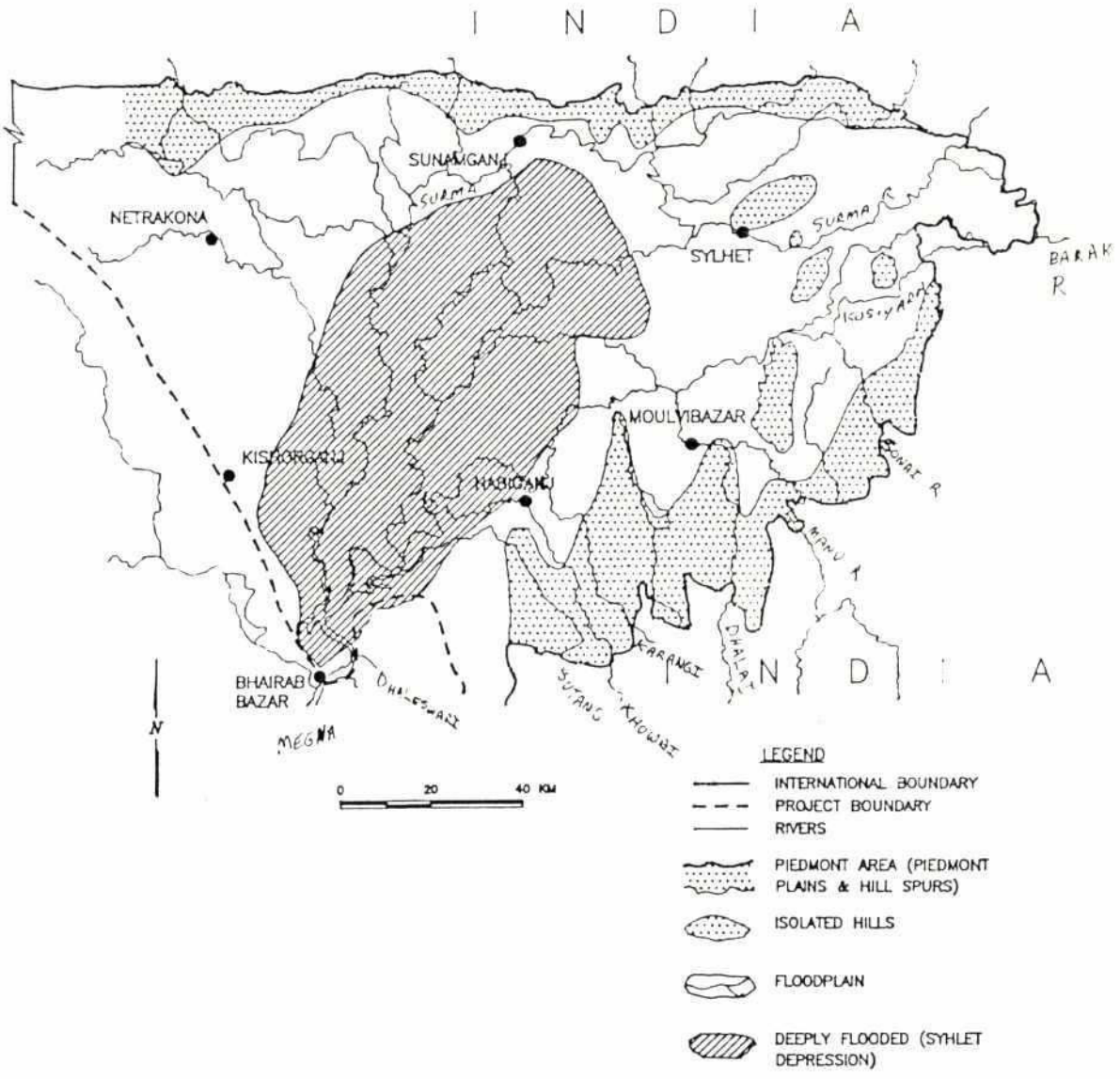


PROJECT AREA

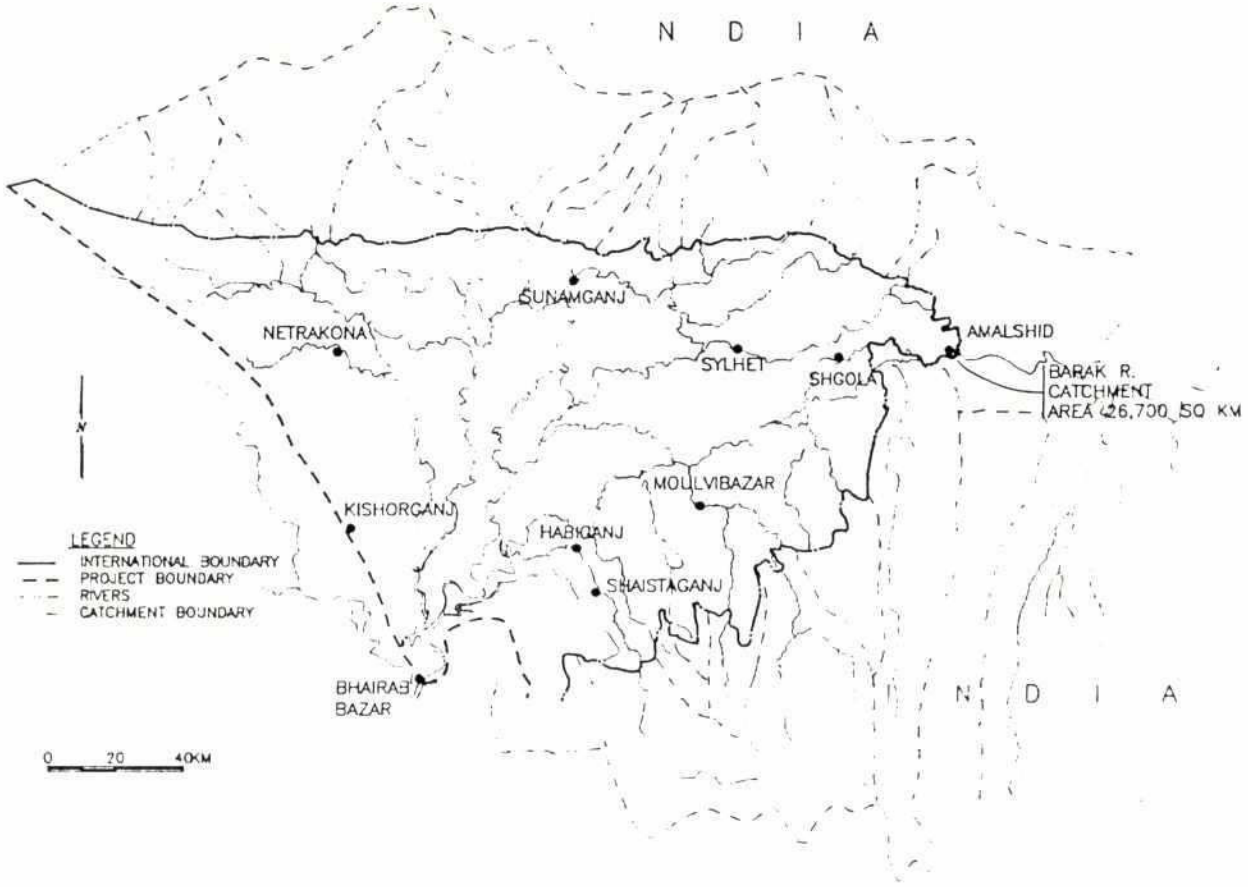


BANGLADESH

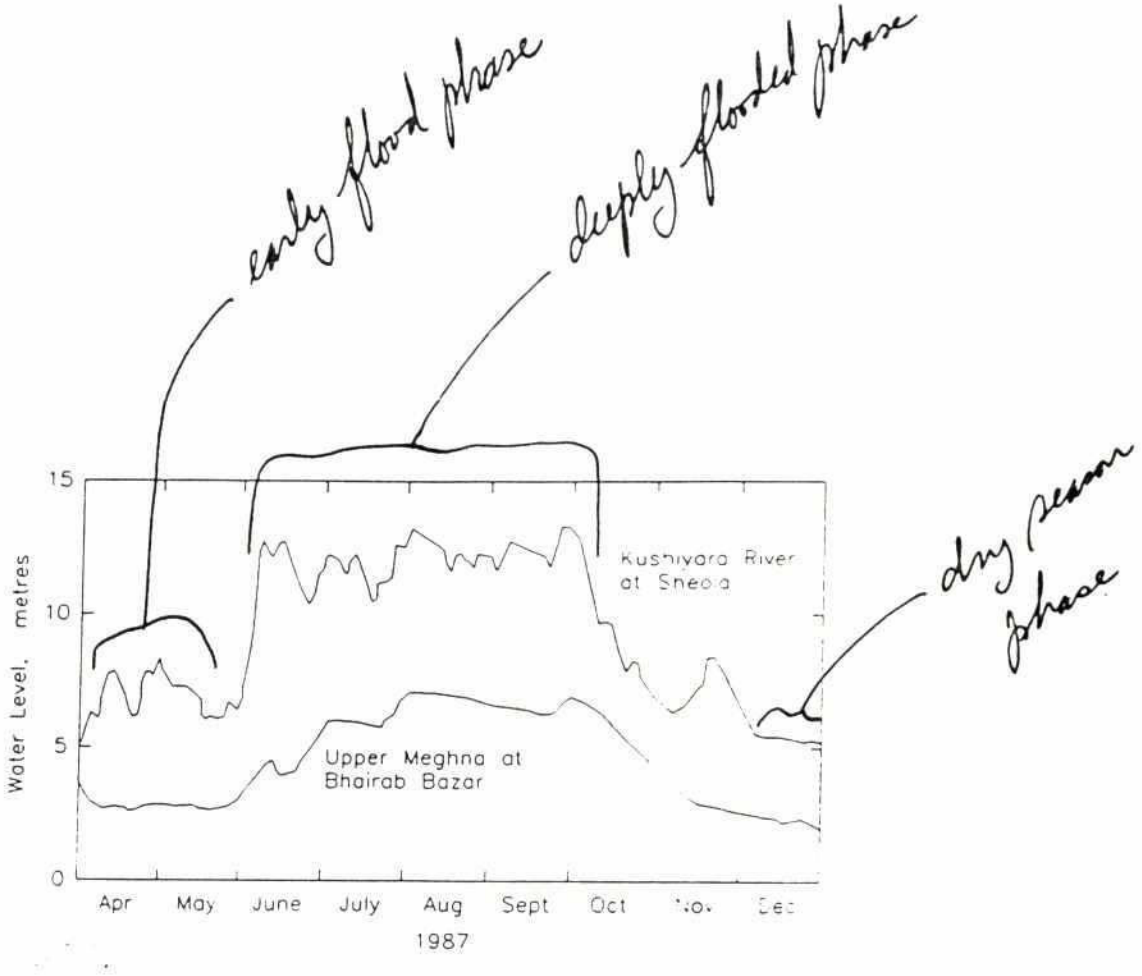
PROJECT AREA – NORTHEAST
REGIONAL WATER MANAGEMENT STUDY



PHYSIOGRAPHY OF NORTHEAST REGION



EXTERNAL CATCHMENTS TO THE NORTHEAST REGION



HYDROGRAPHS OF WATER LEVELS FOR THE KUSHIYARA AND UPPER MEGHNA RIVERS

3. FISHERIES RESOURCE BASE

3.1 Ichthyodiversity

Of the 260 species of freshwater fish known to inhabit Bangladesh, some 133 native plus 8 exotic introductions are known or suspected to inhabit the water bodies of the Northeast Region. These are listed at the end of this chapter, along with their common names. Cyprinids and catfishes dominate the ichthyofauna. Virtually all species are of some commercial importance in so far as they appear in retail markets. Major carps and large catfish are the most commercially valuable, but other groups such as the knifefish, 'livefishes' (KOI, MAGUR, SINGI), and herring (HILSA) are also very important. Miscellaneous species are of great importance for subsistence and self-provisioning. It is significant that even these species are attaining market importance and entering commercial networks.

Much of the life history information presented below is from Azadi (1985), Rahman (1989) and Tsai and Ali (1985).

3.2 Major carps

There are four cyprinid species which are commonly grouped as the major carps:

- RUI *Labeo rohita*
- CATLA *Catla catla*
- MRIGEL *Cirrhinus mrigala*
- KALIBAUS *Labeo calbasu*

[TOR MAHASEER (*Tor tor*) and PUTITOR MOHASEER (*Tor putitora)* are too rare at present in the Northeast Region to be considered commercially important major carp.]

The major carps are important commercial species. RUI is perhaps the most highly esteemed food fish in Bangladesh. RUI and CATLA are generally more abundant in markets than MRIGEL and KALIBAUS. RUI, MRIGEL and KALIBAUS are bottom feeders on plant matter and decaying vegetation. CATLA is a surface and midwater feeder. MRIGEL attains sexual maturity at 2 years of age RUI at 2 to 3 years, and CATLA and KALIBAUS at 3 years (Azadi, 1985). Tsai and Ali (1987) suggest that the major carp populations of the Surma and Kushiyara River basins might differ and that several different geographical populations may exist.

All four species are thought to have similar reproductive strategies. Brood stock overwinter the dry season in large rivers and beels. Spawning migrations occur during the early monsoon. Typically brood stock from beels swim down the khals and out into the rivers, then upstream to reach shallower areas which are favored spawning localities. Ox-bow bends in particular appear to be favored, probably because they possess unique hydrological features (deep pools in outer bend, turbulence, upwelling and backwater currents at inner bends [Tsai et al, 1981]). Eggs are non-adhesive and drift with the current. The embryo hatches out in 5 to 24 hours, depending on species. Yolk absorption takes 3 to 4 days, after which the fry begin feeding. Occurrence of drifting fertilized eggs and hatchlings is an indication of nearby major carp spawning grounds. Information on spawning localities in the Northeast Region is fragmentary. Well known spawning localities (ie spawn collection sites) are in the Old Brahmaputra River where spawn and hatchlings are collected from May to July. Jhingran (1983) notes that in India major carp spawn is found in the headwater streams of the Surma River (ie Barak River basin). This suggests that part of the Upper Meghna

River basin broodstock present in Bangladesh swims upstream into India to spawn (ie an internationally shared stock). Local fishermen and fisheries officers in Bangladesh state that 'major carp fry are available in many tributaries' (Tsai and Ali, 1985). Information on major carp spawning localities collected from fishermen and DFOs is as follows:

- Fishermen see spawn of major carp in the Surma and Kushiyara Rivers and catch fingerlings.
- Natural spawning of RUI, CATLA and MRIGEL takes places in the Surma River at Dwara Bazar (river section 79 x 2).
- RUI and MRIGEL (but not CATLA) are said to swim up the Luba River (tributary of the Surma River) during the monsoon.
- Fishermen say RUI and CATLA spawn in the Surma River near Kanairghat. Females with eggs are caught, but spawn in not seen drifting in the river.
- Major carp spawn in the Kushiyara River near Fenchuganj.
- Adult RUI and CATLA (females with eggs) are present in the Kushiyara near Sherpur during the rainy season according to local fishermen. They are said to spawn in the river. Other fishermen say they spawn mainly in beels. KALIBAUS are said to breed mainly in beels, and then move into the river.
- In Habiganj District, carp eggs (species unknown) have been found in the Kushiyara River. According to the Habiganj DFO major carp spawn from February to May. The spawning season has been gradually advancing in the calendar year. Previously spawning used to begin only around mid April and extend to the end of May. Carp are thought to also spawn in haor areas.

While major carp are known to spawn in rivers, it is interesting that some fishermen state that they spawn in beels. This needs to be investigated further. Khan and Jhingran (1975) and Jhingran and Khan (1979) report that RUI and MRIGEL spawn in fields adjacent to rivers which are flooded after heavy showers, and in shallow marginal areas of bundhs on flood fields. It may mean that major carp brood stock does not necessarily have to migrate across embankments into rivers to spawn. Increasing beel water levels during the early monsoon may be sufficient stimulus to induce them to spawn in their overwintering beels. Broodstock which have overwintered in rivers might thus have two options for spawning migrations at the onset of the monsoon: 1) swim upstream to locate suitable spawning habitats (ie oxbow bends) in the river, or 2) remain in the vicinity of the overwintering ground, wait until the river bank is overtopped and then move laterally on to the floodplain.

3.3 Large catfishes

Six species of large catfish occur in the Northeast Region:

- BOAL *Wallago attu*
- PANGAS *Pangasius pangasius*
- AIR *Aorichthys aor*
- GUIZZA AIR *Aorichthys seenghala*
- BAGHAIR *Bagarius bagarius*
- RITA *Rita rita*

BOAL is the most common species seen in markets followed by GUIZZA AIR and AIR. A few large BAGHAIR are regularly seen, but RITA and PANGAS are rare, at least in the upper parts of the region. PANGAS is occasionally caught in the Kushiyara River around Sherpur.

BOAL inhabits all manner of lotic and lentic water bodies. It breed in rivers (and possibly also in beels) during the monsoon in July and August. It is an extremely voracious piscivore. Its flesh is very tasty with few bones. AIR and GUIZZA AIR inhabit both rivers and beels. Spawning may take place from early April up to the end of August. A nest (breeding pit) is dug in soft mud of stream beds where the current is sluggish. Both males and females guard the nest. Egg incubation lasts about 26 hours. Yolk absorption takes 7 days. PANGAS usually lives in large deep rivers. It carries out long distance spawning migration, from the brackish estuarine lower delta up the Jamuna and Ganga Rivers into India. It spawns early in the monsoon over the inundated muddy islands of the main river channel. There is no evidence that PANGAS spawns in the Northeast Region. Occasional individuals appear at markets, and originate from the Kushiyara River. BAGHAIR occurs in low abundance in the Surma, Kangsha and Old Brahmaputra Rivers. It is a voracious predator. RITA is found in muddy rivers and is carnivorous.

3.4 Minor carps

The most common of the minor carps is GONIA (*Labeo gonius*), followed by LASU (*Cirrhinus reba*). NANDINA (*Labeo nandina*) and ANGROT (*Labeo angra*) were previously quite abundant but are now almost extinct in the Northeast Region. LASU feeds on plankton and detritus. GONIA breeds during the early monsoon in rivers and beels. Breeding sites are known from the Gorautra River near Bajitpur (Kishorganj District), where it is the most common carp, and from the beels of Halir Haor (Sunamganj District).

3.5 Small catfishes

Several of the numerous small catfish species are important commercially:

MAGUR (*Clarias batrachus*) is able to breathe air and is usually sold live (ie livefish). It can live in almost any type of habitat, but is usually found in stagnant and muddy water, in association with SINGI. MAGUR breeds during the rainy season (April to August) in shallow water. A hole is excavated for a nest, or nesting may take in bamboo or hollow palm trees. The eggs are guarded by the male and hatch out after 20 hours.

SINGI (*Heteropneustes fossilis*) is also able to breathe air and is sold as 'livefish'. It lives in ponds, ditches and haors, often in waters with decomposing organic matter or under water hyacinth mats. Sexual maturity is reached at one year of age. Spawning takes place during the monsoon months, April to July. There is no brood care. Incubation lasts 18-20 hours. Yolk absorption takes four days.

KANI PABDA (*Ompok bimaculatus*) and MADHU PABDA (Ompok pabda), collectively known as PABDA, inhabit all types of inland waters, from beels to rivers. They are commercially valuable. Little is known about their habits other than that they are omnivorous.

Two small schilbeid catfishes, BASA (*Eutropiichthys vacha*) and GHAURA (*Clupisoma garua*), are commonly available at retail markets. They are omnivorous and found mainly in rivers.

TENGRA refers collectively to a group of small bagrid catfishes of the genera *Batasio* and *Mystus*. They are considered very highly as both commercial and subsistence food fish. They are widely distributed in various habitat types.

3.6 Hilsa

Although of the greatest economic importance in Bangladesh fisheries as a whole, HILSA (*Hilsa ilisha*) is of only secondary importance in the Northeast Region. The adults migrate from the sea far up rivers to spawn. Some stock enters the Upper Meghna River, and may penetrate far up the Kushiyara and Surma Rivers. Thus, 1-2 kg females with eggs are caught in the Kushiyara River near Sherpur during the monsoon season. Two major spawning migrations of 4 and 5 year olds occur, peaking in March and August. Breeding, egg development and fry development take place in rivers. Eggs hatch after 18-26 hours. Yolk absorption is completed after 8 days. Small HILSA (JATKA) are the object of a special river fishery as they move downstream to the sea and can be caught in the Kushiyara River in Sunamganj District. Small HILSA occasionally appear in markets in the Northeast Region. Most adult HILSA sold is iced product originating from Chittagong and elsewhere.

3.7 Snakeheads

Five species of Channa occur in the Northeast Region:

- SHOL (*Channa striatus*)
- GAJAR (*Channa marulius*)
- TILA (*Channa barca*)
- TAKI (*Channa punctatus*)
- CHENGI (*Channa orientalis*).

They are voracious predators. Equipped with breathing organs, they are often marketed in 'livefish' form. They can travel overland and are capable of aestivating in the mud of dried out pond and ditches (to revive at the onset of the next monsoon). They are usually found in stagnant waters including beels. Breeding takes place during the early monsoon (March-April) in stagnant waters. A nest is constructed of aquatic weeds. The fry form shoals and are guarded by their parents.

3.8 Knifefishes

CHITAL (*Notopterus chitala*) is of substantial commercial importance. Aside from major carps, large catfish and snakeheads, it is the only other large fish taxon routinely seen at markets. It inhabits beels as well as rivers, but prefers clear water. During the rainy season they migrate on to the floodplain. They are also reported to spawn in rivers around Sunamganj. Breeding takes place in June and July. A nest is dug in the bottom mud. The adhesive eggs are deposited in the nest, on submerged aquatic plants or on branches of submerged trees. Both parents guard the nest. CHITAL is a carnivorous and predatory feeder.

FOLI (*Notopterus notopterus*) is a second but smaller species of knifefish. It is very abundant in stagnant as well as running waters. Breeding takes place in May and June. The eggs receive parental care. The diet is carnivorous.

3.9 Miscellaneous species

The remaining part of the ichthyofauna has been lumped together here as 'miscellaneous' species. This includes both commercial and subsistence taxa. The following groups require comment:

NEEDLEFISHES: KAIKKA (*Xenentodon cutcutia*) is very common in beels and flood lands. It is usually marketed in sun dried form.

MINNOWS, RASBORAS and BARBS: Various small cyprinids such as PUNTI, CHELA and JAYA regularly appear in markets in both fresh and sun-dried form. These species are also very important for subsistence consumption. They occur widely in virtually every type of aquatic habitat. The previously important SARPUNTI (Puntius sarana) has declined in recent years.

LOACHES: RANI (*Botia dario*) is regularly seen at markets. GUTUM (*Lepidocephalus guntea*) is widespread and used for subsistence.

ANCHOVIES and SARDINES: PHASA (*Setipinna phasa*), KACHKI *(Corica soborna*) and GONI CHAPILA (*Gonialosa manminna*) occur mainly in rivers, while CHAPILA (*Gudusia chapra*) is also found in beels, ditches and flood lands. They are important subsistence species and often sold in dry form.

SPINY EELS: BAIM (*Mastacembelus aculeatus*) is widely distributed in rivers, beels and flood lands. It is regularly seen at markets and enjoys good demand.

CLIMBING PERCH: KOI (*Anabas testudineus*) possesses a breathing organ and is usually sold as 'livefish'. It is tasty and popular, and sold at most markets. It is also a staple subsistence food item. It prefers stagnant water habitats and can travel overland. During the dry season it remains buried under the mud. Breeding lasts from May to July. Eggs float at the surface and there is no parental care. Hatching takes 18 hours, and yolk absorption 4 days.

GOBIES: BAILLA (*Glossogobius giuris*) is common in rivers, and caught at nite during the dry season by constructing low bunds out from the shore. It is carnivorous. Primarily of subsistence importance.

MUD PERCHES: MENI (*Nandus nandus*) is occaisonally seen at markets. It is predatory. Common in ditches and flood lands.

GLASSFISHES: CHANDA (*Chanda spp*) is found in beels, and is marketed in fresh and dry form.

3.10 Shrimps

The giant freshwater prawn (GOLDA CHINGRI, Macrobrachium rosenbergi) is widespread in rivers and beels and economically very valuable. Adults migrate downstream to spawn in estuaries and the sea. Juveniles move back into rivers to grow and mature. Small shrimp species are also abundant and are collectively known as ITCHA.

3.11 Exotic introductions

Five carps, two cichlids and one barb have been introduced to Bangladesh. All are present within the Northeast Region. The two TILAPIAs were intended primarily as pond fish and are widely distributed. Common carp appear to be established on floodplains and small numbers of adults are seen regularly at markets. Silver carp are raised in ponds and 0+ and I+ year classes are occasionally marketed. Bighead, grass and black carp are as yet not often seen at markets. The Thai Barb is not yet widely cultured.

FISH SPECIES OCCURRING IN THE NORTHEAST REGION

SYNGNATHIDAE, Pipefishes
- Microphis deocata KUMIRER KHIL
- Doryichthys cuncalus KUMIRER KHIL
- Doryichthys chokderi KUMIRER KHIL

ANGUILLIDAE, Freshwater eels
- Anguilla bengalensis BANEHARA, BAMOSH

SYNBRANCHIDAE, Mud eels
- Monopterus cuchia KUCHIA, KUICHA, KUNCHE

TETRAODONTIDAE, Puffers
- Tetraodon cutcutia TEPA, KUTKUITTA, POTKA

BELONIDAE, Needlefishes
- Xenentodon cancila KAIKKA, KAKILA

HEMIRHAMPHIDAE, Halfbeaks
- Hyporhamphus gaimardi EK THUITA, EK THOTA
- Dermogenys pussilus EK THOTA

CYPRINODONTIDAE, Killifishes
- Aplocheilus panchax TECHOUKKA, KANPONA, CHOUKKANI

CHANNIDAE, Snakeheads
- Channa striatus SHOL
- Channa marulius GAJAR, GAJAL
- Channa barca PIPLA, TILA SHOL, TILA
- Channa punctatus TAKI, LATA, LATI, OKOL, CHAITAN
- Channa orientalis GACHUA, RAGA, CHENG, CHENGI

PSILORHYNCHIDAE, Minnows
- Psilorhynchus sucatio TITARI

CYPRINIDAE, Carps, minnows, rasboras, barbs, suckers

LEUSCISCINAE, Minnows
- Oxygaster gora GHORA CHELA
- Salmostoma argentea CHELA
- Salmostoma phulo FULCHELA
- Salmostoma bacaila KATARI, NARKALICHELA

RASBORINAE, Rasboras
- Esomus danricus DARKINA, DANRIKA, DARKA, DADHIKA
- Chela laubuca LAUBUCA, KASH KHAIRA
- Aspidoparia jaya JAYA, LAIYA
- Rasbora elanga ALONG, SEPHATIA
- Rasbora rasbora DARKINA, LEUZZA DARKINA
- Rasbora daniconius DARKINA
- Barilius bola BHOL, BOL
- Barilius tileo TILA, TILA KOKSA, PATHARCHATA
- Barilius bendelisis JOIA, HIRALU, TILA, CHEDRA, KOKSA
- Danio devario DEBARI, CHAPCHELA, BANSPATA, CHEBLI
- Danio rerio ANJU

Danio aequipinnatus CHEBLI

CYPRININAE, Carps and barbs

Amblypharyngodon mola MOLA, MOLONGI, MOYA
Amblypharyngodon microlepis MOLA
Rohtee cotio KETI, CHELA, LOHASURA, DHIPALI
Chagunius chagunio JARUA, UTTI
Osteochilus neilli
Labeo gonius GHAINNA, GONI, GONIA, KURCHI
Labeo nandina NANDINA, NANDIL
Labeo calbasu KALIBAUS, BAUS, KALIA
Labeo rohita RUI, ROHIT, ROU, ROHU
Labeo angra ANGROT, KHARSA, KHARISH
Labeo pangusia GHORA MAACH, LONGU, GHORA MUIKHA
Labeo bata BATA, BHANGON BATA
Labeo dero KURSHA, KATAL KUSHI
Cirrhinus mrigala MRIGEL, MIRKA
Cirrhinus reba LASU, LAACHO, BHANGA, RAIK, TATKINI, BAT
Puntius sarana SARPUNTI, SARNAPUTI, SARALPUNTI, KURTI
Puntius chola CHALA PUNTI
Puntius guganio MOLA PUNTI
Puntius phutunio PHUTANI PUNTI
Puntius conchonius KANCHAN PUNTI, TAKA PUNTI
Puntius ticto TIT PUNTI
Puntius gelius GILIPUNTI
Puntius sophore PUNTI, JAT PUNTI, VADI PUNTI
Puntius terio TERI PUNTI
Puntius cosuatis KOSUATI
Tor tor MOHASOL, MOHAL, TOR MAHASEER
Tor putitora MOHASHOL, MAHASEER, PUTITOR MOHASEER
Catla catla CATLA, KATAL

GARRINAE, Suckers

Crossocheilus latius KALABATA
Garra gotyla GHAR POIA
Garra annandalei

COBITIDAE, Loaches

Nemachilus botia BILTURI, NATWA, BALICHATA
Nemachilus zonalternans
Nemachilus zonatus DARI, CHANKIRA
Nemachilus beavani
Nemachilus sikmaiensis
Nemachilus savona SAVON KHORKA
Acanthophthalmus pangia PANGA
Somileptes gongota POIA, GHAR-POIA, PAHARI GUTUM, PUIYA
Botia dario RANI
Lepidocephalus guntea GUTUM, PUIYA
Lepidocephalus irrorata PUIYA

Lepidocephalus berdmorei PUIYA
Neoeucirrhichthys maydelli

CLARIIDAE, Walking catfishes
Clarias batrachus MAGUR

SILURIDAE, Butter catfishes, Freshwater shark
Wallago attu BOAL, BOALMAS
Ompok bimaculatus KANI PABDA, BOALI PABDA, PUPTA, PAFTA
Ompok pabda MADHU PABDA

HETEROPNEUSTIDAE, Stinging catfishes
Heteropneustes fossilis SINGI

OLYRIDAE, Catfishes
Olyra kempi

CHACIDAE, Catfishes
Chaca chaca CHEKA

SCHILBEIDAE, Catfishes
Silonia silondia SHILLONG
Pangasius pangasius PANGAS
Ailia coila KAJULI, BASPATA
Ailiichthys punctata KAJULI, BASPATA
Pseudeutropius atherinoides BATASI
Eutropiichthys vacha BACHA, BASA
Clupisoma murius MURI BACHA
Clupisoma garua GHAURA, LAURA, LARIA

AMBLYCIPITIDAE, Torrent catfishes
Amblyceps mangois

BAGRIDAE, Catfishes
Rita rita RITA
Chandramara chandramara
Batasio tengana TENGRA
Aorichthys aor AYRE, AIR, AIRMAS
Aorichthys seenghala GUIZZA, GUIZZA AIR
Mystus cavasius KABASHI-TENGRA, GOLSHA, GOLSHA-TENGRA
Mystus bleekeri TENGRA, GOLSHA-TENGRA
Mystus tengara BAJARI-TENGRA, GHUITTA-TENGRA
Mystus vittatus TENGRA
Mystus armatus

SISORIDAE, Catfishes
Conta conta
Glyptothorax telchitta TELI, TELCHITTA
Pseudecheneis sulcatus
Gagata viridescens GANG TENGRA
Gagata youssoufi GANG TENGRA
Bagarius bagarius BAGHAIR, BAGMAS
Erethistes pussilus KUTAKANTI
Hara jerdoni KUTAKANTI
Hara hara KUTAKANTI

92

NOTOPTERIDAE, Knifefishes
- Notopterus chitala CHITAL
- Notopterus notopterus FOLI

ENGRAULIDAE, Anchovies
- Setipinna phasa PHASA

CLUPEIDAE, Shads, herrings, sradines
- Gudusia chapra CHAPILA
- Hilsa ilisha HILSA, ILISH, ILSHA
- Corica soborna KACHKI
- Gonialosa manminna CHAPILA, GONI CHAPILA

MASTACEMBELIDAE, Spiny eels
- Macrognathus aculeatus TARA BAIM
- Mastacembelus armatus BAIM, BAM, SAL BAIM
- Mastacembelus pancalus GUCHI, BAIM, PANKAL, TURI, CHIRKA

MUGILIDAE, Mullets
- Rhinomugil corsula KHORSULA, BATA, KHALLA
- Mugil cascasia KACHKI, BATA

ANABANTIDAE, Climbing perches, gouramies
- Colisa sota CHUNA KHAILSHA, BOICHA
- Colisa fasciatus KHAILSHA, KHALISHA, KHAILA
- Ctenops nobilis NEFTANI
- Macropodus cupanus
- Anabas testudineus KOI

GOBIIDAE, Gobies
- Brachygobius nunus NUNA BAILLA
- Glossogobius giuris BELE, BAILLA

NANDIDAE, Mud perches, leaffishes
- Nandus nandus MENI, BHEDA
- Badis badis KOI BANDI, NAPIT

AMBASSIDAE, Glassfishes
- Chanda nama CHANDA, NAMA CHANDA
- Chanda ranga CHANDA, RANGA-CHANDA, LAL CHANDA

SHRIMP
- Macrobrachium rosenbergi, GOLDA CHINGRI, CHOWICHA
- Small shrimp ITCHA, ICHA, CHINGRI

EXOTIC INTRODUCTIONS
- Hypophthalmichthys molitrix SILVER CARP
- Aristichthys nobilis BIGHEAD CARP
- Cyprinus carpio COMMON CARP, CARPIO
- Ctenopharyngodon idellus GRASS CARP
- Mylopharyngodon pisceus BLACK CARP
- Oreochromis mossambicus TILAPIA
- Oreochromis niloticus TILAPIA
- Puntius gonionotus THAI BARB

4. STRUCTURAL ORGANIZATION AND SUPPORT OF THE PRODUCTION SECTOR

4.1 Open water capture fishing and jalmohal leasing system

In the Northeast Region, the term *open water capture fisheries* refers to fisheries practiced in rivers, khals, beels, and on the floodplain. Borrow pits dug for home construction and used for fish culture are classified as *closed water culture fisheries*, but borrow pits left from road embankment and FCDI construction are approximately classifiable as open water capture fisheries. A few open water fisheries are in the hands of private owners in the form of WAQF estate or DEBOTTAR property, and income from these is used to maintain Muslim and Hindu religious institutions, respectively.

Information on water body ownership is taken mainly from BCAS (1989), Ali (1990) and original sources. All rivers, khals and beels (with the exceptions noted above) are the property of the Government under the MOL. A comprehensive system of water body registration is in existence which is used for the collection of revenue from the fishery resources contained by these waters. Thus, each river is segmented into compartments. Each compartment is defined as a single *fishery* (JALMOHAL, or water estate), and is coded with a name and number. All beels are similarly named and numbered as individual fisheries. In some cases several small beels are lumped together as a *group fishery* and this can include parts of adjacent rivers. In theory, all river and beel fisheries units, of which there are about 10,000 in the Northeast Region, are recorded in the revenue registers of district government. There are about 5,000 beel fisheries units.

The Government is interested to collect revenue from fisheries. It does so primarily by leasing out under MOL individual fisheries, usually through open auction. Deputy Commissioners are the custodians of all jamohals within their district. Lease planning and auctioning is carried out with the assistance of the Additional Deputy Commissioner (Revenue). The lease fee goes into the account of the DOR. River fisheries and seasonal (annual) beels normally are leased out for one year periods, while permanent beels are leased for 3 year terms. Some beel leases may run for 6 or, exceptionally, 9 years. Beels over 20 acres (8.1 ha) are leased by MOL, while some beels between 3 (1.2 ha) and 20 acres have been transferred to the revenue collection systems of Upazila Parishads for a token rent to MOL (in order to establish MOL ownership) in order for upazilas to lease them out and earn revenue for their own use. Beels under 3 acres are not leased out but the MOL allows local community residents to fish freely for subsistence purposes. Roadside borrow pits are leased out by the DRH, and FCDI borrow pits are leased out by BWDB.

Because lease fees for large beels may run into several lakhs taka, lease holders are usually rich status quo individuals who are not fishermen themselves. They act as middlemen (JALMOHANS). They may either hire fishermen as daily labor to carry out fishing operations on their behalf, or may sublease to fishermen (ie sell individual fishing rights for a fee). Daily fishing laborers are paid in cash and/or receive a small share of the catch. Most of the sales value accrues to the leaseholder.

Examples of lease fees and sublease fishing rights fees are as follows:

- 5 lakh/= lease fee for a small beel next to the Manu River barrage;
- 8 lakhs/= for Futahawaboni Beel in Hakaluki Haor for a three year lease. The value of the fish produced may be 100 lakhs/= over 3 years.
- 8 lakhs/= lease fee for a beel adjacent to the Gorautra River, near Patli (Kishorganj District).
- 100 - 200/= fishing rights fee for fishermen to set up a katha in the Mogra River (at Solisa, near Netrakona), payable to a middleman who holds the lease to that stretch of the river.
- 100/= for the right to use a FLAN JAL and 10,000 - 20,000/= for a BER JAL at Hail Haor, payable to a middleman who holds the beel lease.
- 50,000/= lease fee for a 32 acre stretch of the Kushiyara River near Sherpur. The leaseholder sells fishing rights to genuine fishermen for a fee of 1,000/= per boat per year.
- 1,000/= per net fee for fishing rights on a 5 mile stretch of the Kushiyara River near Sherpur, payable to the leaseholder.
- 50/50 division of catch between leaseholder and fishermen on a 3 km stretch of the Surma River near Kanairghat.
- 3,000/= for the right to set up a fish fence (DURI) across the Surma River near Kanairghat during the dry season, payable to the leaseholder. The auction lease fee paid by the leaseholder for a 3 mile stretch was 68,000/= (the fee was bid much higher than the normal auction fee of about 30,000/= due to rivalry between the incumbent and a challenger).

In certain public waters, such as a drainage canal near Netrakona, local people need not pay any fee to install katha.

Nationally, government collects about 46.4 crore/= from jalmohal leasing, and this constitutes an important source of revenue for national and local governments.

Some examples of lease fees for roadside borrow pits paid to the DRH are:

- 1,500/= per year, plus 15/= tax, for a one mile stretch, both sides of road, near Kulaura (Moulvi Bazar District);
- 3,000/= per year for a one km stretch, near Kanairghat (Sylhet District).

In practice, jalmohal leasing applies only to the period of the year when the individual river and beel fisheries are demarcated (separated) from other fisheries by land. During the monsoon flood season, when much of the Northeast Region is covered by a single continuous sheet of water, the jalmohal system is de facto canceled out because of the difficulty of enforcing private access rights to geographical boundaries that no longer exist. [Leaseholders usually post guards, often armed, around their jalmohals to prevent poor people and dacoits from taking fish during the dry season.] Customarily therefore there is open access to all fishermen on the inundated floodplain during the monsoon with no fishing fees payable (although jalmohal and fishing fees are paid on an annual basis). The biannual conversion of the Northeast Region's fishery resources from private access to public access through the agency of flood is of tremendous social and economic importance, as

the flood phase allows many poor local residents to share in the benefits of a resource which is concentrated in the hands of status quo during the dry phase (Sadeque, 1990). Inundation removes "the rigid borders of private property. The whole floodplain becomes a large pool of common property resource. Erstwhile privately held agricultural plots become capture fisheries ground, source of other aquatic resources and provide numerous boatmen opportunity to earn a living. In general, the floodplains become the only common property people, particularly the poor, can depend on to make a living."

Khals can come under private ownership. Such a situation arises when a breach in a river embankment occurs. This results in the formation of a new khal which crosses private agricultural land. Apparently the owners of the land cum khal are free to exploit the new khal for fish production without having to obtain a lease or license.

There are various type of share systems (and this list is not exhaustive):

- 50% to leaseholder, 50% to fishermen (ie arrangement for a DHR roadside borrow pit).
- a moneylender who pays the lease fee on behalf of a fishermen's coop, may, in addition to requiring repayment of the principal in cash, receive a share of the profits from the catch (which constitutes his interest).
- fishermen may be paid a flat daily wage rate.
- fishermen may get a small share of the catch.
- fishermen may get small cash shares of the proceeds of the sale of the catch.

The leasing system promotes overexploitation. Not only does the leaseholder believe it is his right to harvest all fish in his jalmohal, the fisherman is also driven to maximizing catch. He faces exploitation from middlemen, money lenders and government revenue collectors, and so has to catch enough to satisfy these exposures and also be left with enough for his family to live on.

4.2 New Fisheries Management Policy and genuine fishermen organizations

The jalmohal lease system is oriented toward generating revenue for government and substantial income for leaseholders. However it exacerbates exploitation of fishermen (who do not own their own produce and therefore realize only a small part of its full economic benefits) and leads to resource mining (as the leaseholder considers all fish in the jalmohal to be his personal property to be exploited so as to maximize his profit). The ownership of jalmohals by MOL severely weakens the capacity of the MFL to carry out its mandate to scientifically manage, protect and conserve the inland fisheries resources of Bangladesh.

Beginning in 1986, MFL has begun a major new initiative to overcome problems of exploitation of fishermen and resource mining. This is known as the New Fisheries Management Policy (NFMP). It seeks to divert the maximum benefits from fishing to the actual fishermen (termed genuine fishermen) and put into place management systems which attempt to ensure long term sustainability of fisheries resources. Under NFMP, access to fishing rights is only given to genuine fishermen. This is done through a process of local peer/official selection and certification and issuing of renewable annual fishing licenses to approved and listed genuine fishermen. Because most jalmohals are much larger than what one fisherman can harvest, the DOF has elected to license out jalmohals to fishermen collectives (ie cooperatives, associations, etc). The license fee is based on the lease fee that would have been collected had that jalmohal remained under the old

leasing system, as the Government insists that the aggregate total of all license fees for individual fishing gears issued for a particular jalmohal must be equal to the old lease fee. Because fishermen have little accumulated capital, NFMP also contains a credit component. The Krishi Bank has a credit window in support of NFMP and genuine fishermen to enable them to purchase gear. Resource conservation is to be achieved through installation of permanent kathas and similar FADs in designated 'sanctuary areas' within NFMP jalmohals. Closed seasons for certain species were also to be enforced.

Nationally, the MOL has handed over some 300 jamohals to NFMP under the direct supervision of the DOF. The NFS, representing the fishing industry, jointly administers with government through a Committee the 300 DOF supervised NFMP jalmohals (DOF/FAO, 1991).
Numbers of jalmohals under NFMP in various Northeast Region districts are as follows:

DISTRICT	NFMP
Sunamganj	43
Sylhet	7
Moulvi Bazar	4
Habiganj	6
Netrakona	8
Kishorganj	6
Mymensingh	7

New jalmohals are in theory brought under NFMP based on recommendations of the local NFS chapter.

In Habiganj, under NFMP, typically a fishermen society (with about 300 members) gets a beel fishing license at an annual starting fee of 1 - 3 lakh/= for a 6 year period. The fee increases by 10% each year, thus building government induced inflationary pressure into the cost structure of fish production. A bank loan to pay the fee costs 13% interest. In Halir Haor near Sunamganj, the Satidora Beel Group Fishery pays 2.57 lakhs/= for 3 years for fishing rights to Satidora Beel and Rotla Khal/Beel. The lease is held directly by the fishermen's coop and not by leaseholders. The group has fished here for 6 years. The value of the catch is 10 - 12 lakhs/=. The fee for the large Tangor Haor near Sunamganj is 70 lakhs/=.

NFMP does not appear to present any great impediment to the rent-seeking aspirations of ex-jalmohal leaseholders and money lenders. NFMP is subverted and defeated in a number of ways. If the license fee is too high only middlemen and moneylenders can afford to pay. Poor genuine fishermen cannot and must turn to them for credit. Middlemen are strong opponents of NFMP and try to take control of fishermen coops. They also try to extract fees for getting fishermen's names on to the district approved list of genuine fishermen. If the aggregate license fee for a particular jalmohal demanded of a fishermen's coop is too large, an ex-leaseholder may bribe coop leaders to sell him exclusive fishing rights to the beel in exchange for paying the fee. In one such case, the leaseholder went so far as to attempt to extract a tax on all shrimp caught in an adjacent river, as well as monopsony rights to purchase the shrimp at a fixed price. In some cases, NFMP thus simply reflects existing power relationships in fisheries rather than instituting a new trend.

In contrast, studies by BCAS (1989) on selected NFMP fisheries indicate that NFMP is a breakthrough in ensuring equity and benefits to genuine fishermen. The objective of increasing earnings of fishermen is by and large achieved under NFMP. Economic returns to capital and labor, catch value, net and pure profit and implicit daily wage rates were all significantly higher

for DOF/NFMP fisheries compared to MOL-leased fisheries. NFMP has been well accepted and appreciated by fishermen. Exploitation by middlemen is largely eliminated. Fishermen own their own produce and can market it themselves, thus increasing gross income. But resource conservation is more difficult to implement. There is presently no biological fisheries management at all. And not encouragingly, the Government's first concern continues to be revenue collection. Because of the DOR's insistence on high license fees, many fishermen who lack the opportunity to raise credit to pay the fee are not able to keep their fishing license and end up having to sell the fishing rights back to ex-jalmohal leaseholders.

So-called *fishermen societies* are parts of political parties, while *fishermen cooperatives* are under the MLGRDC. The top people in both are not fishermen. Fishermen coops have share systems for member benefits depending on the amount of work done and the size of the net brought into the fishery. However mushrooming growth of coops around highly productive jalmohals has presented problems, and many coops are still controlled by powerful middlemen who reap most of the benefits from the fisheries. Coops find their own positions and financial resources too weak to defend fisheries user rights. Members often don't play an effective role in obtaining leases of jalmohals or in fisheries management. A major problem with coops is that the officials/leaders may be corrupt. For example, the secretary of the Uttorlongla Fishermen's Committee, at Shadipur village, Hakaluki Haor, absconded with 5 lakhs/= that had been collected from members to pay the lease fee for their jalmohal. As a result the jalmohal reverted back to a middleman leaseholder.

At present the transfer of jalmohals from leasing to NFMP is very slow. Lack of serious political will is responsible for this feeble and timid effort lacking in determination. The DOF does not consider itself well equipped to 'manage' all jalmohals and therefore is not presently actively seeking their transfer. The MOL and DOR criticize the inability of the DOF to provide enough backstopping to genuine fishermen, and use this as an argument against transferring more jalmohal to DOF jurisdiction. The basic premise is that it is the DOF (and not the fishermen) who are supposed to be the managers of the fisheries. 'Management' is also used more in the sense of revenue collection rather than the conventional fisheries usage of regulating or limiting fishing effort on the fish stock.

4.3 Subsistence fishing

Subsistence fishing is of great importance for maintaining the nutritional health of the rural population. About 76.0% (838,000) of all rural households in greater Sylhet carry out subsistence fishing, and 57.4% (1,072,000) in greater Mymensingh. During the flood season, there is open access over the entire flooded area. No fishing licenses are needed. People can catch RUI, CATLA, BOAL, etc, at this time of the years (whereas during the dry season these fish are privatized and a costly license is required). However because the stocks are dispersed over a large area, catchability is low. During the dry season when stocks are concentrated and catchability is high, open access is restricted to local beels under 3 acres. In addition, land owners will attempt to harvest any fish present on their rice fields. Low bunds (AIL) are constructed around fields to regulate water levels. Fish fences and basket traps to harvest fish are installed at drainage cuts in the AIL in order to harvest fish. As the plot drains, the fish on the plot try to escape back towards the khal or river and are caught in the trap. Finally the field is fished out with FLAN JALs or cast nets. The fish represents free bonus high value produce from the farmer's field.

Leaseholders of large beels will sometimes allow subsistence fishing with FLAN JAL dipnets in marginal areas well away from their katha, but apparently this 'privilege' is being withdrawn in

many beels because even small miscellaneous species are becoming increasingly valuable and marketable.

4.4 Ponds and hatcheries

In the Northeast Region, the term closed water culture fisheries refers chiefly to aquaculture practiced in ponds. Most ponds are privately owned, but some have been acquired by MOL and are leased out as jalmohals. There are many government-owned khas ponds/reservoirs around urban areas which are derelict and could be brought into production.

Aquaculture is supported by some 20 public sector hatcheries in the Northeast Region. Hatcheries have now been designated as an industry by the Government, thus qualifying for low interest loans and other incentives. The supply of seed for village ponds is a lucrative and developing business. Prepared feed based on fishmeal is too expensive. The preferred locally available feed is rice bran. Mustard seed cake is also used.

4.5 Fishing vessels, gears and materials

Many types of fishing boats are used in the region, depending on water body type and fishing gear employed. These include:

- CHANDI NAUKA, 15 to 50 ft, drift netting for HILSA.
- BACHARI NAUKA, <50 ft, seine netting.
- DINGHI NAUKA, <30 ft, various types of nets.
- KOSHA NAUKA, 12 to 30 ft, various types of nets.
- DONGA, dugout <20 ft, light gear.

Most fishing boats are unmotorized plank canoes, using sail, paddle or pole propulsion. For operating large nets such as UTARJAL, two boats are joined together with a bamboo bridge to form a long stable working platform. Rafts made out of banana tree trunks are used for angling in calm waters in many places.

A great many different types of nets and gear are used in the Northeast Region. The specifications depend on target species, hydrological conditions, portability, labor intensiveness, capital costs, gear material availability and profitability. The more commonly observed fishing gears and methods are:

- *FLAN JAL* (= THELA JAL), a small triangular dip or push net on a bamboo frame. It is the most widely used subsistence fishing gear (ie the 'poor man's net'). The fisherman wades in the water, sometime up to his neck, pushing the net along the bottom. No fishing license is normally required to own and operate a FLAN JAL, however a middleman might ask for a fee of 100/= per year.
- *DORMO JAL*, a small, simple lift net, operated from the shore. The net is allowed to sink to the bottom, and then raised by pulling on a rope. The net is portable and can be moved easily and quickly from one fishing spot to another, but is limited to application in very small water bodies and from the shore. License fee is 1,000 - 2,000/= per year.
- *KHARA JAL*, a large, fixed lift net with a complicated frame. The net includes two horizontal lever arms to which the net is attached and a platform for the fisherman to sit. It catches small fish (PUNTI, TENGRA). Middlemen often own khara jals, and the

fisherman who actually operates the net makes little money.License fee is 3,000 - 4,000/= per year.

- *JHAKI JAL*, castnet. Owned by many subsistence fishermen, and also used to harvest beels. Catches small fish (TENGRA, SINGI, KOI, TAKI, ITCHA, PUNTI).
- *BER JAL*, or beach seine. It is hauled by a team of fishermen (usually 12 to 15) whose number depends on the size and weight of the net. It is used in beels, and also rivers during the dry season when water flow is minimal. Large mesh sizes are used for RUI and CATLA. Small mesh sizes are used in rivers for TENGRA, BASA, PUTI and ITCHA. License fees vary from 7,000 to 50,000/= per year.
- *UTARJAL*, a large conical net, 5 inch stretched mesh size, fished like a seine net. It is used for BOAL, AIR, CHITAL and BAGMAS. Typically, two canoes are joined together end-to-end with a bamboo bridge to create a long working platform from which to operate the net.
- *DAK JAL*, a large mesh gillnet used for RUI, CATLA and BOAL. Group fishing characterizes the use of this net. Typically, a group of eight canoes (each with 2 fishermen and a DAK JAL played out from the stern) arranges itself into a rough circle. Each canoe drops a DAK JAL and then is vigorously paddled outward away from the center of the circle, in a characteristic 'sunburst' pattern. The center of the circle is situated over KOOM known to harbor large carp and catfish.
- *CAPRI JAL*, a large net with very small mesh size, used for diminutive fish species such as KACHKI.
- *CURRENT JAL*, a small mesh (1 to 1.5 in stretched) monofilament net used to catch small species. It is an extremely effective net and has been declared illegal because of its potential to overexploit juvenile fish.
- *MOHAJAL*, a small mesh seine net, used in rivers for small species such as BASA, LARIA, BAPTA, KACHKI, CHAPATI and CHAPILA. Large mesh sizes are used for RUI, CATLA and BOAL. It is also fished from twinned canoes (see UTARJAL, above).
- Special basket traps are used to catch AIR in rivers.
- Spears are used for large catfish.
- *BORSI*, hooks and long-lines, baited with PUNTI, are used in many places for large catfish such as BOAL and BAGMAS.
- *DURI*, fish fence with basket trap(s). These can be quite small (ie spanning a bund opening in a rice field or a roadside borrow pit) to quite large (ie spanning the Surma River near Kanairghat). DURI are erected during the dry season from late October to March. Mostly small species of fish are caught (ie CHANKIRA, KACHKI, BAILLA, RANI, CHINGRI on the Surma River).
- *KATHA*, brush piles of hizal gus or bamboo, used to attract fish in beels and rivers during the dry season. Katha are in widespread use everywhere in the Northeast Region. Permanent beels are termed pile fisheries and are supposed to be fished only once every 3 years in order to allow fish to grow to maturity (although it seems unlikely that any individual fish will remain resident in the same katha for 3 years). Since such beels cannot be drained, katha brush parks are installed to attract fish and facilitate their capture. Katha are usually harvested in February and March. A blocking net is placed

around the katha, the brush is removed and the fish are harvested using cast nets or seines. Some leaseholders have begun harvesting katha every year or every second year. It is customary for leaseholders to allow some fishing each year for small species outside of the katha area for subsistence purposes, but this is no longer permitted by some leaseholders. Katha selectively attract carps (RUI, CATLA, MRIGEL, KALIBAUS, GONIA) as shown by the difference in species composition of annual and pile fishery catches. Small species such as TENGRA, ITCHA, PUTI and CHAPILA are also attracted. The katha typically has a mat of water hyacinth covering it, and bamboo stakes anchor the brush and mat in place. Some katha even have elaborate cane fences around them, and this converts them into 'fish pens'. Katha is highly efficient in harvesting fish from beels. This results in virtual total harvests each year. Materials for a katha cost 1,500 - 2,000/=. Middlemen may charge 100 - 200/= for the right to install a katha in a river.

- *DONGA* is a method for fishing seasonal beels. The 'donga' itself is a pond excavated in the outlet khal of a seasonal beel. Several katha are installed in the donga. Bamboo screens/blocking nets are set across the downstream end of the donga to prevent fish from escaping. The beel is harvested by a large group of people in the conventional manner with various types of nets. To avoid capture, many fish move into the donga where they congregate in the kathas and are easily caught.

Nets used in rivers are typically equipped with meter long bamboo floats which ride vertically in the water. This sinks the headline sufficiently to prevent it from becoming entangled in boat propellers. The juice of a local fruit called GAB is used to preserve nets. Although net factories are operated by BFDC, many nets are woven by hand by women.

4.6 Credit and investment

There are five possible sources of finance for fishing operations:

- Personal savings/capital. Status quo usually have sufficient personal resources to pay lease fees and fishing labor costs. Genuine fishermen generally are constrained by lack of personal capital.
- Informal creditors or moneylenders (MOHAJAN) finance most artisanal fishing activity. Fishermen coops sometimes raise loans from MOHAJANs from their own village. Sometimes they lend money outright to a fishermen cooperative or association, and sometimes they take on a lease in their own name and disburse credit in the form of subleases to fishermen. The sublease fee represents their principle, while a share of the catch represents their interest. Loan periods are often short and consequently interest rates are usually relatively enormous, in the order of 7-20% per month, compounded to 300-340% per annum. Loans are used to buy nets. Lease fees may be paid in part out of a mohajan loan and in part out of a fishermen's own capital savings.
- Community-based group savings institutions, most notably the Grameen Bank, are not especially well focused on the fisheries sector. They need to develop better programmes tailored for different fisheries needs: ie nets, boats, fish processing, etc.
- Formal institutional credit is geared more towards capital investment projects such as hatcheries (which have recently been designated as industries and hence qualify for concessional interest rate loans) or large-scale intensive pond operations. However some support exists for genuine fishermen. The Krishi Bank for example has a window for genuine fishermen under NFMP to enable them to purchase gear.

- Infrequently, a rich local benefactor may pay the lease fee on behalf of a group of fishermen.

A major problem with implementation of NFMP has been failure of banks (ie Krishi Bank) to come up with credit to genuine fishermen, although bound by government policy to do so. Banks request mortgages and other securities for loans, conditions which fishermen can not meet. In a few cases loans were granted and used successfully, but by and large the loans given were insufficient. The Krishi Bank fisheries investment window is more oriented towards capital investment projects, such as large intensive pond culture projects. But earmarked capital is very underutilized, despite a very competitive annual interest rate of 16%. Fishermen do not come and ask for loans to pay license fees. Many fishermen are not aware that the bank has a fisheries window. Boats and nets are acceptable security. Loan recovery is a major problem.

5. FISHERIES PRODUCTION TRENDS

5.1 Collection of nominal fisheries statistics

Prior to 1983/84, fish production estimates were based primarily on fish consumption data generated by Nutrition Surveys of Rural Bangladesh for 1962-64, 1975/76 and 1981/82. Adjustments were made for intervening years by incorporating results of Household Expenditure Surveys and DOF surveys. BFRSS was initiated in 1983/84 to provide a more systematic and sharper focused fisheries statistics collection service. BFRSS uses different statistical approaches for different water body groups:

- *River fisheries* production is estimated using CAS at selected fish landing points (ie fishing villages) for riverine fisheries. Raising factors are used to estimate catch for the total number of canoes (determined from frame surveys) operating on a particular river.
- *Beel* production estimates are derived by determining mean yield per unit area for some selected beels through surveys, and then multiplying by the total area of beels in each greater (old) district.
- *Subsistence catch on flood lands* is determined by CAS of sample households in selected villages to determine the mean catch per household and raising this by the total number of fishing households. The latter is calculated by multiplying the total number of all rural households by district (as determined by the Bangladesh Bureau of Statistics) by the ratio of subsistence fishing households obtained by the DOF CAS.
- *Ponds* are classified by the categories: cultured, culturable and derelict. CAS determine mean yields for each category, and total production is calculated by multiplying the aggregate pond areas by mean yields.

Raw data is collected in the field by DOF scientific officers from sampling stations and sent to Dhaka were it is processed. There is currently a two year backlog of data due to insufficient processing capacity.

BFRSS requires further development and strengthening. Shortcoming of the system include small samples and too few sampling villages. Some 24 river fishery landing points are sampled in the Northeast Region, and the head of BFRSS feels that this is too few. He would like to be able to do sampling at the upazilla level. This requires more and better trained manpower. Poor supervision of field enumerators also leads in some cases to fabrication of raw data.

Staff employed by BFRSS include 64 survey officers (one for each district), 4 divisional scientific officers and 10 technical officers in Dhaka. It is not possible to increase the number of staff out of Government revenue. So BFRSS will try to do this through a project. Besides field staff, there is also a need for more staff in Dhaka to process raw data. Currently there is a backlog of two years. There is only one computer presently functioning.

The last river fishery frame survey was done in 1981/82, with FAO support. Data on the number of canoes from this frame survey is still being used today even though the situation has undoubtedly changed over the years (the justification is that it is better to use the old frame survey data than no data at all). There is no data available on the numbers of fishermen. BFRSS is looking for donors to finance a new frame survey.

Given the complexity and diffuseness of floodplain fisheries in Bangladesh, collection of reliable statistics is a daunting task even with the best of conditions and resources. Greater use might be made of consumption and market surveys (carried out by other government agencies) for comparison with BFRSS outputs.

Opinion varies on the accuracy of BFRSS statistical data products, especially for more recent years given the use of old raising factors based on the 1981/82 frame survey. One might have some reservations on the capability of BFRSS to 'see' actual production trends, but it would be unjustifiable to regard the system as completely 'blind' to historical truth. It is here accepted that the indicated trends are approximately correct but subject to an enumeration error.

As published annually by the DOF, fish catch statistics of Bangladesh are aggregated by administrative unit into old (greater) Districts. Thus the primary statistical geo-administrative units applying to the Northeast Region are old Sylhet and old Mymensingh Districts. These units approximately but not exactly overlap the area covered by NERP. Since it is not possible to conveniently reaggregate BFRSS statistics to exactly conform to the NERP 'region', they are used here in unmodified form. Pre-BFRSS statistics are not considered.

5.2 Production trends

The discussion below is based on the nominal statistics produced by BFRSS for the 6 year period 1983/84 to 1988/89. Statistical data tables and text figures are presented at the end of this chapter.

Overall fish production in the Northeast Region has shown an average annual growth of 3.8%, increasing from 95,895 to 114,273 tons (18,378 tons or 19.2% increment). Openwater capture fisheries grew by 3.0% per annum, from 83,555 to 96,198 tons (12,643 tons or 15.1% increment). Species composition of capture fisheries production is dominated by miscellaneous species, which increased from 48,018 tons (57.5% of total) to 58,331 tons (60.6% of total). HILSA and livefish production also increased. Carp and catfish production decreased over most of the period, but recovered in 1988/89. Large shrimp also declined, while small shrimp show an initial increase followed by a decrease.

Rivers are the most important harvesting habitat in the Northeast Region, accounting for 31.6% of overall production in 1988/89. Mean annual growth was 3.2%. About 40% of riverine production comes from the Upper Meghna River (mainly the stretch in greater Dhaka and Comilla Districts), and 60% from its tributaries (ie Surma, Kushiyara, Kangsha, etc, which are collectively termed *other rivers*). Upper Meghna River production grew by a mean annual rate of 6.9%. Miscellaneous species and HILSA dominate the catch, the latter increasing significantly. Production from other rivers grew by 3.1% annually . There has been a major increase in catches of miscellaneous species, and severe declines in carp and catfish (although a significant carp recovery was recorded in 1988/89).

Beel production constitutes 29.3% of overall production. Mean annual growth in output was 3.7%. It is widely reported in the Northeast Region that this year's catches (1991/92) are down compared to last year (1990/91). A possible explanation of this is that the production boom resulting from the extensive floods of 1987 and 1988 was fished out in 1988/89, 1989/90 and 1990/91. Thus in 1991/92 fish biomass was reduced. Around Sunamganj beel fishing began late this year because of high water levels due to heavy unseasonal rains in December 1991. Seasonal beels are termed *annual fisheries*. During the dry season in March-April they are completely harvested. Katha are sometimes (but not normally) installed in annual beels. Often the water is drained out to facilitate

capture of all fish. A whole village may participate in the annual fish out, which has a festive air (community fishing). Permanent beels are termed *pile fisheries* and are supposed to be fished only once every 3 years in order to allow fish to grow to maturity. Since such beels cannot be drained, katha brush parks are installed to attract fish and facilitate their capture. Katha appear to selectively attract major carps (RUI, CATLA, MRIGEL, KALIBAUS) and especially the minor carp GONIA as shown by the difference in species composition of annual and pile fishery catches. Carp constitute 29.1% of pile fishery production, but only 8.4% of annual fishery production. The aggregate percentages for large catfish (BOAL, AIR) and for small shrimp are similar for the two beel fishery types. The other species not listed in the tables are much more important in the annual fishery (62.1%) than in the pile fishery (37.1%).

The subsistence fishery on floodlands constitutes 23.3% of overall production, and has grown annually by 5.7%. Miscellaneous species dominate the catch (of which snakeheads are an important component). Catfish, livefish and small shrimp are important secondary components. Carp are of only marginal importance. Much of the floodland subsistence fishing takes place during the monsoon when the floodplain is inundated.

DRH and BWDB borrow pit production is not recorded separately from floodland production. Most of the catch consists of small species: SINGI, PUTI, BAIM, ITCHA, GUTUM, KAIKKA, KOI, MAGUR, FOLI, TAKI and KACHKI.

Closed water (pond) culture fisheries grew by 9.7% per annum, from 12,340 to 18,075 tons (5,735 tons or 46.5% increment). Ponds contribute 15.8% of overall production. Pond production in greater Mymensingh District is mainly major carps, while in Sylhet AIR, PUNTI and other species are also of importance. Collection of natural carp spawn from the Old Brahmaputra River to supply ponds has declined steeply, but a small recovery took place in 1989. This is a lucrative business as spawn can sell for up to 5,000/= per kg.

5.3 Biomass, MSY and yield estimates

No estimates have been made of overall fish standing crop (biomass) for the Northeast Region. Because fish stocks are on the whole not rigidly tied to any one major aquatic habitat and can move relatively freely between rivers, floodlands and beels, standing crop estimates for discrete habitats are limited in their usefulness from the prospectus of the whole floodplain (which still largely functions as a single holistic, dynamic and integrated system in the Northeast Region). It is probably true to say that for many species any individual fish specimen represents a biological production composite originating from river, beel and floodplain habitats.

An empirical approach to obtain a robust first approximation of MSY is to equate catch with maximum flooded area (Welcomme, 1985). The relationship determined from catch and area data of 25 tropical floodplains exploited at a reasonably intense level is:

$$C = 4.23\ A^{1.005}$$

where: C is catch in tons
A is area in km sq

The range of yields fall between 40 and 60 kg/ha/yr.

As the maximum area flooded in the Northeast Region is 16,000 km sq (floodplain plus permanent water bodies plus river channels), MSY is calculated at 71,000 tons (yield of 44 kg/ha/yr). Actual capture fishery production from the Northeast Region is between 80,000 and 97,000 tons (yield

range of 50 - 61 kg/ha/yr). This is greater than the empirically predicted MSY, but still within the upper part of the range expected from tropical floodplain fisheries. This suggests that the fish stocks of the Northeast Region are probably heavily exploited.

The observed increase in miscellaneous species (which are mostly small sized species) would appear to be in agreement with conventional wisdom which predicts that FCDI will drive species composition towards small species. However, a change in the species composition from larger to smaller species is a normal feature of heavily exploited floodplain fisheries which is unrelated to FCDI (except in cases where FCDI increases the catchability of fish stocks). Tsai and Ali (1985, 1987) presented evidence that major carp stocks in beels in the Northeast Region were being severely depleted by overfishing. 'Fishing out' of larger slow growing species certainly appears to be taking place everywhere in the Northeast Region and affects both predatory species (ie large catfish) and non-predators (ie major carps). This may be due to intensification of beel harvesting by leaseholders (annual and biennial harvesting of katha) and general intensification of subsistence fishing due to the increase in population, rather than a direct FCDI effect. The declines in carp and catfish production evident from the statistical data suggest that the high levels of fishing mortality on carp and large catfish exceed the level sustainable by the stocks. Removal of large species from the environment can be expected to create more 'ecological space' for small species (which have a faster turnover rate), and the present boom in subsistence catch supports this. However it is not clear how much additional fishing mortality the stocks of small species will be able to sustain before also entering a decline. Catch versus effort models of floodplain fisheries indicate that catch reaches a broad plateau that is sustainable (but without increasing) over a wide range of effort before finally collapsing (Welcomme, 1985, and see text figures at end of chapter). Be that as it may, the increase in production of miscellaneous species in very timely in view of the high rate of population growth, since the subsistence fishery for small species provides most of the dietary animal protein of the rural poor. It may even be viewed as a desirable resource allocation equity shift within the broader Northeast fisheries.

Year to year variation in catch is a normal feature of floodplain fisheries. Studies on tropical floodplain fish production dynamics in other parts of the world have shown that a significant part of this variation can be attributed to annual variation in flood intensity. The most general index of flood intensity in the Northeast Region is the discharge of the Upper Meghna River at Bhairab Bazar. Preliminary correlation analysis between annual catch and mean discharge in June and July (normally the peak flow months) indeed shows a positive correlation, with probability due to chance of between 5% and 10%. However, considerable more analytical refinement will be required before any valid application of hydrological indices for predicting fish yields will be possible.

It is interesting to note that, in general, year to year % changes in rivers and flood land production are much greater than fluctuations in beel (and pond) production. The average % change in any direction of the Upper Meghna River is $\pm$14.1%, other rivers $\pm$15.8%, and flood lands $\pm$20.5%. Beels in contrast vary only $\pm$ 4.6%. This is most probably due to a general difference in lotic and lentic habitats arising from hydrological variables driving fish production. Variation in catch of rivers is a function of river discharge and catch of flood lands is a function of area flooded, both of which can vary widely from year to year. Beel area, after flood recession, is probably more constant from year to year and the carrying capacity is probably fixed within a narrow range.

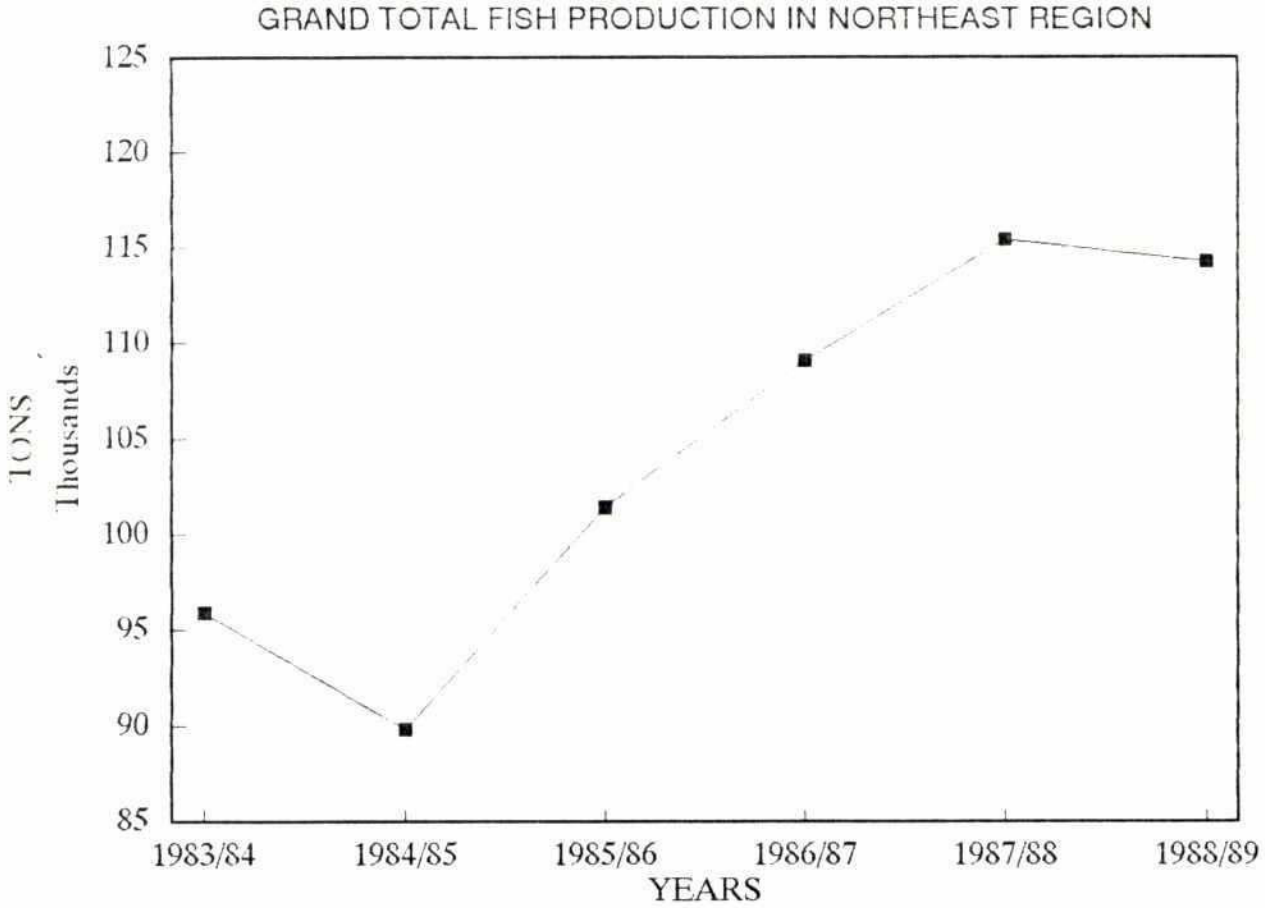
Nominal DOF statistics indicate a recovery of carp catches in 1988/89, probably due to heavy flooding in 1987 and 1988. This could imply that even if carp stocks and other fish stocks are overharvested, they have a capacity to recover during periodic heavy flood years.

Overall fish production in Northeast Region,
broken down by water body groups and greater districts.

in metric tons

WATER BODY \ YEAR	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1988/89 % GRAND TOTAL
UPPER MEGHNA RIVER							
Sylhet	755	1853	3058	2292	2662	1806	
Mymensingh	1234	1677	872	632	607	1025	
Comila	3668	2639	5679	5200	3732	6347	
Dhaka	5183	4255	5169	8255	7855	4952	
Subtotal	10840	10424	14778	16379	14856	14130	12.4%
OTHER RIVERS							
Sylhet	NA	7591	8789	8659	11531	11272	
Mymensingh	NA	15916	8978	9796	12132	10681	
Subtotal	20417	23507	17767	18455	23663	21953	19.2%
TOTAL RIVER FISHERIES	31257	33931	32545	34834	38519	36083	31.6%
BEELS*							
Sylhet	14715	15519	16993	15999	17098	17999	
Mymensingh	13233	13734	12811	13152	13479	15478	
Subtotal	27948	29253	29804	29151	30577	33477	29.3%
FLOOD LANDS							
Sylhet	16976	9837	15259	15300	15596	14812	
Mymensingh	7374	6731	11030	12434	12437	11826	
Subtotal	24350	16568	26289	27734	28033	26638	23.3%
TOTAL CAPTURE FISHERIES	83555	79752	88638	91719	97129	96198	84.2%
PONDS							
Sylhet	3905	2625	5561	9603	8722	8340	
Mymensingh	8435	7450	7227	7769	9551	9735	
Subtotal	12340	10075	12788	17372	18273	18075	15.8%
GRAND TOTAL	95895	89827	101426	109091	115402	114273	100.0%

* 1989/90 beel production: Sylhet = 19,030; Mymensingh = 13,984; Subtotal = 33,014.



Northeast Region is defined as greater Sylhet and Mymensingh Districts, plus the entire U

Species composition of overall fish production in Northeast Region, broken down by water body groups.

in metric tons

WATER BODY SPECIES \ YEAR	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89
UPPER MEGHNA RIVER						
Carp	705	451	496	48	86	630
Catfish	256	227	464	52	249	316
Livefish	92	0	0	0	0	0
Hilsa	2466	1971	3778	5611	5882	5357
Big shrimp	1240	1511	81	20	38	168
Small shrimp	0	1418	1707	1020	833	1213
Miscellaneous	6081	4846	8252	9628	7768	6446
Subtotal	10840	10424	14778	16379	14856	14130
OTHER RIVERS						
Carp	5822	6703	1971	784	804	3435
Catfish	2980	3431	1581	753	710	739
Livefish	802	923	1	26	0	8
Hilsa	618	711	1504	1940	689	1517
Big shrimp	1	1	6	15	11	0
Small shrimp	0	0	665	240	215	290
Miscellaneous	10194	11738	12039	14697	21234	15964
Subtotal	20417	23507	17767	18455	23663	21953
TOTAL ALL RIVERS						
Carp	6527	7154	2467	832	890	4065
Catfish	3236	3658	2045	805	959	1055
Livefish	894	923	1	26	0	8
Hilsa	3084	2682	5282	7551	6571	6874
Big shrimp	1241	1512	87	35	49	168
Small shrimp	0	1418	2372	1260	1048	1503
Miscellaneous	16275	16584	20291	24325	29002	22410
Subtotal	31257	33931	32545	34834	38519	36083
BEELS*						
Carp	6696	7009	7141	6985	7326	8021
Catfish	5198	5441	5544	5422	5687	6227
Livefish	196	205	209	204	214	234
Hilsa	0	0	0	0	0	0
Big shrimp	0	0	0	0	0	0
Small shrimp	833	872	888	869	911	998
Miscellaneous	15025	15726	16023	15672	16438	17997
Subtotal	27948	29253	29804	29151	30577	33477

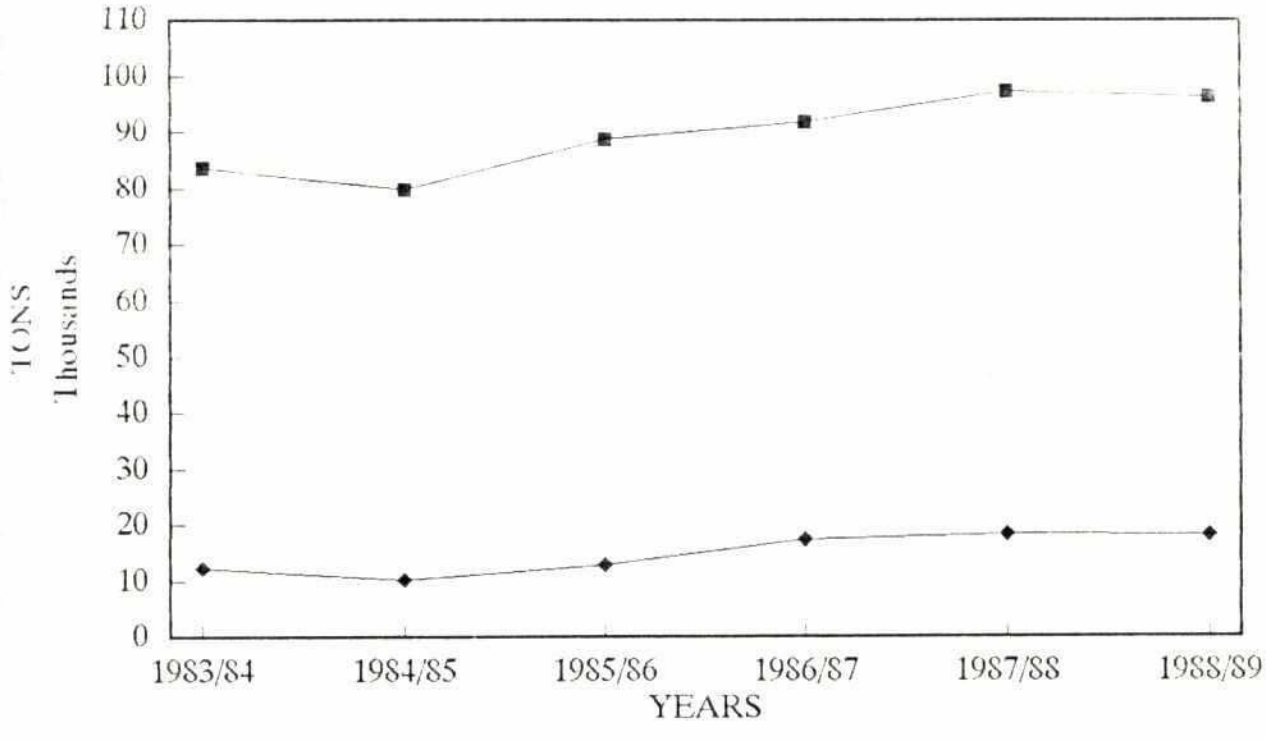
FLOOD LANDS						
Carp	40	36	60	67	67	0
Catfish	341	271	437	479	482	1030
Livefish	4054	2996	4803	5177	5215	5846
Hilsa	0	0	0	0	0	0
Big shrimp	0	0	0	0	0	0
Small shrimp	3197	1869	2903	2920	2975	1838
Miscellaneous	16718	11396	18086	19090	19294	17924
Subtotal	24350	16568	26289	27733	28033	26638
TOTAL CAPTURE FISHERIES						
Carp	13263	14199	9668	7884	8283	12086
Catfish	8775	9370	8026	6706	7128	8312
Livefish	5144	4124	5013	5407	5429	6088
Hilsa	3084	2682	5282	7551	6571	6874
Big shrimp	1241	1512	87	35	49	168
Small shrimp	4030	4159	6163	5049	4934	4339
Miscellaneous	48018	43706	54400	59087	64734	58331
Subtotal	83555	79752	88638	91718	97129	96198
PONDS**						
Carp	8430	7056	8268	10600	11575	11538
Catfish	441	298	625	1075	978	936
Livefish	59	49	61	81	86	85
Hilsa	0	0	0	0	0	0
Big shrimp	30	20	43	74	67	64
Small shrimp	0	0	0	0	0	0
Miscellaneous	3380	2652	3792	5542	5566	5451
Subtotal	12340	10075	12788	17372	18273	18075
TOTAL FOR NORTHEAST REGION						
Carp	21693	21255	17936	18483	19858	23624
Catfish	9216	9668	8650	7781	8107	9248
Livefish	5203	4173	5073	5488	5515	6174
Hilsa	3084	2682	5282	7551	6571	6874
Big shrimp	1271	1532	130	109	116	232
Small shrimp	4030	4159	6163	5049	4934	4339
Miscellaneous	51398	46359	58191	64629	70301	63782
GRAND TOTAL	95895	89827	101426	109091	115402	114273

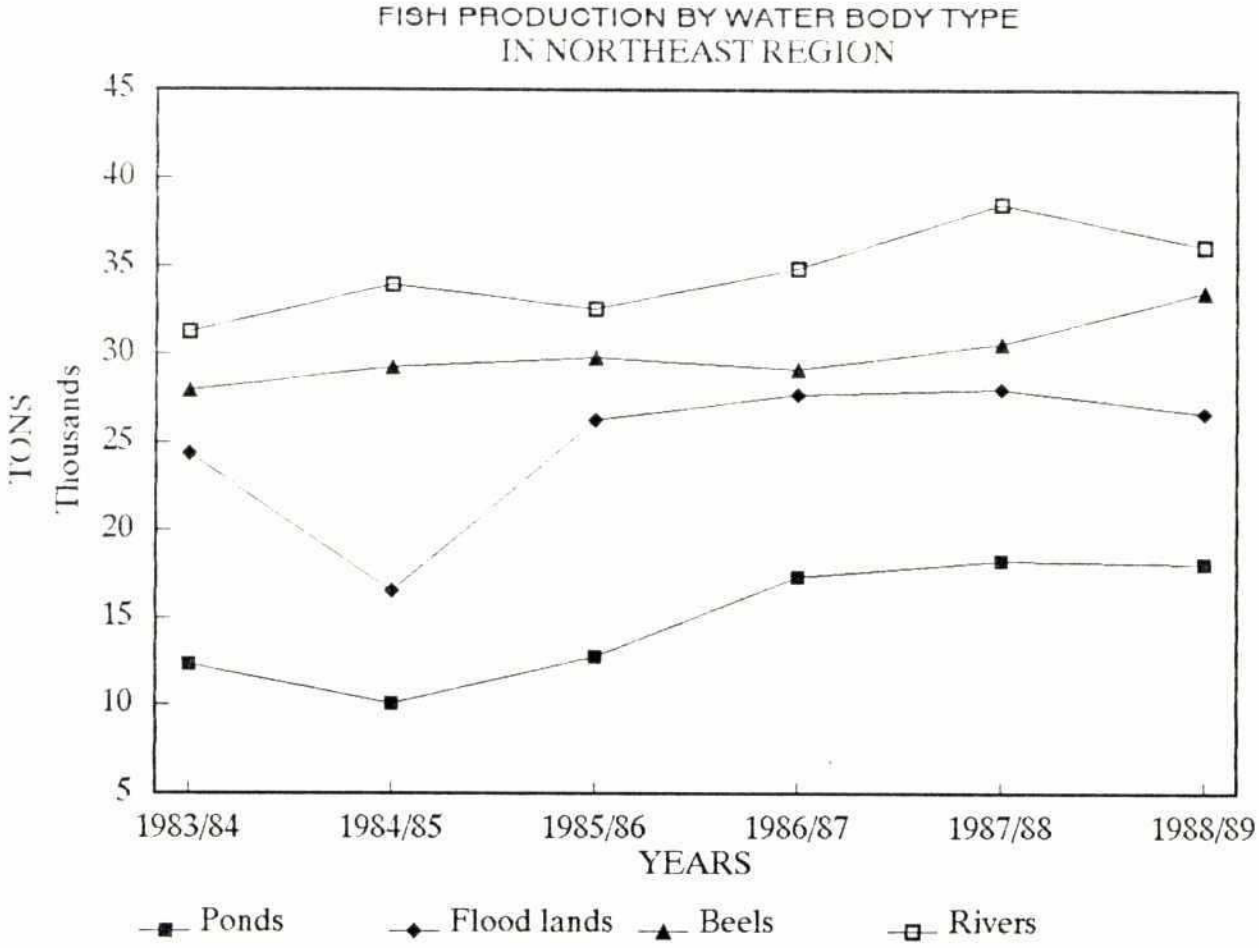
* Based on 4 year means, and assuming 75% of production coming from pile fishery and 25% from annual fishery.

** Based on 4 year means for greater Sylhet and Mymensingh Districts.

FISH PRODUCTION BY SECTOR

IN NORTHEAST REGION

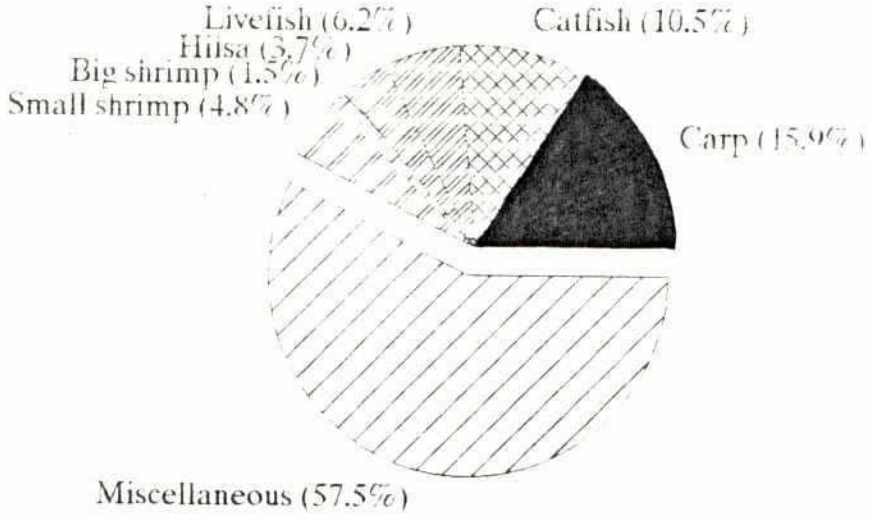



FISH PRODUCTION BY WATER BODY TYPE
IN NORTHEAST REGION
TONS
Thousands
45
40
35
30
25
20
15
10
5
1983/84
1984/85
1985/86
1986/87
1987/88
1988/89
YEARS
Ponds
Flood lands
Beels
Rivers

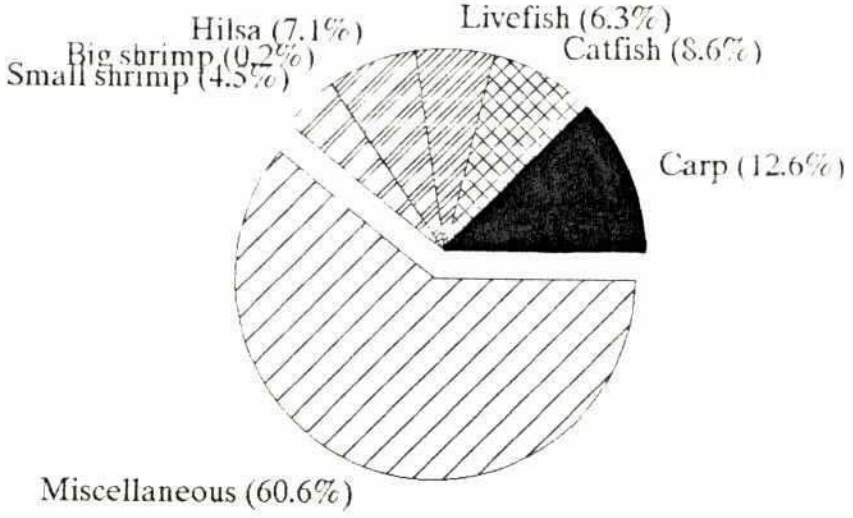
Annual % change in fish production in Northeast Region, by water body groups.

WATER BODY GROUP \ YEAR	1984/85	1985/86	1986/87	1987/88	1988/89	Mean
Upper Meghna River	-3.8%	41.8%	10.8%	-9.3%	-4.9%	6.9%
Other rivers	15.1%	-24.4%	3.9%	28.2%	-7.2%	3.1%
TOTAL RIVER FISHERIES	8.6%	-4.1%	7.0%	10.6%	-6.3%	3.2%
BEELS	4.7%	1.9%	-2.2%	4.9%	9.5%	3.7%
FLOOD LANDS	-32.0%	58.7%	5.5%	1.1%	-5.0%	5.7%
TOTAL CAPTURE FISHERIES	-4.6%	11.1%	3.5%	5.9%	-1.0%	3.0%
PONDS	-18.4%	26.9%	35.8%	5.2%	-1.1%	9.7%
GRAND TOTAL	-6.3%	12.9%	7.6%	5.8%	-1.0%	3.8%

SPECIES COMPOSITION OF TOTAL CATCH
FROM OPENWATER CAPTURE FISHERIES IN NORTHEAST REGION



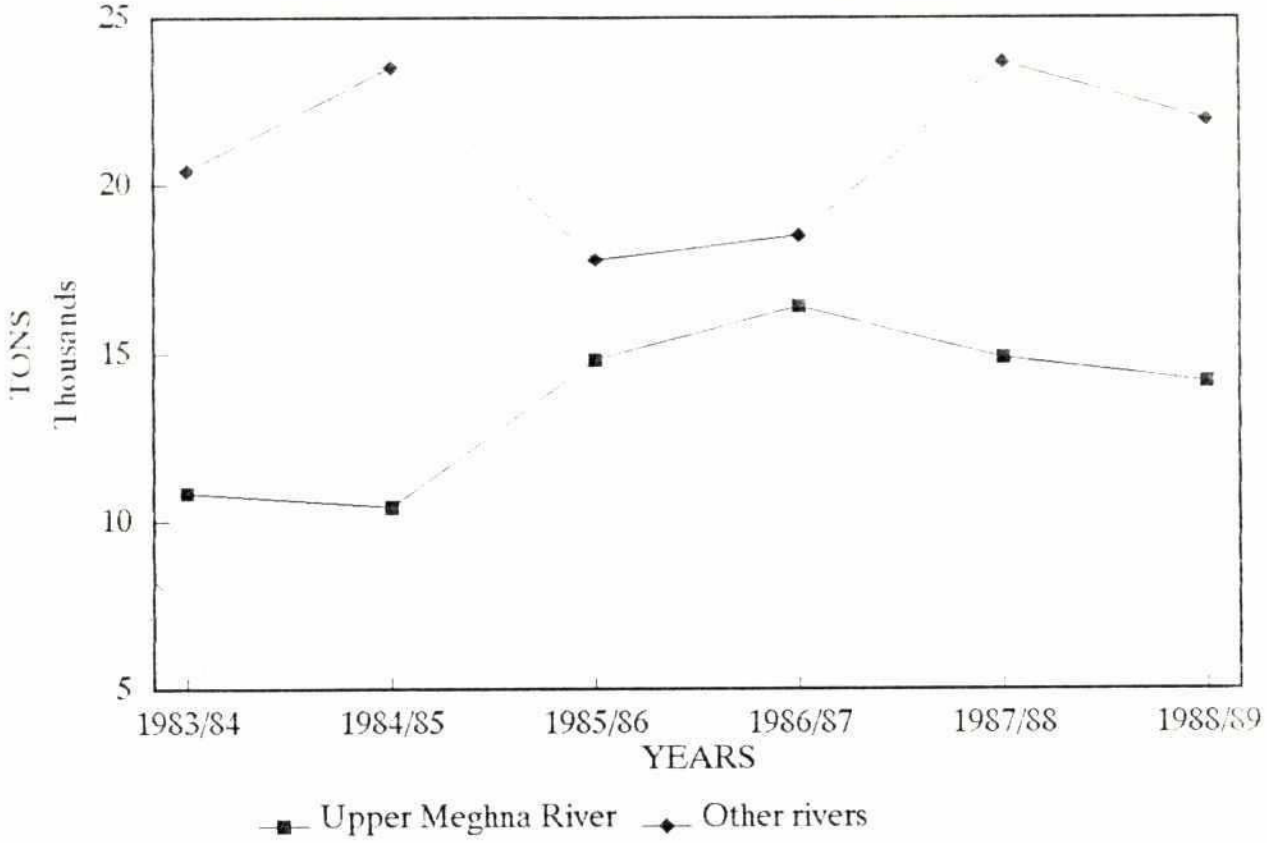
in 1983/84



in 1988/89

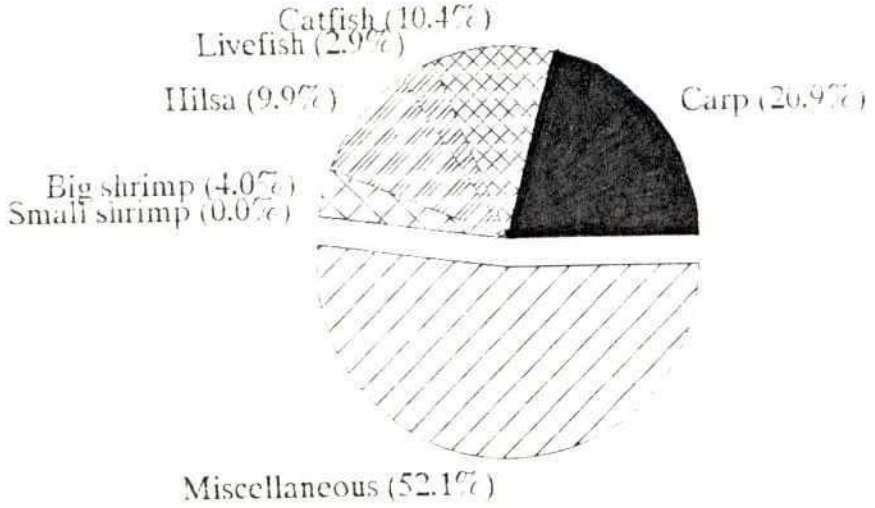
FISH PRODUCTION FROM RIVERS

IN NORTHEAST REGION

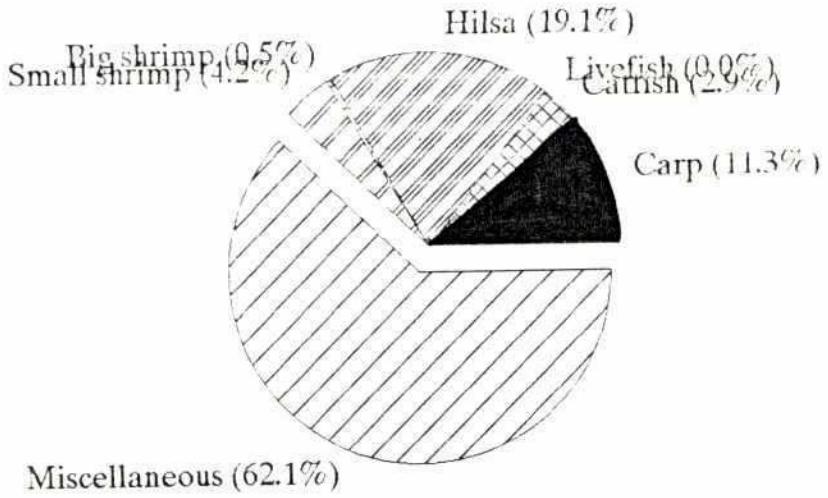


SPECIES COMPOSITION OF CATCH

FROM ALL RIVERS IN NORTHEAST REGION

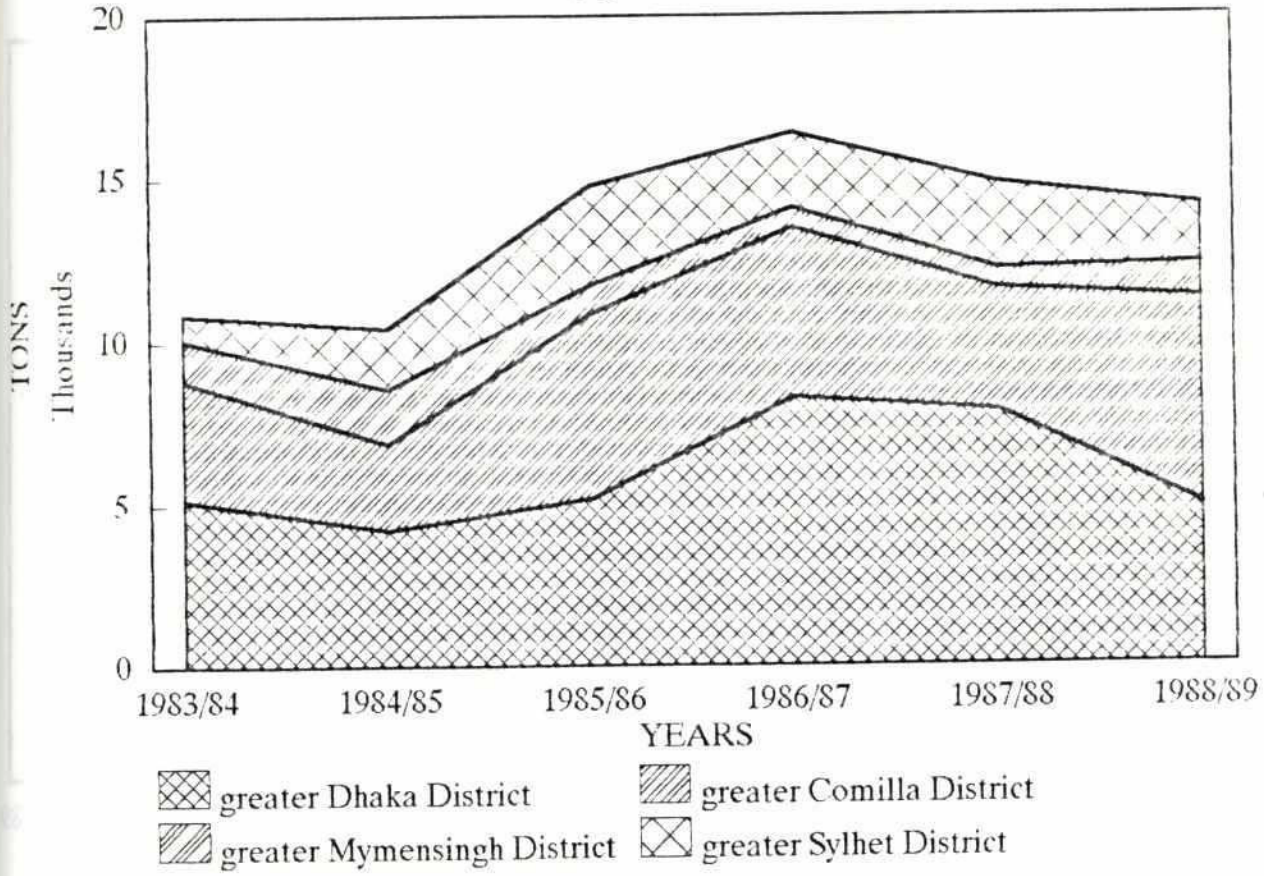


in 1983/84



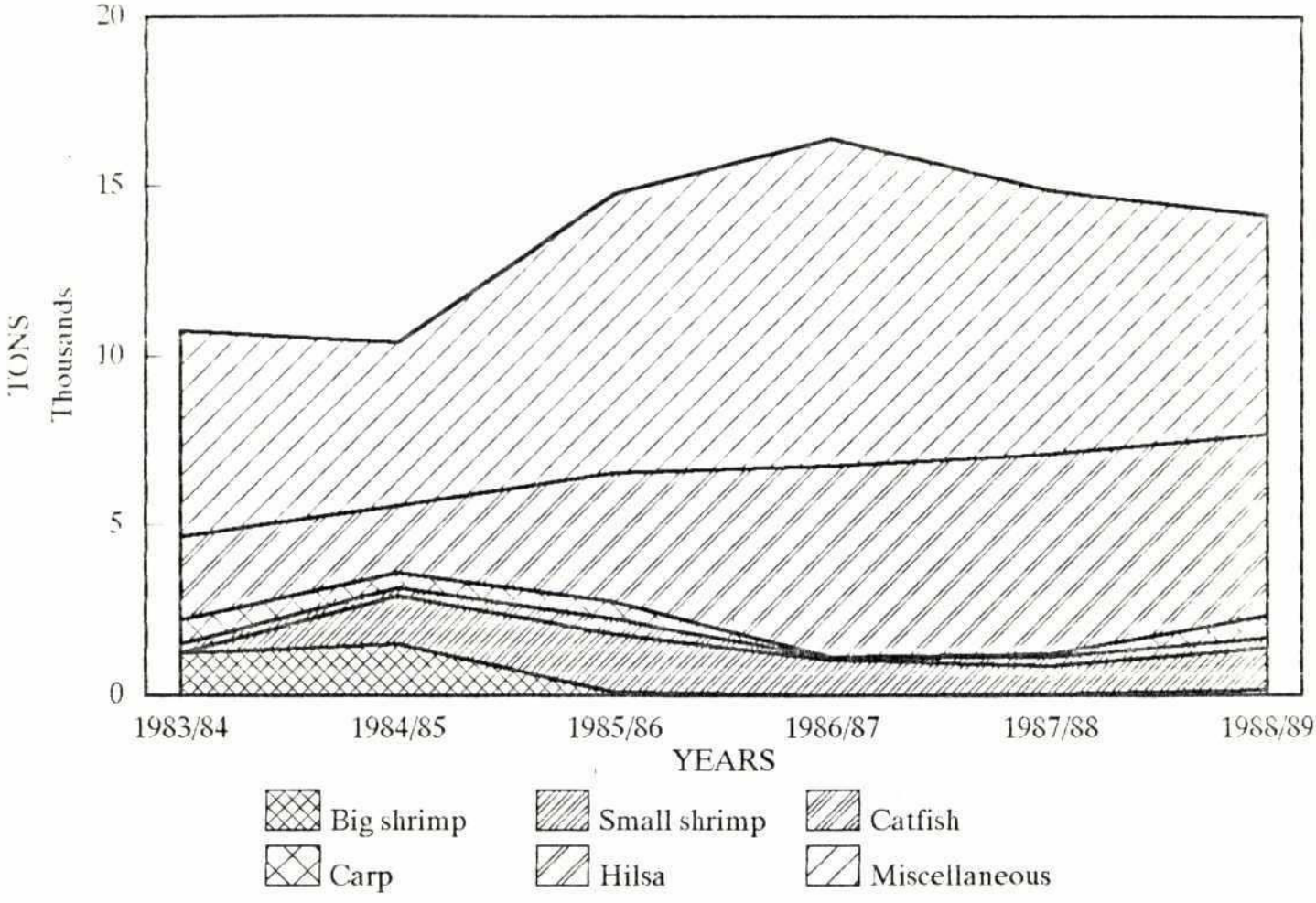
in 1988/89

FISH PRODUCTION FROM UPPER MEGHNA RIVER
by greater districts



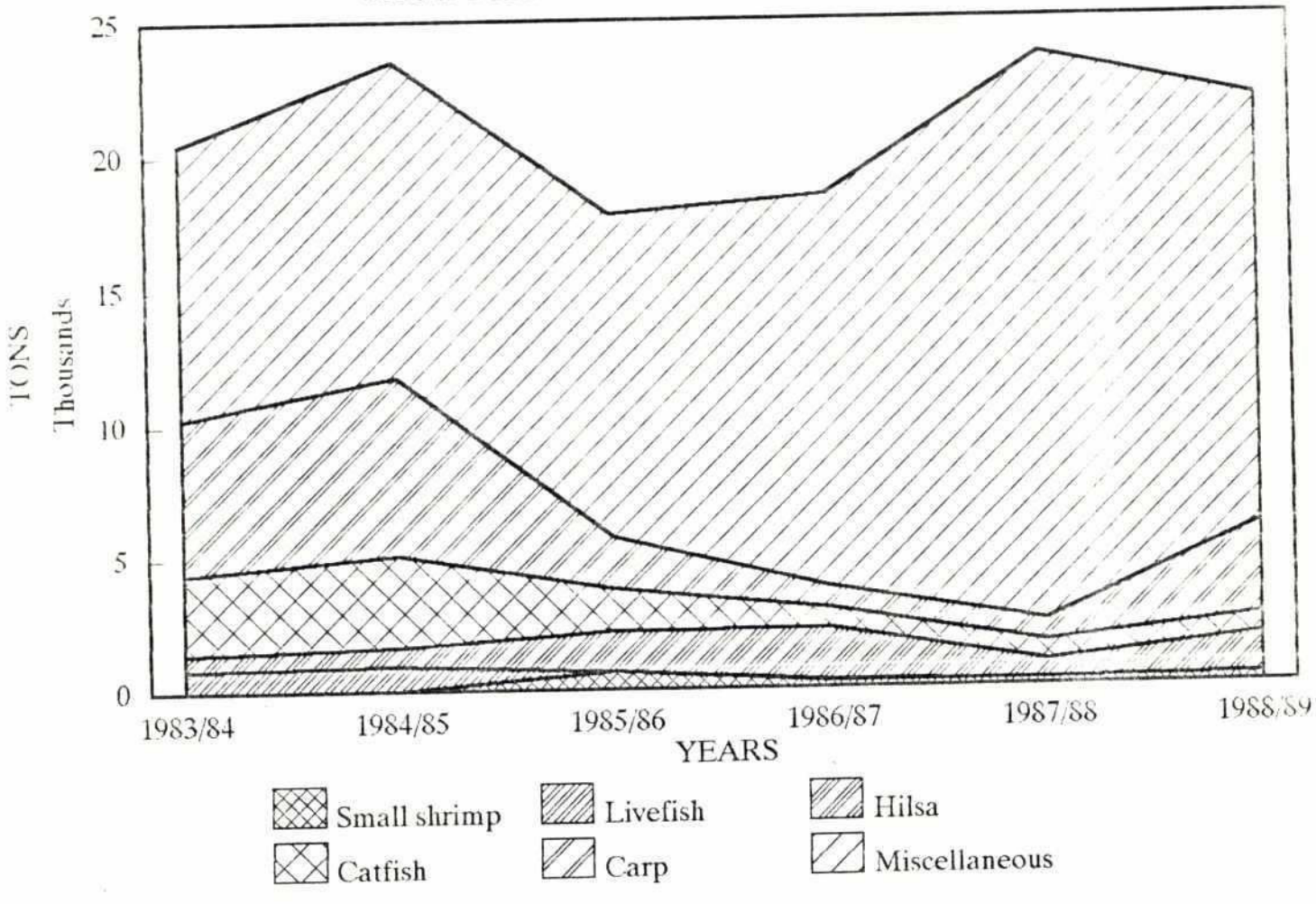
SPECIES COMPOSITION OF CATCH

FROM UPPER MEGHNA RIVER



SPECIES COMPOSITION OF CATCH

FROM OTHER RIVERS IN NORTHEAST REGION

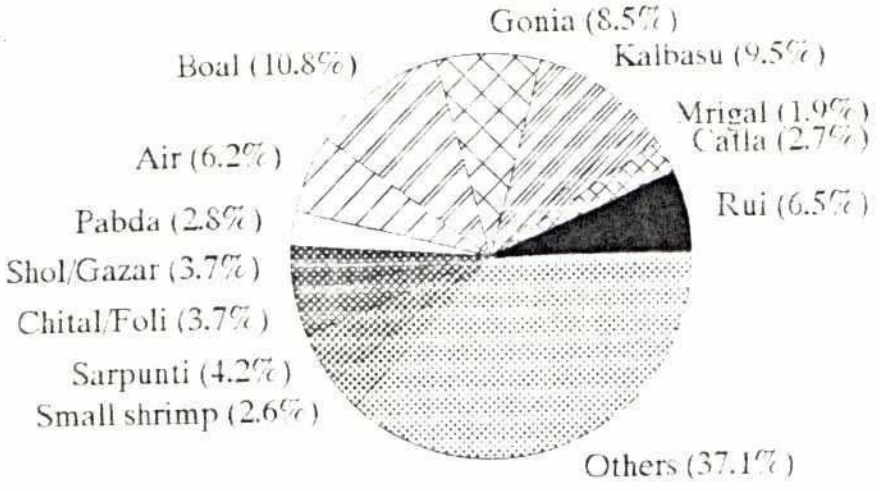


Species composition of production from pile fisheries and annual fisheries of beels in the Northeast Region (based on sampled beel survey in greater Sylhet and Mymensingh Districts).

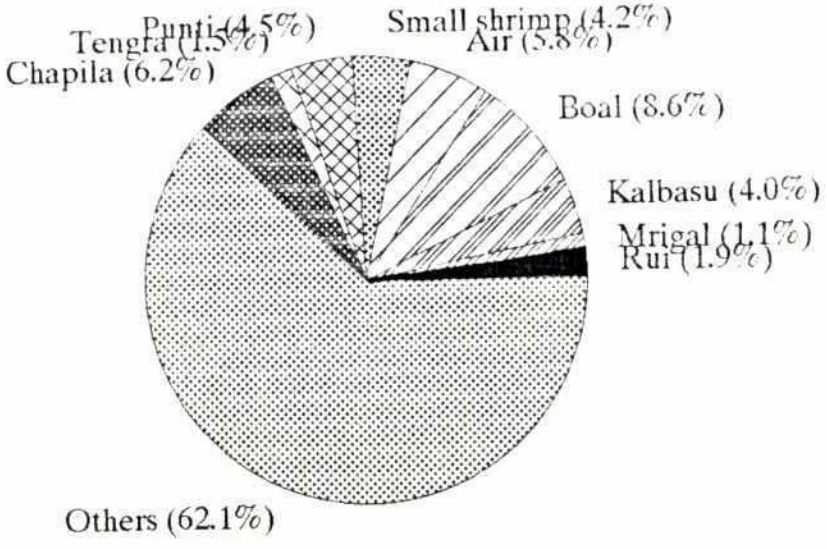
by percentage weight

	1985/86	1986/87	1987/88	1988/89	4 year mean	1989/90
P I L E F I S H E R Y						
Rui (Labeo rohita)	4.95	9.10	4.49	7.25	6.46	9.48
Catla (Catla catla)	6.80	1.57	0.88	1.60	2.71	3.46
Mrigal (Cirrhinus mrigala)	0.38	1.91	2.03	3.38	1.93	5.84
Kalbasu (Labeo calbasu)	15.10	7.21	9.10	6.70	9.53	11.90
Gonia (Labeo gonius)	9.71	6.88	13.36	4.10	8.51	10.05
Boal (Wallago attu)	5.15	18.73	8.96	10.26	10.78	14.28
Air (Mystus aor, M.seenghala)	4.50	7.96	6.69	5.64	6.20	6.94
Pabda (Ompok pabda)	2.10	1.34	3.62	4.00	2.77	2.42
Shol/Gazar (Channa spp)	1.78	7.22	3.26	2.40	3.67	3.49
Chital/Foli (Notopterus spp)	2.93	3.98	4.44	3.26	3.65	4.24
Koi (Anabas testudineus)	0.00	0.34	0.16	0.11	0.15	0.43
Singi/Magur (Heteropneustes, Clarias spp)	0.01	0.41	0.68	0.76	0.47	0.38
Sarpunti (Puntius sarana)	6.91	5.83	2.12	1.85	4.18	2.24
Small shrimp	0.51	1.13	3.14	5.49	2.57	5.95
Carpio (Cyprinus carpio)	0.14	0.00	0.00	1.07	0.30	0.00
Punti (Puntius spp)	0.00	0.00	0.00	0.00	0.00	0.00
Tengra (Mystus spp)	0.00	0.00	0.00	0.83	0.21	4.82
Baim (Mastacembelus spp)	0.00	0.00	0.00	0.15	0.04	0.00
Chapila (Gudusia chapra)	0.00	0.00	0.00	0.00	0.00	0.00
Others	39.00	26.39	37.07	41.15	35.90	14.08
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00
A N N U A L F I S H E R Y						
Rui (Labeo rohita)	0.18	1.84	1.72	4.03	1.94	4.98
Catla (Catla catla)	0.00	0.98	0.40	1.75	0.78	2.55
Mrigal (Cirrhinus mrigala)	0.00	1.00	0.85	2.62	1.12	1.60
Kalbasu (Labeo calbasu)	0.32	5.94	2.91	6.89	4.02	9.29
Gonia (Labeo gonius)	0.24	0.58	0.57	0.84	0.56	3.75
Boal (Wallago attu)	12.38	7.80	4.74	9.51	8.61	13.40
Air (Mystus aor, M.seenghala)	13.54	2.73	3.87	3.03	5.79	4.37
Pabda (Ompok pabda)	0.00	0.00	1.34	1.65	0.75	0.26
Shol/Gazar (Channa spp)	0.78	0.70	0.95	1.25	0.92	1.20
Chital/Foli (Notopterus spp)	1.10	0.11	1.03	2.49	1.18	1.61
Koi (Anabas testudineus)	0.17	0.00	0.40	0.99	0.39	0.16
Singi/Magur (Heteropneustes, Clarias spp)	0.23	0.02	0.36	1.52	0.53	0.75
Sarpunti (Puntius sarana)	2.55	0.14	0.12	0.94	0.94	1.00
Small shrimp	5.85	1.93	5.21	3.79	4.20	3.02
Carpio (Cyprinus carpio)	0.00	0.00	0.00	0.85	0.21	0.80
Punti (Puntius spp)	9.64	0.00	6.28	2.15	4.52	4.01
Tengra (Mystus spp)	4.35	0.00	0.00	1.60	1.49	1.58
Baim (Mastacembelus spp)	0.23	0.00	0.00	0.45	0.17	0.00
Chapila (Gudusia chapra)	0.14	14.66	6.16	3.80	6.19	0.00
Others	48.30	61.57	63.09	49.85	55.70	45.67
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00

SPECIES COMPOSITION OF FISH PRODUCTION FROM BEELS
in Northeast Region (four year mean, 1985/86 to 1988/89)



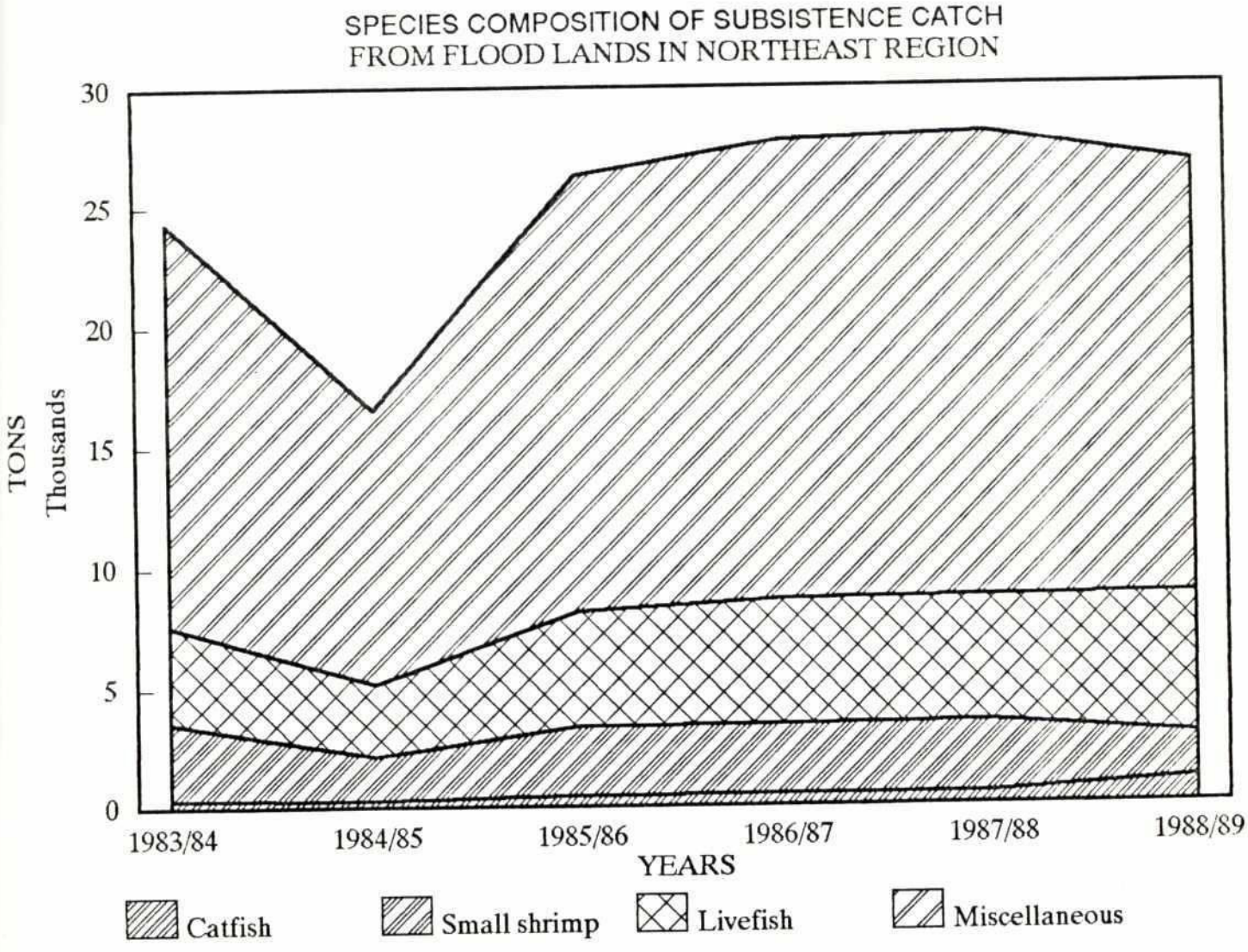
PILE FISHERY



ANNUAL FISHERY

Statistics on subsistence fishing on flood lands in the Northeast Region by greater districts.

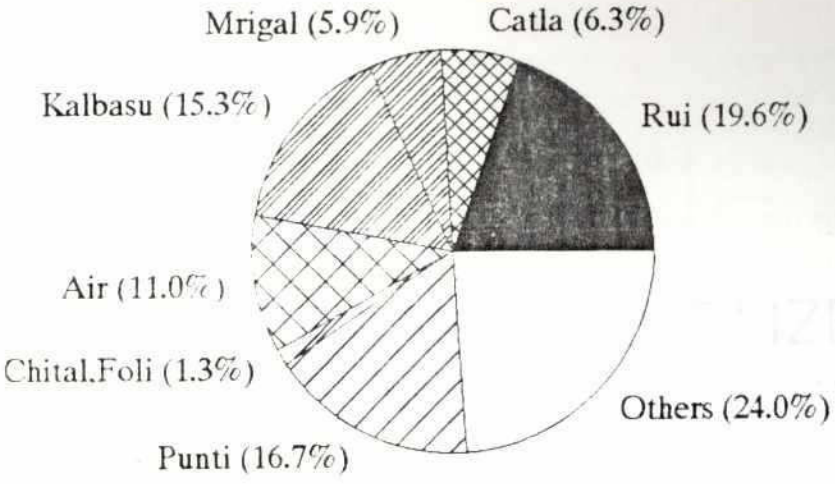
DISTRICT\YEAR	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89
NUMBER OF SUBSISTENCE HOUSEHOLDS						
Sylhet	637000	686000	660000	680000	636000	636000
Mymensingh	615000	699000	729000	947000	947000	810000
TOTAL	1252000	1385000	1389000	1627000	1583000	1446000
AVERAGE CATCH PER HOUSEHOLD (kg)						
Sylhet	26.65	14.34	23.12	22.50	24.52	23.29
Mymensingh	11.99	9.63	15.13	13.13	13.13	14.60
TOTAL	19.45	11.96	18.93	17.05	17.71	18.42
TOTAL CATCH ESTIMATED (t)						
Sylhet	16976	9837	15259	15300	15596	14812
Mymensingh	7374	6731	11030	12434	12437	11826
TOTAL	24350	16568	26289	27734	28033	26638


SPECIES COMPOSITION OF SUBSISTENCE CATCH
FROM FLOOD LANDS IN NORTHEAST REGION
TONS
Thousands
30
25
20
15
10
5
0
1983/84
1984/85
1985/86
1986/87
1987/88
1988/89
YEARS
Catfish
Small shrimp
Livefish
Miscellaneous

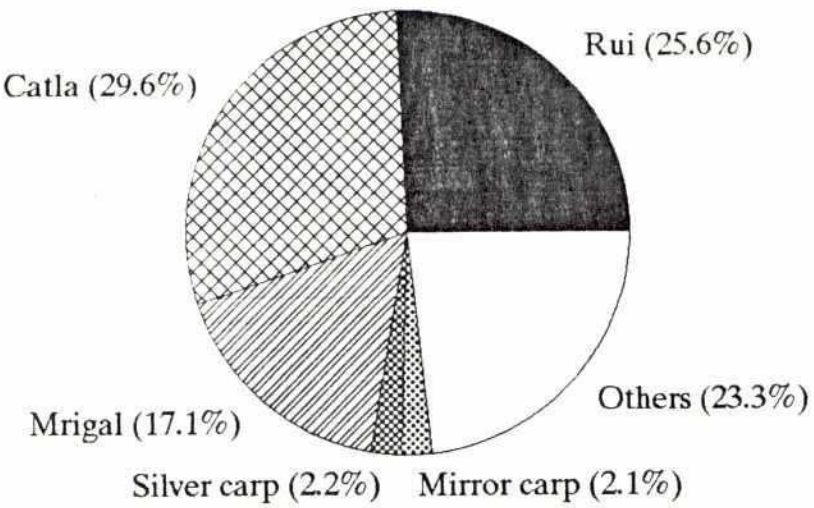
Species composition of fish production from ponds in greater Sylhet and Mymensingh Districts.

DISTRICT SPECIES\YEARS	1985/86	1986/87	1987/88	1988/89	4 year mean
S Y L H E T					
Rui (Labeo rohita)	20.48	20.85	19.36	17.75	19.61
Catla (Catla catla)	11.23	5.06	3.61	5.14	6.26
Mrigal (Cirrhinus mrigala)	3.55	5.69	6.22	8.10	5.89
Kalbasu (Labeo calbasu)	9.38	11.19	22.01	18.61	15.30
Minor carp	0.00	0.00	0.00	0.00	0.00
Silver carp (Hypophthalmichthys)	0.00	0.00	0.00	0.00	0.00
Grass carp(Ctenopharyngodon idellus)	0.60	0.00	0.00	0.00	0.15
Mirror carp (Cyprinus carpio)	0.00	0.00	0.00	0.00	0.00
Tilapia (Oreochromis spp)	0.00	0.00	0.00	0.00	0.00
Shrimp	0.00	1.87	0.73	0.46	0.77
Air (Mystus spp)	8.96	10.61	11.42	13.19	11.05
Boal (Wallago attu)	0.14	0.20	0.00	0.00	0.09
Shol (Channa spp)	0.36	0.86	0.12	0.16	0.38
Chital,Foli (Notopterus spp)	2.40	2.41	0.10	0.28	1.30
Koi (Anabas testudineus)	0.11	0.36	0.36	0.31	0.29
Singi,Magur (Heteropneustes,Clarias)	0.15	0.08	0.24	0.12	0.15
Sarpunti (Puntius sarana)	0.00	0.00	0.00	0.00	0.00
Punti (Puntius spp)	20.43	16.63	14.92	14.62	16.65
Others	22.21	24.19	20.91	21.26	22.14
TOTAL	100.00	100.00	100.00	100.00	100.00
M Y M E N S I N G H					
Rui (Labeo rohita)	30.39	22.64	24.46	25.08	25.64
Catla (Catla catla)	28.25	33.58	32.61	23.87	29.58
Mrigal (Cirrhinus mrigala)	24.50	22.48	11.04	10.41	17.11
Kalbasu (Labeo calbasu)	3.68	1.44	0.34	0.00	1.37
Minor carp	0.00	0.00	0.00	0.00	0.00
Silver carp (Hypophthalmichthys)	5.29	3.70	0.00	0.00	2.25
Grass carp(Ctenopharyngodon idellus)	0.00	0.00	0.00	0.00	0.00
Mirror carp (Cyprinus carpio)	0.00	0.00	0.00	8.51	2.13
Tilapia (Oreochromis spp)	0.00	0.00	0.00	0.00	0.00
Shrimp	0.00	0.00	0.00	0.00	0.00
Air (Mystus spp)	0.00	0.00	0.00	0.00	0.00
Boal (Wallago attu)	0.00	0.27	0.00	0.00	0.07
Shol (Channa spp)	0.15	0.00	0.00	1.14	0.32
Chital,Foli (Notopterus spp)	0.00	0.00	0.00	2.89	0.72
Koi (Anabas testudineus)	0.18	0.29	0.00	0.00	0.12
Singi,Magur (Heteropneustes,Clarias)	1.36	0.17	0.00	0.00	0.38
Sarpunti (Puntius sarana)	0.00	0.00	0.00	0.00	0.00
Punti (Puntius spp)	0.11	0.00	0.00	0.42	0.13
Others	6.09	15.43	31.55	27.68	20.19
TOTAL	100.00	100.00	100.00	100.00	100.00

SPECIES COMPOSITION OF FISH PRODUCTION FROM PONDS
IN NORTHEAST REGION (four year mean 1985/89)



greater Sylhet District



greater Mymensingh District

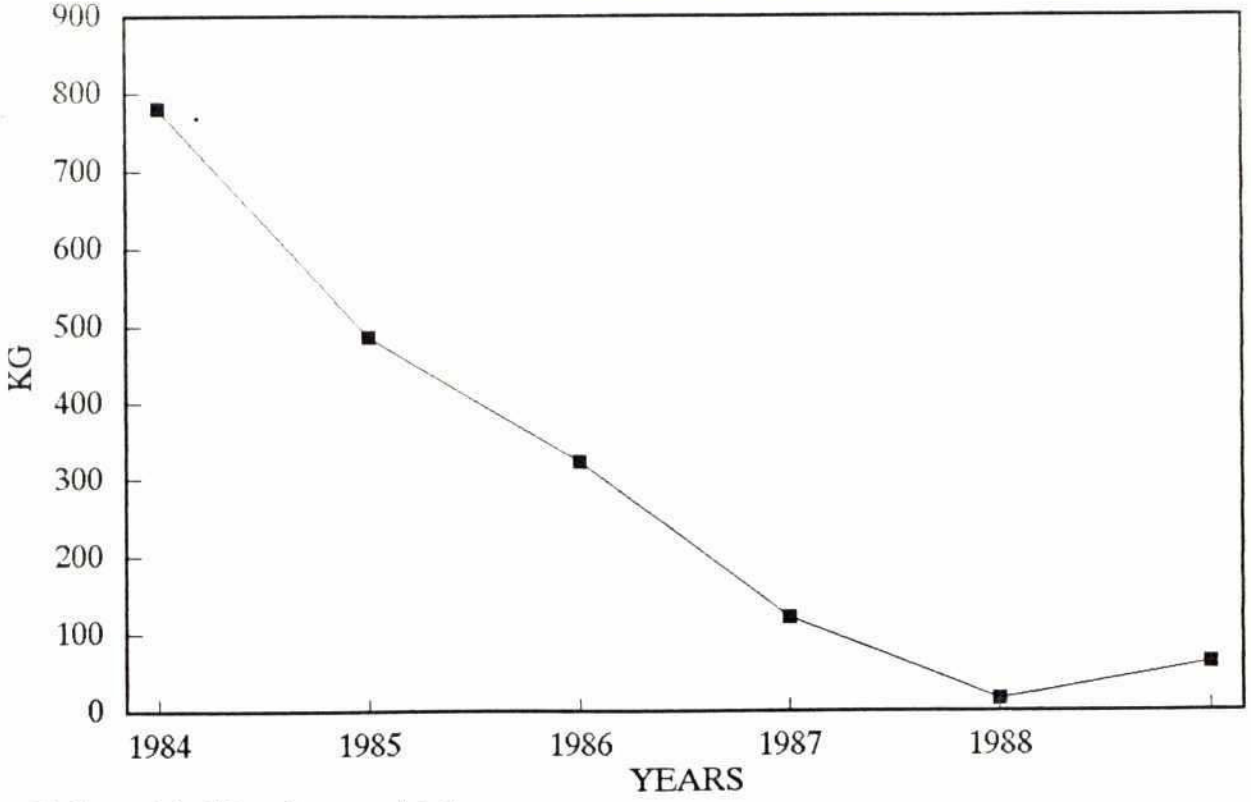
Carp spawn/fertilized eggs collected
from Old Brahmaputra River.

in kg

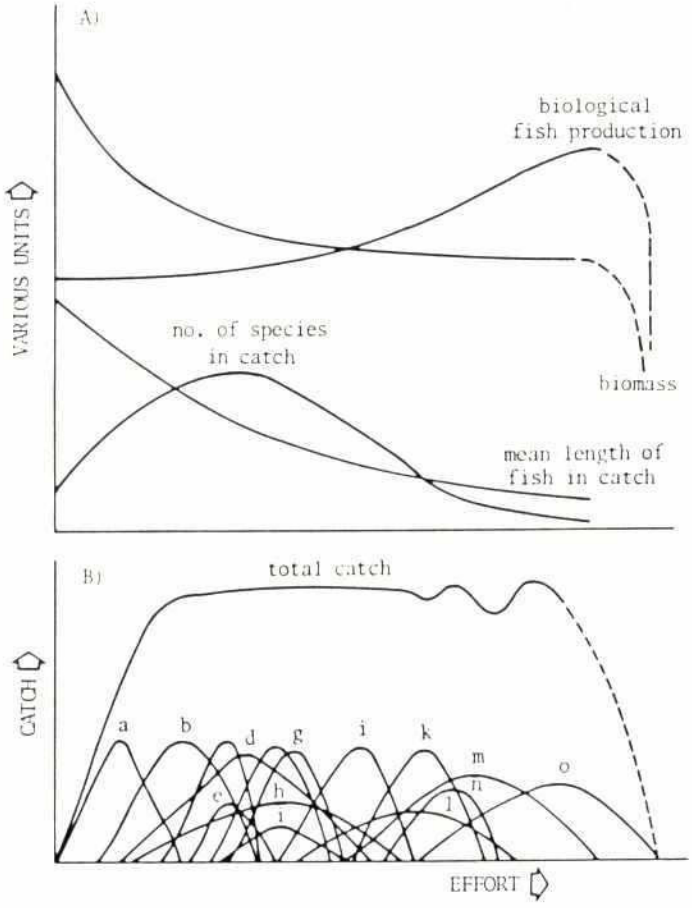
1984	1985	1986	1987	1988	1989
781	486	323	120	14.8	61.3

CARP SPAWN/FERTILIZED EGGS

COLLECTED FROM OLD BRAHMAPUTRA RIVER



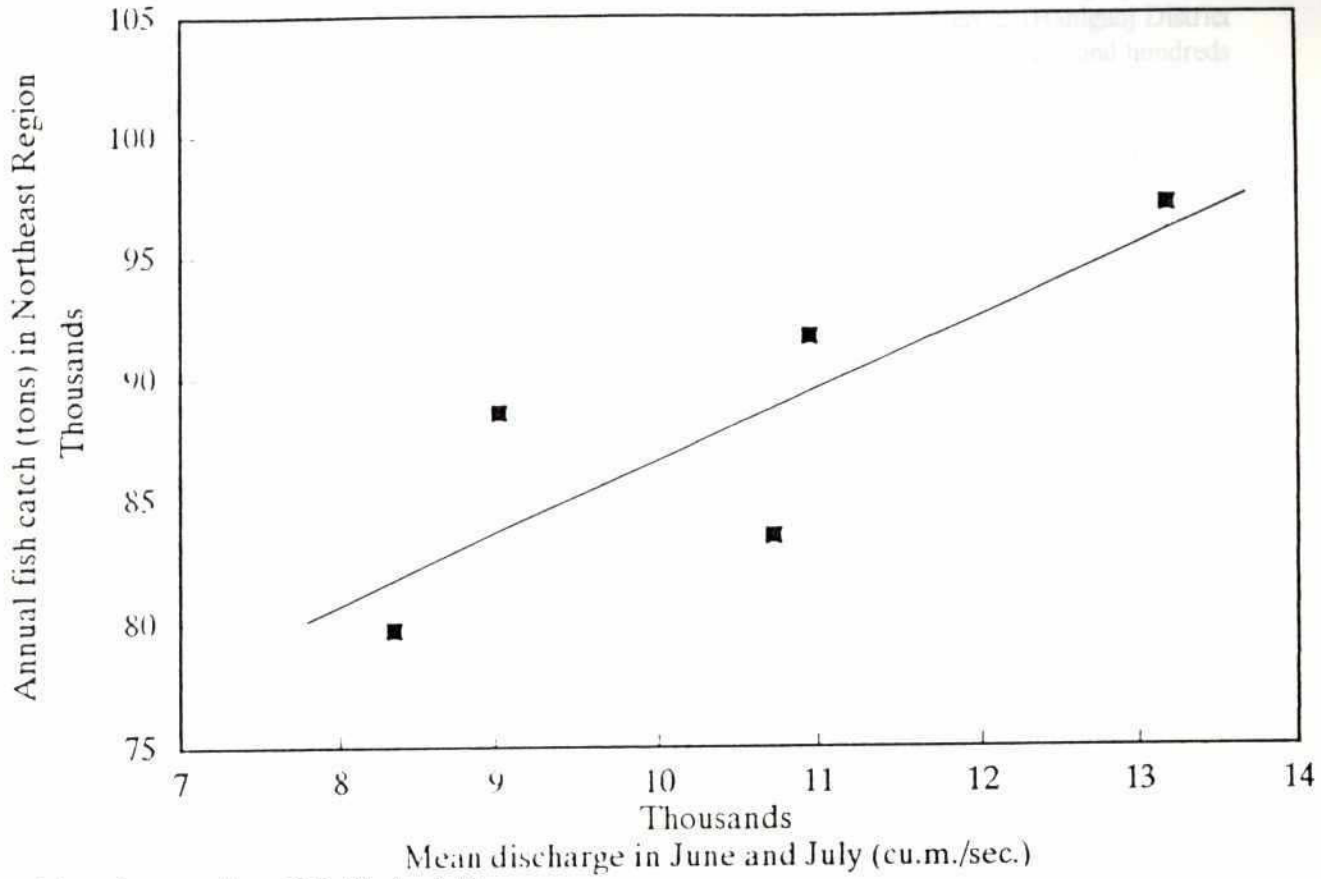
Collected in May, June and July



Theoretical changes in a fish community when subjected to increasing fishing pressure: (A) of certain population and fishery parameters; (B) of total catch showing schematic evolution of individual species 'a' through 'o'

From: Welcomme (1985)

CORRELATION BETWEEN FISH CATCH AND UPPER MEGHNA RIVER DISCHARGE



Metering station: 273 Bhairab Bazar

$Y = 57373 + 2.9489\ X \quad r = 0.8185 \quad df = 3 \quad 0.1 > P > 0.05$

6. POSTHARVEST SYSTEMS AND CONSUMPTION

6.1 Fish processing methods

It is estimated that over 90% of the fish production of the Northeast Region is utilized in fresh or live form (although in some beels up to 50% of the catch is sundried). Typically fresh fish is wholesaled whole and ungutted. Limited use of ice is made to preserve fish destined for local markets, while all fish (major carp, large catfish) destined for distant markets is iced. A small portion of the catch (large shrimp, major carp) is destined for export and undergoes high quality processing in factories. There is one such export processing plant situated in Habiganj District which uses prawns, carp and CHITAL as raw material. Ice plants are numerous (Habiganj District alone has 19). But due to poor catches this year, many ice plants are facing closure and hundreds of workers becoming unemployed.

The most common form of processing is sundrying. Typically the fish is laid out on mats on the ground, or on raised bamboo platforms. The area is protected from birds with small mesh nets or fishing line. Occasionally catch is dried on tarmac road surfaces. Smoking or salting is apparently never done. Sun drying is usually used for large catches of small species, as occurs when a beel is harvested. Some species (ie PUTI, KAIKKA, KACHKI) are not considered to be very tasty in fresh form, and also spoil rapidly. Hence they are sold in dry form. Other species which may be sold sundried are PABDA, BOAL, BAIM, ITCHA, TENGRA, CHANDA, BAILLA, CHAPILA, GONIA, TEPA and CHEKA. Fish are also sundried and stockpiled for future sale when traders and fishermen cannot agree on the price of the fresh product. Most urban retail fish markets have vendors selling sundried fish and people of all classes buy them. Product quality is variable but is often poor as sundrying imparts no preservative into the product (unlike salt or smoke drying). The organoleptic properties of sundried fish are said to be appreciated by consumers. Sun drying is mainly done by women.

Fermented fish is produced in low lying beel areas of Kishorganj and Netrakona. PUNTI is the only species used. Fish is placed into sealed clay pots. These are buried in the ground for 2-3 months during the winter season, and then opened and the product consumed.

In the area of artisanal fish processing there is scope for:

- Better quality control (processing facilities are sometimes unhygienic, and washing and gutting is not properly done);
- New processes (salt fish, fermented fish, marinated fish);
- More employment and income for women.

6.2 Fish marketing

The fish trade is largely controlled by a Muslim caste of fish traders called NIKARI. Fish is marketed in several ways. A fish trader may go to a fishing camp or ghat (fish landing or assembly place) and buy fish directly from the fishermen or jalmohal leaseholders, either by auction or bargaining. The trader then transports the fish to a local retail market and sells it. Or, a trader bringing fish from a ghat may go instead to a local wholesale market and sell the fish to another trader, who then retails the fish. A fish trader may sometimes be related to professional fishermen. Large quantities of high value fish destined for Dhaka may pass through a hierarchy of several traders before reaching the consumer, with most of the finance put up by large fish wholesalers in Dhaka working in cooperation with district wholesalers and jalmohal leaseholders. Assembly

(or arat) boats are used to collect fish from the fishermen. The fish are packed in baskets with ice. Trucks or buses are used to transport the fish to larger towns.

Fishermen on occasion may themselves take their catch to wholesale or retail markets in order to realize a better price. They used to be taxed by middlemen at ghats. Sometimes there are several ghats along a stretch of road. Under NFMP genuine fishermen cannot be subjected to a ghat toll. They can now go directly to markets and sell their catch for higher net income. Women do not work as fish vendors in markets. But for a fisherman to spend a significant amount of his time trading fish is a poor use of his time since it interferes with fishing operations and the production of raw material (on which the whole market pyramid rests). A better approach might be to vertically integrated production with processing, transport and marketing within family (extended family) units, as this would allow them to capture the full retail value of the products. The fact that women do not retail fish in markets because of religious and social mores is a major impediment to such a development. The DOF should actively promote fish trading as a profession for women.

Much of the fish coming out of the haors of the Sylhet Depression from the Sunamganj side goes to Dhaka. Also, it seems to be common knowledge in the area that a substantial proportion (25%?) finds its way to India. In an effort to intervene in this situation the BFDC opened a large fish marketing center at Dabor in May 1991, which is complete with auction hall, 50 ton cold store (HIMAGAR) and 20 ton/day ice plant (BORAK KAL). The objective was to buy local fish caught in beels, rivers and floodlands during the dry season from November to March and transport them to retail markets in Dhaka, as well as export a portion. During the rainy season from April to September, it is planned to bring HILSA from the coast to sell locally. Fish auctioning will be an 'open market', but contradictorily this means that prices will be fixed by the government.

The Dabor center is still far from meeting its objectives because it has been unable to buy fish locally. Fishermen borrow money from the moneylenders (wholesalers, ARATDARS) in Sylhet. These aratdars are organized into a close cartel to keep prices low. Fishermen sell their fish to the aratdars and not to the BFDC. Furthermore, local wholesalers take loans from Dhaka wholesalers and are bound to sell to them. Seven aratdars have been appointed by BFCD to carry on auction business at the Dabor center, but they have shown no desire to leave the Kazir Bazar Wholesale Market at Sylhet. The result has been that the center has been unable to buy any substantial quantity of floodplain fish locally. Except for 10 tons of iced HILSA brought up from the coast, no other fish has passed through the center. The government is even reluctant to license the procurement of HILSA because it is feared that the fish will be smuggled to India. The sale of ice has however been good (1,000 tons since mid-August 1991), showing that at least this operation meets a real local need.

The BFDC is attempting a new solution to its raw material supply problem. They have submitted a proposal to the Ministry of Revenue to get 10 beels for a 10 year lease period. These would be operated as a joint venture with local influential JALMOHANS. The latter will supply 'genuine' fishermen who will work as daily wage laborers. Local fish prices are high right now. RUI of 4 kg size go for 90-110/= per kg. In the Sylhet market it sells for 100/= per kg. But BFDC can not pay more than 80-85/= per kg if it is to make a profit transporting the fish to Dhaka. So BFDC cannot buy fish on the local market, hence the proposal to vertically integrate production with marketing. The complete incompatibility of this BFDC proposal with the DOF NFMP is rather stunning.

Kazir Bazar is the most important regional wholesale fish market in greater Sylhet. Maach Bazar is the wholesale fish market in Mymensingh. It handles a lot of pond carp production.

Urban retail fish market facilities are often very poor: cramped, overcrowded, unhygienic, and lacking tables and sun shades. Lack of space results in fish also being sold on the roadside next to markets (ie Moulvi Bazar Central Fish Market). If the trend to increasing commercialization of fish continues, expansion and improvement of retail fish markets in all urban centers in the region will be needed. The more important retail markets are:

- Bandar Bazar in Sylhet;
- Sherpur roadside fish market;
- Central Market in Moulvi Bazar;
- Chota Bazar in Netrakona;
- Purantana Fish Market in Kishorganj.

Retail fish traders usually pay a small market stall/position fee to the town market committee. In Moulvi Bazar this is 10/= for fresh fish (plus 5/= baksheesh to the police for traders overflowing on to the roadside) and 5/= for a dry fish stall. Retail fish markets are usually well supplied with local produce. Apart from fresh fish, sundried fish is usually available and iced HILSA from the coast is often offered. Large fish such as RUI and CATLA may be sold whole, or by the piece. Mostly middle class people buy major carp and large catfish. Canned tuna and mackerel is available in grocery stores at high prices for richer consumers.

A constraint on retail market development is the general poverty of the population, which lacks ready disposable cash to buy fish. Also, many rich people have their own ponds and have less need to buy fish from local markets. Thus the quantity of fish seen to pass through retail markets in the Northeast Region is not especially large compared to overall production in the region.

Local fish prices vary (see tables at end of this chapter). The major carps, large catfish, CHITAL and large shrimp are usually the most expensive. Prices in the region are somewhat lower than Dhaka prices: some indicative fish prices per kg in Dhaka in March 1992 were:

- PANGAS, 150/=
- CATLA, 125/=
- HILSA, 70/=
- ITCHA, 100/=
- GOLDA CHINGRI, 130/=

Dry fish is expensive on a dry product weight basis, but cheap on an equivalent wet weight basis. Fishermen thus suffer a loss if they are unable to sell their catch in fresh form, but have to resort to drying it.

Another factor affecting price of some species is fish size. Thus small RUI sell for about 40/= per kg, while large adult RUI sell for 100 to 150/= per kg.

Retailer trade margins vary between 6% and 33%.

FRESH FISH PRICES

Species	Origin	Trader's purchase price /= per kg	Trader's** retail price /= per kg	% markup
PURANTANA FISH MARKET, in Kishorganj, Jan 1992.				
RUI			100	
CATLA			80	
BOAL			70	
CENTRAL FISH MARKET, in Moulvi Bazar, Feb 1992.				
CARPIO	Pathashing Haor,fishermen		90	
JAYA	Bisnagn River,fishermen	30	55	
CATLA	Hail Haor,leaseholder auction	80	100	25%
MRIGEL	Hail Haor,leaseholder auction		100	
CATLA	Kawadhighi Haor, " "	60	70	17%
CARPIO	Kawadhighi Haor, " "	60	70	17%
BOAL	Dhaleswari River,middlemen direct	42	50	19%
MAGUR	Nobiganj, middleman		75	
SINGI	Nobiganj, middleman		60	
KOI	Bogbokia Haor		100	
GAJAR	Hail Haor,fishermen	38	50	33%
RUI,small	Shorail Haor pond,middleman		40	
Silvercarp	Shorail Haor pond,middleman		45	
GUIZZA AIR			75	
GONIA			38	
FOLI			25	
BASA	Manu River		200	
GHAURA	Manu River		100	
ROADSIDE FISH MARKET, at Sherpur Bridge, Feb 1992.				
BOAL	Kushiyara River,wholesaler	80	100	25%
LargeShrimp	Kushiyara River		150	
CHITAL	Kushiyara River, wholesale	94	100	6%
BASA		80	100	25%
RUI	Kushiyara River	117	135	15%
BOAL	wholesaler		100	
BANDAR BAZAR, in Sylhet, Feb 1992.				
RUI			150	
PUBLIC MARKET, in Kanairghat, Feb 1992.				
CHAPILA	Surma River		15-20	
CHAPATI	Surma River		20-25	
SATIDORA BEEL GROUP FISHERY CAMP, in Halir Haor, Sunamganj District, Feb 1992.				
PABDA	Halir Haor,from fishermen	55		
BOAL	Halir Haor, " "	25		
KALIBAUS	Halir Haor, " "	25		

** *Apparently, many fish retailers habitually quote low prices when questioned casually in order not to scare off customers. However, the price goes up when one shows serious intent to buy. Thus, some prices quoted above are nominal rather than actual.*

DRY FISH PRICES

Species	Origin	Trader's purchase price Tk per kg	Trader's retail price Tk per kg	Equivalent wet weight price Tk per kg
CENTRAL FISH MARKET, in Moulvi Bazar, Feb 1992.				
TENGRA	Sylhet/Sunamganj areas		90	27
PABDA	" "		180	54
KAIKKA	" "		80	24
PUNTI	" "		90	27
BOAL	" "		150	45
SATIDORA BEEL GROUP FISHERY CAMP, in Halir Haor, Sunamganj District, Feb 1992.				
PUTI	Halir Haor,from fishermen	125		38
TENGRA	Halir Haor,	63		19
CHINGRI	Halir Haor,	15-18		4.5-5.4
KAIKKA	Halir Haor,	100		30

6.3 Fish imports and exports

Aside from limited quantities of highly priced canned fish, there is no significant retailing of imported fish products in the Northeast Region.

The export overseas of high value shrimp and carp from the Northeast Region is modest. Grey market exports of beel fish and HILSA to India (Assam) appears to be well established, although not viewed with enthusiasm by the Government of Bangladesh. Quantities may be substantial (ie as much as 25% of beel production from around Sunamganj).

Officially recorded international exports of non-shrimp fish commodities are small. In 1987/88, for Bangladesh as a whole, exports were:

- Frozen major carp, 259 t, US$ 1 million.
- Frozen catfish, 243 t, US$ 840,000.

These total 502 t, valued at US$ 1.84 million. The unit price is about US$ 3,700 per ton.

Ex-region and in-region shipment of fish within Bangladesh is substantial. Much beel production of major carp and large catfish finds its way to Dhaka. Iced HILSA from Chittagong travels in the opposite direction to the larger towns in the Northeast Region.

In view of the continuous general increase in demand for fish products on the world market, it is almost axiomatic that potentials exist for expansion of international fish exports from the Northeast Region. At the same time, given the growth in the Bangladesh population and soaring demand for food fish, potential exists for increasing imports of low value fish commodities such as frozen small pelagics (assuming an effort is made at market development). Increasing international fish trade however involves not only economic considerations but also political and social factors, especially assessment of potential benefits and losses by different population segments. Changes

in subsistence and local commercial fish supplies, employment, income distribution, and cross border trade patterns can all result from increasing international commodity trade and need to be very carefully evaluated before a trade programme is put into place.

6.4 Fish consumption

Only a rough approximation can be made of the quantity of fish consumed in the Northeast Region. For the year 1987/88 it may be assumed that all 70,069 tons of miscellaneous species from capture fisheries are consumed intraregionally. It is arbitrarily assumed that 20% of carp, catfish, HILSA and shrimp from capture fisheries production (5,408 tons) and 75% of pond culture production (13,705 tons) in consumed within the region. Coastal-origin HILSA and imported canned fish quantities are small, perhaps 100 tons at the most. The nominal regional fish food supply for 1987/88 is estimated at 89,282 tons. The population of the region in 1987/88 was about 11.9 million. Nominal per caput supply is calculated at 7.5 kg/yr. This is almost the same as the 7.3-7.4 kg/yr calculated by Laureti (1991) for Bangladesh as a whole (see table at end of chapter). The role of fish in the Bangladesh diet is substantial. Just under half of all dietary animal protein is derived from fish.

BFRSS data indicate that 1.4 million households carried out subsistence fishing in the Northeast Region in 1988/89, catching 18.42 kg per household. Assuming that the average household consists of 5 persons, the estimated per caput supply from subsistence fishing is only 3.7 kg per annum, or about half of the estimated mean regional supply of 7.5 kg. This suggests an unequal distribution of fish among consumers, with the bias in favor of non-subsistence households (ie wealthy rural households, urban populations). However, if the subsistence catch is underestimated in BFRSS statistics (as the World Bank [1991] suggests), actual subsistence consumption should be higher.

The historical trend in fish consumption for Bangladesh as a whole has been one of decline. In 1961, per caput supply was a respectable 14.4 kg/yr (compared to 9.1 kg/yr for the world), but had decreased by 50% to 7.2 kg/yr by 1989 (while world supply grew to 13.4 kg/yr). It is not known if a similar pattern has taken place in the Northeast Region, given differences in regional and national population growth rates and probable changes in fish quantities moving through interdistrict fish trading networks in response to urban market demand.

The future trend of fish consumption will undoubtedly be influenced by population growth (which will tend to decrease per caput supply) and increased demand from large urban centers outside of the region (further decreasing local regional supply). Increased marketing of miscellaneous species is already occurring, and this trend can be expected to continue. The result will be less fish available for subsistence consumption and greater commercialization of catch. Unless there is a substantial increase in the purchasing power of the rural population of the Northeast Region, increased transport of fish out of the region is the most likely future scenario.

The mid-estimate population forecast for 2010 is 20.8 million. Even to maintain the current nominal per caput supply of 7.5 kg/yr would require production of 156,000 tons (an increase of 75%, or 67,000 tons over the current supply). There are three ways in which this might be achieved:

- Increasing capture fishery production would in theory be possible through effective fishing effort management, stock rehabilitation, production enhancement systems using artificial habitats, civil engineering works to increase dry season water hectare-months and installing fish bypass structures. A yield of about 100 kg/ha/yr (ie an increase of near 100% over the present yield) would need to be achieved. However this would

near 100% over the present yield) would need to be achieved. However this would require a massive structural change, from jalmohal leasing and government revenue collection to community-based management and tenure, coupled with an enormous support programme from the DOF and BWDB. There is no indication that the government is willing to give up revenue collection from jalmohals and transfer ownership of the fishery resources to genuine fishermen, so there are no grounds for optimism that capture fishery production will accelerate in the medium term future. Any increase in the supply of major carp resulting from the current floodplain stocking effort will most likely not be consumed within the region but find its way to more lucrative markets outside the region.

- Increases in pond culture production might fill part, but not all, of the supply deficit. To meet the entire deficit would require almost a ten fold increase in pond production - an unlikely scenario unless exceptional economic factors and support materialize (Minkin, 1989).

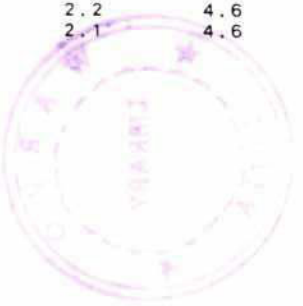
- Increasing imports of cheap food fish (such as frozen small pelagics from Latin America or Africa, which sells for about US$ 350 per ton on the world market) might ultimately be necessary. A constraint is availability of foreign exchange. However, tying regional imports of fish approximately to regional exports of fish would seem a possible option. The Northeast Region's fish commodity terms of trade ratio may be in the order of 10, implying that for every ton of high value fish commodity exported, 10 tons of low cost food fish could be imported. This would establish a positive nutritional balance of fish trade. For example the 502 t of frozen major carp and catfish exported from Bangladesh in 1987/88 (see section 6.3 above) valued at US$ 1.84 million, could have been used to import some 5,300 tons of frozen small pelagics food fish.

BANGLADESH

- FOOD BALANCE SHEET OF FISH AND FISHERY PRODUCTS IN LIVE WEIGHT AND FISH CONTRIBUTION TO ANIMAL PROTEIN SUPPLY

YEAR	PRODUCTION	NON-FOOD USES	IMPORTS	EXPORTS	STOCKS CHANGES	FOOD SUPPLY	POPULATION	PER CAPUT SUPPLY	FISH PROTEINS	ANIMAL PROTEINS	FISH/ANIMAL PROTEINS
	(.....	METRIC TONS	.....				) (THOUSANDS)	(KG/YEAR)	(GR/PER CAPUT/DAY)		(%)
1961	777200.	0.	0.	16000.	0.	761200.	52701.	14.4	4.3	7.0	61.2
1962	789800.	0.	0.	27505.	0.	762295.	54025.	14.1	4.2	7.0	60.5
1963	790500.	0.	0.	27497.	0.	763003.	55398.	13.8	4.1	6.9	59.3
1964	822500.	0.	0.	23199.	0.	799301.	56825.	14.1	4.2	7.1	59.5
1965	810900.	0.	0.	7189.	0.	803711.	58312.	13.8	4.1	7.0	59.0
1966	829900.	0.	0.	1293.	0.	828607.	59860.	13.8	4.1	6.8	60.4
1967	857500.	0.	0.	1703.	0.	855797.	61471.	13.9	4.2	6.9	60.4
1968	860000.	0.	0.	2708.	0.	857292.	63144.	13.6	4.1	6.8	59.9
1969	877200.	0.	0.	3583.	0.	873617.	64878.	13.5	4.0	6.8	59.4
1970	690100.	0.	0.	1900.	0.	688200.	66671.	10.3	3.1	5.9	52.2
1971	740100.	0.	0.	1300.	0.	738800.	68522.	10.8	3.2	5.9	55.0
1972	818100.	0.	0.	700.	0.	817400.	70435.	11.6	3.5	5.9	58.6
1973	820200.	0.	400.	3400.	0.	817200.	72412.	11.3	3.4	5.9	57.5
1974	822082.	0.	80.	5203.	0.	816959.	74460.	11.0	3.3	5.7	57.7
1975	640070.	0.	0.	2029.	0.	638041.	76582.	8.3	2.5	4.9	51.3
1976	641605.	0.	0.	4018.	0.	637588.	78780.	8.1	2.4	4.9	49.4
1977	643769.	0.	400.	3737.	0.	640432.	81051.	7.9	2.4	4.8	49.8
1978	646895.	0.	40.	3123.	0.	643812.	83389.	7.7	2.3	5.3	43.9
1979	647128.	0.	225.	5246.	0.	642107.	85781.	7.5	2.2	5.0	44.4
1980	646970.	0.	101.	10324.	0.	636747.	88219.	7.2	2.2	4.5	47.6
1981	651256.	0.	33.	8696.	0.	642593.	90703.	7.1	2.1	4.5	46.7
1982	689498.	0.	0.	10299.	0.	679199.	93235.	7.3	2.2	4.5	48.9
1983	726587.	0.	0.	15658.	0.	710929.	95818.	7.4	2.2	4.6	48.4
1984	756013.	0.	0.	22093.	0.	733920.	98454.	7.5	2.2	4.6	48.9
1985	772631.	0.	0.	28329.	0.	744302.	101147.	7.4	2.2	4.8	45.9
1986	796910.	0.	0.	26638.	0.	770272.	103900.	7.4	2.2	4.8	46.5
1987	817003.	0.	0.	28535.	0.	788468.	106717.	7.4	2.2	4.7	46.8
1988	829929.	0.	0.	29209.	0.	800720.	109602.	7.3	2.2	4.6	47.6
1989	832791.	0.	0.	20123.	0.	812668.	112559.	7.2	2.1	4.6	46.7

from Laureti (1991)



7. EMPLOYMENT, INCOME AND WELFARE

7.1 Employment within the fisheries sector

Four general occupational categories within the production sector are recognizable (apart from caste/ethnic groupings):

- *Professional fishermen,* who earn their livelihood entirely from fishing;
- *Part-time fishermen,* who fish for only part of the year to supplement their income, and are engaged in other employment (ie agriculture, etc) during the rest of the year;
- *Occasional fishermen,* who fish irregularly, and mainly for subsistence rather than income.
- *Fish farmers,* who own ponds and operate at various levels of production intensity.

There are several castes of highly experienced Hindu fishermen, the most important being the KAIBARTA. Muslim fishermen are not caste defined, are generally less skillful in fishing and have inadequate knowledge of the aquatic environment and fish stocks. Many enter fisheries as a 'last resort' because they are landless. Because of the socioeconomic conditions they are reduced to, their fishing practices are short-run, income-maximizing in nature, and not conservationistic.

The production support industries include boatbuilding and net making (artisanal hand weaving, factory mechanized weaving). In the postharvest sector employment categories include fish vendors/traders (wholesale and retail), processors (artisanal sundrying, export factories), and transporters (from collector boats to insulated trucks). Business investment interests include jalmohal leaseholders and moneylenders.

The role of women in fisheries is limited. They are employed mainly in processing and net weaving/repair, and may also carry out pond feeding. Girls often participate in fish harvesting in rice fields and borrow pits. Unlike in many other countries, women do not work as fish vendors/traders because of Muslim rules forbidding women to handle money. Because they rarely receive any money for their efforts, women never achieve a position of economic strength or capital accumulation within the fisheries sector. Hindu women tend to be somewhat more active in the fisheries sector, but Muslim women are constrained by purdah.

During the dry season when there is no free access to fishery resources, many genuine fishermen have to work as fisheries wage laborers. In Hakaluki Haor, the fishermen work for leaseholders as wage laborers, getting paid 20-25/= per day. Fishermen receive no shares of the catch. But this employment is only during the dry season. Sometimes the leaseholder brings fishermen laborers from far away villages (possibly to undermine any strengthening of local labor organizational power). During the rainy season, when the entire haor is flooded out, the fishermen are free to fish anywhere on the floodplain. They prefer the rainy season because they are independent and can sell their catch directly at the market. It is during the flood months of June and October that seasonal labor absorption capacity peaks in fisheries. During 4 months of flood season, a fisherman can earn about 40-50/= per day selling his fish. During the dry season which lasts 6 months, fishery wage earning work for leaseholders is not continuous and pays only 20-25/= per day.

No reliable data exists on the numbers of persons employed in the fisheries sector in the Northeast Region. Observations of many artisanal inland fisheries in different parts of the world has shown that limitations on the physical capacity of individual artisanal fishermen to handle their catch, as

well as lack of efficient gear and adequate infrastructure, restrict output per commercial fisherman to about 1 to 4 tons per year. Assuming the lower value to be appropriate for the Northeast Region (given the high intensity of exploitation), the overall production of 1987/88 (115,402 tons) suggests that the number of fishermen, in terms of equivalents to commercial fishermen units, might be 115,000. The actual number of persons involved in fishing activity is however much greater as 24% of overall production results from occasional subsistence fishing. Over 70% of all households in the Northeast Region participate in some type of fishing activity. Furthermore, the production sector creates employment both upstream (boatbuilding and net making) and downstream in postharvest (processing, transport, marketing). Studies elsewhere indicate that for every job in the production sector 2 to 3 jobs are automatically created in the postharvest sector. Direct employment in fisheries in the Northeast Region might be in the order of 345,000 - 460,000 persons (or 6.8% to 9.0% of the regional labor force of 5.1 million). Self-provisioning subsistence fishing might be carried out by several million individuals in the region.

Expansion of the labor force will increase the demand for employment. The regional population is expected to increase by about 66% in the two decades between 1990 and 2010. The labor force could increase by an additional 3.4 million persons. If the fisheries sector is to maintain its current share, an additional 340,000 jobs will have to be created in fisheries over the next 20 years.

There is also increasing incidence of landlessness among the poor because small holders are going broke and selling out. This increases the supply of agricultural wage laborers. Because they have a low opportunity cost, many are drawn into fishing, which puts even more pressure on the fish resources.

Potential areas for creation of new jobs are:

- capture fisheries
- pond culture production
- processing
- marketing and transport
- netmaking and repair
- boatbuilding and repair
- construction works supporting fisheries (embankments around beels, excavation of borrow pits and ponds, fish ladders, etc)

7.2 Income from production and postharvest sectors

Little direct information is available on income levels within the fisheries sector of the Northeast Region. But a first approximation can be made. At an estimated average current retail price of 60/= per kg, the total value of fish production from the Northeast Region is about 6.9 billion/=. Assuming that 76% of this pertains to commercially marketed produce (the remaining 24% is an equivalent market value for subsistence produce), a total of 5.2 billion/= is shared out among the 500,000 persons guestimated to be directly employed in the fisheries sector. Mean per caput income is therefore 10,400/=. However, jalmohal lease holders, money lenders and government taxation capture a large share of total income, leading to severe inequality of income distribution in the fisheries sector. Actual hands-on 'genuine' fishermen and artisanal and factory processing labor undoubtedly earn considerably less than the mean income.

- BBS (1991) gives data from the 1988/89 household expenditure survey for all of Bangladesh. Average monthly income per rural households are:
- 39.3% are farming households, 3,129/=
  - owner farming, 3,696/=
  - owner-cum-tenant, 2,737/=
  - pure tenant, 1,968/=
- 21.1% are agricultural wage labor households, 1,565/=
- 1.6% are fishing households, 2,068/=

Although these figures may not be accurate for the Northeast Region, they do indicate that fishing is more remunerative than agricultural wage laboring, or tenant farming.

Genuine fishermen are apparently now better off than before NFMP. In Habiganj, NFMP fishermen are said to earn up to 4,000/= per year, whereas before they earned less under the jalmohal lease system. Implicit daily wage rates determined by BCAS (1989) for NFMP fisheries range between 57/= and 167/=, but these are high season averages, not annual means.

Given the range of retail trader markups, the retail prices of fish and the quantities of fish sold per trader, it would seem likely that a small fish trader's income might exceed that of a fishermen by a modest margin.

7.3 Living standards of fishing communities

Fishermen tend to live in three types of community situations:

- *Permanent fishing villages,* where most or all of the inhabitants are involved in fishing;
- *Permanent agricultural villages*, where only a minor proportion of inhabitants are involved in commercial fishing (although many more may carry out occasional subsistence fishing);
- *Temporary fishing camps* (KOLA) situated near beels in haors and in deeply flooded areas. Typically fishermen live here for only five months during the dry season, and move back to permanent villages during the rainy season. The temporary buildings are re-erected each year after the flood recedes using materials brought in from outside.

Most fishing families (ie Muslim) own their own homestead, and have a small amount of agricultural land (garden plot). This plot is however too small to yield an economic return. Movable properties are productive assets (fishing gear, boats). Professional Hindu fishermen are mostly poor, low caste and absolutely landless (no plot).

From the available evidence it is not clear that permanent fishing villages differ substantially from agricultural villages and general rural norms in terms of quality of life/living conditions (ie health services, potable water, energy, roads, transport, housing, electrification, child mortality, nutrition, life expectancy). Hygienic conditions in KOLAs appear to be better than in permanent villages, possibly because of the shortage of time for accumulation of refuse, annual flood flushing of the site and greater care because of the need to reduce the vulnerability of the fish drying operations to rodents and other pests.

In general however, fishing communities are extremely poor. Illiteracy is almost total among fishermen. Fishermen often do not want their sons to become fishermen. But they have no money to send their boys to school. The value of education for getting better jobs is clearly recognized.

Low incomes prevent capital accumulation or expenditure on human development (ie education for children). Unless there are concrete and significant shifts in fisheries resource allocation and tenure in favor of genuine fishermen/producers, backed up by institutional support in technology, marketing and finance, no change in the living conditions of fishing communities can be expected in the foreseeable future.

The poverty and increasing marginalization of fishing communities can be attributed to three primary factors which are beyond their immediate control and are not the result of any inefficiencies or inabilities of genuine fishermen to compete in a 'free market' context:

- Lack of tenure over the fish resources;
- Lack of credit;
- Lack of management mandate.

All three of these factors are firmly under government mandate (if not entirely under its control) and therefore suffer from a high degree of inefficiency. Relinquishing and/or modification of government jurisdiction could result in an immediate improvement in living standards, productivity and economic growth. The actions that government needs to take are:

- Government must hand over all tenure rights to fishery resources exclusively to genuine fishermen cooperatives, associations and fishing communities, and reduce license fees to a nominal level (thus renouncing revenue generation from the production sector). Security of tenure must be for at least 10 years, and renewable thereafter.
- Government must make available credit through a special facility within the Grameen Bank for genuine fishermen groups which they can apply for by right.
- Government must delegate full fishery management powers to fishermen groups to control the number of fishermen operating in a particular water body (ie limited to group members), the type of gear permitted, closed season, sanctuary kathas, and any other measures that the fishing community identifies as being necessary to protect the long term sustainability of fish production from their jalmohal(s). The fishing groups need full government technical backstopping and support (but not control).

8. FISHERIES INSTITUTIONS AND CURRENT DEVELOPMENT PROJECTS

8.1 Department of Fisheries

The DOF is the line agency of the Government responsible for fisheries management, development, enforcement, statistics, quality control, extension and training. The staff consists of some 4,300 persons, 28% of whom are professionals.

Hotta (1990) notes that the DOF suffers from shortcomings in planning, project implementation, design of extension activities and interagency coordination. With regard to the latter, the absence of a clear mandate for the DOF results in 'confusing and/or overlapping divisions of responsibility" between DOF and MIWDFC, MLGRDC, FRI, BFDC and Upazilla administrations. There is also a proliferation of staff. Key persons are usually delegated to projects, thus perpetuating weaknesses of DOF's main structure. Insufficient staff are trained in planning, economics, social sciences, management finance and accounting. The DOF staff and resources are definitely overextended. All funds available for development projects cannot be spent. The absorption capacity of the DOF for more external assistance is nil, and committed assistance cannot be fully utilized.

8.2 Fisheries Research Institute

The FRI was established in 1984. It operates four research stations:

- Aquaculture station in Mymensingh;
- Riverine fisheries station in Chandpur;
- Marine fisheries station in Cox's Bazar;
- Brackishwater fisheries station in Khulna.

There are 59 scientific staff and 105 supporting staff. The FRI is involved in some 26 research projects, including borrow pits and HILSA (Chandpur Station). There is a need for involvement of DOF in programme prioritization of FRI research activities.

8.3 Bangladesh Fisheries Development Corporation

Established in 1964, the BFDC is concerned with developing marine fisheries, Kaptai Lake and fish processing/marketing. A number of fish landing centers have been built around the country and are intended to operate as commercial enterprises. Only those in Chittagong and Cox's Bazar are functioning properly. Another 9 (including Dabor center near Sunamganj) are practically lying idle. Lucrative contracts were awarded for the construction of these poorly planned centers. The BFDC's financial performance is particularly poor. It loses 5 crore/= every year, and the total liability of the Government now stands at 75 crore/=. Opinion has been expressed that most of BFDC holding should be sold off to the private sector as soon as possible. Given the generally efficient marketing system for fish which exists in Bangladesh, it seems unjustifiable for a government agency such as BFDC to attempt to enter into fish marketing and compete with the private sector using public funds. Clearly, if BFDC is to play a useful role in the future development of fisheries in Bangladesh a reevaluation of its mandate is urgently needed, followed by speedy reform.

8.4 Other institutions and NGOs

Other public institutions involved in inland fisheries are:

- MOL: administration and leasing of jalmohals over 20 acres;
- Upazila Parishads: administration and leasing of jalmohals of 3 to 20 acres. Most of their development finance is spent on agricultural projects and there is little investment in fisheries;
- MIWDFC: leasing of borrow pits resulting from FCDI construction;
- MRH: leasing of borrow pits resulting from road embankment construction;
- Ministry of Commerce: export of frozen fish commodities;
- Ministry of Finance: budget and administration of externally funded fisheries projects;
- Nationalized banks (Krishi, Agrani, Rupali): provision of credit for fisheries;
- Planning Commission: planning for fisheries sector within national economic planning;
- Universities, whose staff members carry out fisheries related research.

More than 100 local, national and international NGOs are involved in fisheries in Bangladesh. In the Northeast Region works is carried out by BRAC, IDEA, CARITAS, FIDVB and PROSHIKA MUK, among others. Some NGOs lack competency in administering fisheries management projects.

8.5 Current fisheries development projects

Five DOF managed fisheries development projects are currently being executed in the Northeast Region.

The ***2nd Aquaculture Development Project*** is financed by the ADB. It started up in June 1987, and is currently in its last year of life (although an extension is likely). There are four major project components:

- culture-based floodplain fisheries (ie stocking of native and exotic major carp in selected beels in the Northeast Region);
- carp culture extension (ie purchase of seed, fertilizer, feed for fish farmers, training and demonstration, credit, in Sylhet, Habiganj and Kishorganj Districts);
- construction of 6 major government-owned hatcheries (of which 3 will be in the Northeast);
- shrimp culture extension in coastal districts.

The project budget has undergone revision:

	Original	Revised
in crore/=		
DOF portion	72.75	99.02
Credit	98.01	114.70
TOTAL	170.76	213.72

The project finance has been procured from the ADB as a soft loan to the Government of Bangladesh, at 0.75% service charge and 40 year maturity. Credit lines of the project are

administered by the Bank of Bangladesh and disbursed through three commercial banks (Krishi, Agrani and Rupali).

Progress to date has been slow. There have been major problems in selecting both national and foreign consultants. The national project director has been changed twice. Criticism of project components by seconded DOF staff has resulted in further delays. Hail Haor was stocked last year with RUI, CATLA, MRIGEL, Silver carp and Common carp. Local fishermen say catches are increasing. However, 0+ and I+ year classes are not showing up in local markets, and may be going to Dhaka or India.

The project has been criticized for the following reasons:

- it diverts hatchery production away from pond production, and has resulted in scarcity of fry for aquaculture (thus leading to a decrease in pond production);
- rotenoning of beels for carp nursery purpose (it was planned to rotenone 1,600 ha of beels in the final year) which will kill miscellaneous subsistence fish, and disrupt the food chain and life cycle of the environment.
- subsidizing jalmohal leaseholders and rewarding bad management practices (ie benefits go to rich not poor fishermen). It is said that middlemen are benefitting and not fishing communities, as the stocked carp go into the katha of leaseholders.
- in the long term, stocking is unlikely to be financially sustainable. Unless very strict management of fishing effort on natural brood stock overwintering in beels is implemented, any rehabilitation of the carp stock which the project may be successful in achieving will be defeated within 2 or 3 years by uncontrolled beel harvesting by jalmohal leaseholders.
- large government owned hatcheries take up to 7 years to build because of red tape in procurement procedures, and furthermore do not operate in an economically efficient manner. Hatcheries should be smaller, more numerous and entirely under private sector ownership.

The ***Integrated Fisheries Development Project*** is financed by the Government of Bangladesh. It was intended as a time gap filling pilot project prior to start-up of the current 2nd Aquaculture Project. Several of its components are of importance to fisheries in the Northeast Region:

- establishment of mini hatcheries at the upazilla level;
- establishment of fish sanctuaries;
- implementation of NFMP in borrow pits belonging to the BWDB;
- survey of public water bodies in urban centers.

Total value of the project is 17.73 crore/=.

Mini hatcheries are being established in Moulvi Bazar (Kulaura), Sherpur and Narshingdi Districts. BWDB borrow pit development is being done to gain experience in development of FCDI-impacted jalmohals. No project sites are in the Northeast Region, but a planned second phase will have a site in the Manu River Project near Moulvi Bazar.

The following fish sanctuaries are being established in the Northeast Region:

- Sari River and Luba River, near Kanairghat in Sylhet District, 1,000 ha total area (to protect migrating RUI, CATLA, GONIA, KALIBAUS);
- Surma River, at Sunamganj, 1,000 ha area;
- Ublakha River and Hogla Beel, in Khaliajuri Upazilla of Netrakona District, 500 ha total area;
- Kali River, in Kuliachar Upazilla of Kishorganj District, 500 ha area.

Uniformed 'fish guards' have been appointed to prevent fishing for migrating or overwintering carp and other stocks in sanctuary areas. Fish guards have at their disposal mechanized country boats. The system is new and not yet very effective.

There are numerous derelict government khas ponds and reservoirs in urban centers. All districts are being surveyed in order to bring these jalmohals into productive use.

A successor project is being planned, entitled "***Integrated Aquaculture Development in FCDI Project Areas***". This will focus on fisheries in BWDB borrow pits. Re-excavation of pits will be carried out under a food for work arrangement supported by WFP. Project expenditures will be met by the Government of Bangladesh, at least initially.

The ***Improved Management of Open Water Fisheries Project*** is a follow-up project to the earlier experimental management project (BCAS, 1989). It is financed by Ford Foundation and has a budget of 1.12 crore/=. This project seeks to improve socioeconomic conditions of NFMP fishing communities. It supplies boats, gear and credit, and is concerned with community development. For example, it attempts to introduce handicrafts as a new source of income. An important aim is of the project is to try to transfer authority for management to the fishermen themselves (ie *community-based fisheries management*). The project works in association with NGOs (BRAC, CARITAS, FIDVB, PROSHIKA MUK), but does not provide them with finance. The project's beneficiary jalmohals are all under NFMP: rivers in Netrakona and Kishorganj, Kanglir Haor near Sunamganj, beels in Habiganj and Netrakona and a dead river (baor) in Sherpur. The project budget has provisions for holding two workshops, foreign training for DOF staff and computer training.

The ***Aquaculture Extension Project*** is financed by DANIDA. It operates only in Mymensingh District (half of which falls within the NERP area). The current project is nearing completion and will likely go into a second phase. The project targets primarily small scale pond owners. The total project budget is 6.94 crore/=, of which DANIDA contributed 6.29 crore/= and the Government of Bangladesh 0.65 crore/=.

The project has 3 main components:

- credit for those who qualify;
- demonstration for those who don't qualify for credit;
- contact farming advisory service.

Project impact has been good and increases in production and income from ponds have been recorded.

The ***Institutional Strengthening in the Fisheries Sector Project*** is financed by UNDP and executed by FAO. In the Northeast Region it provides some support to aquaculture extension in Netrakona and Kishorganj.

9. APPARENT IMPACTS OF FCDI ON FISHERIES IN THE NORTHEAST REGION

9.1 Conventional wisdom on FCDI impacts on fisheries

The conventional wisdom on FCDI impacts on floodplain fisheries has been determined (sometimes, but not always) from actual case studies in Bangladesh, such as the Chandpur Project, Chalan Beel Project, etc. (MPO, 1985; Ali, 1991). The following impacts are attributed to FCDI:

- open water fish production declines due to general reduction in the area (hectare-months) of lentic waters such as beels and floodlands (ie reducing the nursery and feeding grounds area);
- regulators prevent migration and recruitment of migratory species, especially major carps;
- small sized fish and prawn species replace large sized species;
- elimination of oxbows by channelization destroys prime carp spawning grounds;
- cross dams on rivers prevent migration upstream, and consequently the upstream fishery disappears;
- embankments cut off channels (khals) which connect beels to rivers thus preventing both water and fish stock replenishment of beels.
- submersible embankments delay spawning migrations, resulting in resorption of ova and milt in frustrated brood stock.

To summarize, negative impacts center on interference with fish migration/reproduction and general reduction/disruption of aquatic habitat quality and area. One may even identify a deeply ingrained pessimism (defeatism? fatalism?) about FCDI impacts on fisheries in the policy shifts of the Bangladeshi fisheries institutions away from capture fisheries and towards aquaculture.

Most of the impact information presented below was collected by the NERP water resources management field programme and is of a preliminary nature only. Reproduced here almost verbatim from NERP (1992). Many of the project will be visited by the fisheries team to make a more comprehensive assessment of impacts.

9.2 River channelization projects

KHOWAI RIVER SYSTEM (Habiganj District)
NO IMPACT. There is very little fishing activity in the Khowai River and, reportedly, before project implementation fishing activity was low. Local people have not noticed any impact from the project on floodplain fisheries.

[Embankments along the Khowai River prevent fish from reaching shallow floodlands lateral to the river channel to spawn. But fish growth inside embanked areas is good because closing of sluice gates results in higher water levels during the dry season. If the sluice is properly utilized it should not have a negative effect on fish spawning. There is the example of the Mattajuri fishery. It was a useless borrow pit before FCDI, but after the Khowai River embankment was built the fishery was much improved. It now produces 2,000 kg/ha of carp, BOAL, shrimp and MAGUR.]

KONAPARA EMBANKMENT PROJECT (Mymensingh District)
NO IMPACT. Local people report that before project implementation there was very little fish in the project area, and that the quantity of fish has not changed after construction of the embankment.

SURMA RIVER LEFT BANK SYSTEM (Sylhet District)
NO IMPACT. At present, there are no embankments along the right bank of the Surma River, and the left bank area remains open to flooding from the Kushiyara River. It appears the embankment has had little impact on floodplain fisheries.

The embankments along parts of the Kushiyara River have no impact on fisheries according to one fisherman. Another says it is very bad for fisheries. It prevents big fish from coming into the river from the beels. A breach in the embankment is good for the fishery in the beel behind the breach.

One river training practice is 'river loop cutting'. This involves excavating a bypass channel to straighten out a meandering river channel. This was done to the Khowai River near Habiganj to reduce flood risk to the town. The isolated river loop (oxbow or baor) becomes a new jalmohal suitable for more intensive fisheries production. But looping also has a severe negative impact on carp reproduction as ox-bow bends are a favored spawning habitat.

9.3 Full flood protection projects with pumped drainage and irrigation

MANU RIVER IRRIGATION PROJECT (Moulvi Bazar District)
NEGATIVE IMPACT. The project has reduced the area of permanent water bodies. Reportedly, employment in fishing declined by about 20% due to the project, and the wages of fishermen declined by about 32%. The total annual income of a fisherman household declined by 15%.

NARAYANGANJ-NARSHINGDI IRRIGATION PROJECT (Narayanganj and Narsingdi Districts)
NEGATIVE IMPACT. Local people state that the project eliminated the floodplain fisheries.

Road embankments are high elevation and are often included as components of FCDI projects. They function effectively as full flood embankments. Thus, they affect flood progression and recession patterns as the capacity of culverts may be inadequate. The road embankment network is fairly extensive, and is a major structural feature of the Northeast Region which needs to be taken into account in impact studies.

9.4 Full flood protection projects without pumped drainage or irrigation

SARI-GOYAIN PROJECT (Sylhet District)
POSITIVE IMPACT. Local people living around the Teli Khal regulator consider that fishery resources have increased due to retention of water in the Teli Khal and Gobrajan Khal by the regulator. Other local people and subsistence fishermen living elsewhere within the project area state that there is no significant change in fishery activities due to the development of the project.

KACHIKATA REGULATOR SCHEME (Narsingdi District)
NO IMPACT. Local people believe there has been no major change in fisheries since the closing of the khal with the structure in 1955.

ADAMPUR SUBPROJECT (Kishorganj District)
NO IMPACT. Local people report that project implementation has had no impact on fisheries.

HAIL HAOR PROJECT (Moulvi Bazar District)
NO IMPACT. Local people consider that the project to date has had little impact on the fisheries in the area.

SHAKA BORAK SUBPROJECT (Moulvi Bazar District)
NO IMPACT. There are no major fishery activities in the project area. Local fishing in the khals has not changed.

SHARIFPUR FCD SUBPROJECT (Moulvi Bazar District)
NO IMPACT. There are no fisheries within the project area. Local people who fish in the Manu River state that the embankment has not affected their fish catch.

KUSHIYARA-BARDAL PROJECT (Sylhet District)
NO IMPACT. There are no major permanent water bodies in the area and it appears that the project has had little impact on fishery resources.

ZILKAR HAOR PROJECT (Sylhet District)
NO IMPACT. Structures include 16 km of full flood embankments and 8 km of submersible embankments. Subsistence fishermen from the Dhum Khal area report that the project's engineering works have had little impact on fisheries.

BALUSHAIR EMBANKMENT PROJECT (Narsingdi District)
NEGATIVE IMPACT. Local people have stated that there has been a reduction in floodplain fishes after construction of the embankment.

DARDARIA KHAL SYSTEM (Gazipur District)
NEGATIVE IMPACT. Includes re-excavation of Dardaria Khal.

Fishermen believe that the project has reduced the numbers of fish in the area.

KAKON NADI SCHEME (Narsingdi District)
NEGATIVE IMPACT. Includes re-excavation of khals.

Fishermen complain that there is less fish now due to the construction of the regulators on the beel outlets.

GAZARIA BEEL SCHEME (Kishorganj District)
NEGATIVE IMPACT. The Gazaria Beel Scheme just outside of Kishorganj has been identified as having an apparent negative impact on fisheries. The reasons are complex. First, land owners / farmers want drainage during the dry season in order to plant boro crop. Some of the beels are in fact privately owned and are viewed by the owners as land which happens to have some unwanted water on it, rather than any kind of natural water body which has its own fixed inherent identity and uses. So the more water that can be drained away, the more land becomes exposed and can be planted with boro crop. Thus, in January the regulator was open, and water was flowing out of the beels, down the khal, past the regulator and out into the adjacent Bathal River. Second, farmers with plots further away from the beels want to water their boro crop during the dry season to increase yield. So they want to use the readily at hand beel water for this purpose. Together these two factors result in heavy pressure to dry out beels during the dry season. The beel/land owners probably also do not miss the opportunity to claim ownership of the fish in the beels on their lands, and the dry-out allows total fish harvest, thus maximizing their short run benefits. All of this is very bad for the health of the overwintering fish brood stocks in the beels. Once all the boro crops is planted and growing on the maximum possible land, no farmer is interested to have pre-monsoon floods spilling in from the Bathal River. So the regulator across the khal is kept closed (and the river's water level builds up in front of the regulator). This prevents river water from entering to replenish beel water levels, and also prevents movements of fish in either direction across the regulator. So there is little chance of the

fish stocks of the beels being replenished from river stocks. The overall result has been that while in the past RUI, CATLA, AIR, BOAL, KOI, MRIGEL and many other fish species used to be harvested, now there are very few fish caught at all. Local people would of course like to have more fish, but they also want more land, and the latter seems to be the far stronger demand. Why? First, land and its acquisition is the most secure and acceptable form of capital accumulation and long term wealth storage available to rural people. Second, it also allows one to produce a consumable staple commodity in great demand which can feed one's own family as well as produce an excess which can be sold for cash. Third, you can build your house on it. Fishing just doesn't measure up to this. The two Gazaria fishermen we met were both landless, implying that they became fishermen because they had no land and thus couldn't farm. Landlessness probably confers low social status and feeble economic weight, and thus nil lobbying powers for non-agricultural interests, such as fisheries. Capital accumulation is probably marginal or nil outside agriculture for the majority of the rural population.

9.5 Submersible embankment projects

GURMAR HAOR PROJECT (Sunamganj District)
POSITIVE IMPACT. Local people, including a jalmohal leaseholder, report that the fishery resources have increased due to the development of the project since it helps to maintain the required depth of water for pile fishery.

MATIAN HAOR PROJECT (Sunamganj District)
POSITIVE IMPACT. A representative of the Bara Beel leaseholder states that the fishery resources have increased substantially due to the development of the Matian Haor Project since it helps to maintain the required depth of water for pile fishery. A large quantity of carp is produced in the beels.

SHANIR HAOR PROJECT (Sunamganj District)
POSITIVE IMPACT. A representative of the jalmohal leaseholder states that fisheries have increased substantially due to development of the project since it helps maintain the required depth of water for pile fishery.

SONAMORAL HAOR PROJECT (Sunamganj District)
POSITIVE IMPACT. The fishery groups at Sonamoral and Kuraijan state that the project has increased fishery resources as it helps to maintain the required water level for pile fishing during the dry season.

HUMAIPUR HAOR PROJECT (Kishorganj District)
NO IMPACT. The people fishing in the project area consider that there is no change in fishing activities due to implementation of the project.

NAWTANA KHAL PROJECT (Netrakona District)
NO IMPACT. Local people report that the project has had little impact on fisheries as the embankment is submerged during the monsoon season.

BHANDA BEEL PROJECT (Sunamganj District)
NO IMPACT. The beels mainly produce small fishes and the project has negligible impact on existing fishery resources.

CHAPTIR HAOR PROJECT (Sunamganj District)
NO IMPACT. Fishermen around Chataler Khara think the project does not have any adverse impact on the existing fish resources.

HALIR HAOR (Sunamganj District)
NO IMPACT. The Chatidhara Group fishery which occupies the Ratla and adjacent small beels say that the project does not have any negative impact on fishery resources.

JOYDHONA HAOR PROJECT (Sunamganj District)
NO IMPACT. Local people consider that the project to date has had no impact on fisheries.

KARCHAR HAOR PROJECT (Sunamganj District)
NO IMPACT. Fisheries have not declined in Karchar Haor or the project beels on the western side of the project.

MOHALIA HAOR PROJECT (Sunamganj District)
NO IMPACT. Local people report that most of the beels become dry in the winter season and the project embankments have not affected the fishery resources.

NALUAR HAOR PROJECT (Sunamganj District)
NO IMPACT. The project works carried out to date have not affected the fisheries in the area as the khals have remained open. However construction of three of the six planned regulators is not yet completed, and this might have an impact in the future.

SHANGHAIR HAOR PROJECT (Sunamganj District)
NO IMPACT. Subsistence fishermen at Hasnabad compartmental bund state that there has been no change in fisheries due to the development of the project.

TANGUA HAOR PROJECT (Sylhet District)
NEGATIVE IMPACT. A representative of the Hawa Beel leaseholder states that the project has affected the migration of fish during the spawning period. Subsistence fishermen around Bhadalia Beel say that the project has a minor negative impact on the existing fish resources.

Submersible embankments are mainly constructed around haors. Positive effects of submersible embankments include an increase in surface area of beels during the dry season. If the regulator gate is closed in December, more water will be retained during the dry season. Ideally, the design elevation should ensure a 6 foot water level at the end of the dry season. However, submersible embankments impede fish migration in either direction for about 10-20 days during the early monsoon until the embankment is overtopped. But as many fish stocks include early spawners and late spawners, submersible embankments will select for late spawners. Early spawners overwintering in rivers will probably swim further up stream to headwaters and tributaries.

9.6 Khal re-excavation projects

BARDAL KHAL RE-EXCAVATION (Kishorganj District)
POSITIVE IMPACT. Local people state that fishery activities have increased after re-excavation of the khal.

SINGUA RIVER RE-EXCAVATION (Kishorganj District)
POSITIVE IMPACT. Local people have stated that fisheries have increased after project implementation.

DEWANKHALI KHAL SYSTEM (Narsingdi District)
NO IMPACT. Local people state that before implementation of the project there were not many fish in the beels and that now fish are still not plentiful.

ALALIA BAHADIA KHAL RE-EXCAVATION (Kishorganj District)
NO IMPACT. Local people report that there was little fishing activity in the khal, either before or after project implementation.

DAMRIR HAOR PROJECT (Sylhet District)
NO IMPACT. Fishermen in the project area consider there to be no change in fishery resources.

২৪

Silted up khals are re-excavated to improve drainage. Thus their water storage volume is increased, leading to greater fish producing capacity. Greater use is probably also made of the re-excavated khals by migrating fish stocks.

9.7 Water retention structure projects

BOHARA WRS SCHEME (Habiganj District)
NO IMPACT. There is little fishery activity in the project area. The structure appears not to have altered the fish habitat in the Sonai River.

9.8 Summary of apparent impacts

The fisheries impact information collected is quite interesting and challenges some of the conventional wisdom on FCDI impacts in Bangladesh. Thirty-eight FCDI projects in the Northeast Region have been evaluated for fisheries impacts to date (see table at end of chapter). Of these 63% have had no apparent impact on fisheries according to local correspondents, 18% have had apparent positive impacts, and 18% apparent negative impacts. Seemingly benign project types (at least, as implemented in the Northeast Region) include river channelization, khal re-excavation and water retention structures. The worst offenders are full flood control projects with pumped drainage and irrigation. Submersible embankments and full flood projects control without pumped drainage or irrigation give mixed impacts, but over 50% of such projects are seemingly benign.

The NERP fisheries team will be investigating FCDI project impacts in greater detail, so these first results of the project reviews are to be considered preliminary and indicative only. Still, the indications are that FCDI impacts on fisheries, at least in the Northeast, are not as catastrophic as conventional wisdom would suggest. The apparent potential for 'no impact' and 'positive impact' outcomes is encouraging, and puts the onus on the NERP planning team to identify the casual factors which result in FCDI projects being 'well behaved' towards the fisheries sector. These factors could then be built into future projects, and might also allow mitigative measures to be carried out at existing projects.

It is of the greatest importance to bear in mind that many FCDI projects do not behave according to design plan. Problems frequently seen are:

- too early overtopping of submersible embankments;
- too much breaching of submersible and full embankments either by floods or by public cuts (ie farmers and/or fishermen trying to drain out fields or to flood them for various and frequently conflicting purposes);
- too many drainage and irrigation structures inoperable due to mechanical damage and siltation;
- river channel siltation contributing to the above and limiting navigation.

The relevance to fisheries of these 'failures' is profound because it implies partial reversions to pre-FCDI conditions (ie natural or local community initiated 'mitigation'). Clearly, the impact of any particular FCDI project has the potential to vary from one year to the next. Furthermore, as there is a general overall decline in maintenance of structures in the region, the general regional direction of drift is towards pre-FCDI conditions. In conceptualizing and assessing the impacts of FCDI projects one must clearly distinguish between what might happen over the long term if the structures performed perfectly, and what has actually transpired given the highly imperfect behavior (from an FCDI engineering perspective) of many projects.

Project Type	Positive Impact		No Impact		Negative Impact		Total Impacted	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
River Channelization	0	0	3	100	0	0	3	8
Full flood control with drainage and pumped irrigation	0	0	0	0	2	100	2	5
Full flood control without pumped drainage and irrigation	1	8	7	58	4	33	12	32
Submersible embankments	4	27	10	67	1	7	15	39
Khal Re-excavation	2	40	3	60	0	0	5	13
Water Retention Structures	0	0	1	100	0	0	1	3
TOTAL	7	18	24	63	7	18	38	100

The overall historical impact on the fisheries sector of the 65+ FCDI projects implemented in the Northeast Region by BWDB is provisionally considered to have been a net benign impact, which may have been partly responsible for an overall increase in production (ie of miscellaneous species).

10. FISHERIES DEVELOPMENT ISSUES

10.1 Apparent negative impacts of FCDI on fisheries

It is a general view in Bangladesh that FCDI projects have had little or no consideration for fisheries, that their impact has been almost entirely negative and that there is no long term future for floodplain fisheries in Bangladesh because eventually almost all flooding will be controlled. Because of the general pessimism about observed and expected negative impacts of FCDI on fisheries, DOF development policy has shifted away from capture fisheries and now is heavily focused on aquaculture.

From the information collected so far (see Section 9), there are no clear grounds for 'catastrophic' pessimism in the Northeast Region. The main purpose of FCDI in the Northeast is to protect winter crop (BORO) from early floods in April-May to allow it to mature and be harvested. After that flooding can overtop embankments in June/July. Fishermen say full flood embankments are bad for fisheries, but submersible embankments increase fisheries. Regulator operation is under the control of the BWDB and normally serves agricultural interests, but the BWDB tries to arrange compromises between fisheries and agriculture (ie recognizing the desire of fishermen to drain beels during the dry season to facilitate fish harvesting).

The importance of public cuts and breaches of embankments for modifying FCDI impacts on fisheries also has to be considered. Man-made breaching is the result of farmers attempting to drain or flood their land (the latter sometimes to build up land elevation). Fishermen cut embankments to drain out beels to facilitate catching fish, or to let fish and water into beels to submerge katha.

Egg resorption may be a non-issue. Tsai et al (1981) for example witnessed 11 spawning episodes of major carp in one river bend locality between 21 April and 25 June. Submersible embankments designed to overtop $\pm$ 15 May will still allow a lot of late spawning to take place. Carp that overwintered in rivers are not inconvenienced as they can simply swim upstream to spawning localities.

Opportunities exist for mitigating losses from full flood protection projects and these must be pursued. Many of the residual FCDI versus fisheries issues in the Northeast Region might be resolvable without recourse to blanket replacement aquaculture scenarios (which may in any case be impractical).

The uniqueness of the hydrology and physiography of the Northeast Region probably also imparts a measure of uniqueness to the region's fisheries and the impacts of FCDI on them, which may not be directly comparable to other regions of Bangladesh.

10.2 Conflicts between agriculture and fisheries

One set of conflicts centers around water use. Beel draining is the most severe example. Jalmohal leaseholders and/or fishermen often want to drain beels to facilitate total harvesting of fish, while farmers want to retain water for their boro crop irrigation needs. Elsewhere, farmers may want to drain beels to create more agricultural land, while fishermen want to retain high water levels required for the katha production system. Timing of draining or flooding constitutes another complex of conflicts.

Social tensions between farmers and fishermen often revolve around the fish resource itself. Fishermen brought in from outside by leaseholders are resented by surrounding farming populations. Fishermen catch fish which would otherwise be available to farmers when their land is seasonally flooded. Farmers claim customary rights to free fishing in waterbodies. Also, wealth accumulation by leaseholders is resented, so leaseholders end up posting armed guards around jalmohals - further increasing tensions.

There are no clear and simple overall solutions to these issues, and each needs to be studied on a case-by-case basis.

Another area of concern is the increasing use of insecticides, which has resulted in mass fish mortality in some cases.

10.3 Government rent-seeking and the jalmohal leaseholder system

A state of conflict exists between MOL and the DOF as regards implementation of NFMP, resulting from a reluctance on the part of MOL to give up ownership (and thus administration and revenue collection jurisdiction) of jalmohals in favor of DOF. Even for jalmohals already under NFMP, MOL retains ownership, and thus these jalmohals are under an arrangement of 'joint management' between MOL and DOF. There are two main reasons why MOL has adopted a position hostile to NFMP:

- Jalmohal leasing is lucrative and the main source of income for the MOL. Net income from revenue collection from MOL land leasing is small because expenditure for the wages of collectors is almost equal to the revenue collected. Jalmohal leasing is in contrast very profitable because public auctioning of leases entails almost no labor costs.
- Jalmohal leasing offers substantial opportunities for corruption and augmenting the income of public officials. This occurs in 3 ways: 1) officially recorded jalmohals are leased out in the normal manner but the lease fee is under-recorded (ie a lease fee of 9 lakh/= is collected, but only 8 lakh/= is recorded as paid); 2) there exist officially recorded jalmohals which are not leased out and are nominally derelict. Payment of baksheesh will result in a blind eye being turned to fishing activity; and 3) undeclared and unrecorded jalmohals which are 'property' of MOL effectively become 'private property' of high public officials, who lease them out at their discretion and pocket the lease fee and any other income from shares and such.

DOF officials maintain that genuine fishermen under NFMP are now better off than before NFMP. Annual earnings of a fisherman may reach 4,000 taka (US$120). If a fisherman's family has 5 members this amounts to a per caput income of $24, still well below the Bangladesh national average per caput income of $180. True, the family will have other sources of income. But as NFMP sets out to develop career professionalism in the fisheries sector it is distressing to see such a low benefit accruing to fishermen. It is difficult to consider the system as anything other than still quite exploitive, and possibly little better than the status quo leasing system it replaces. The key driving force from the government's perspective continues to be rent-seaking. License fee rates (cum loan interest) which can almost equal a fisherman's annual salary seem to be completely unjust - especially as it is not clear that the fisherman is getting very much in return for the fees (other than simple entry into the fishery). NFMP still has a very long way to go before it can make genuine fishermen and their families wealthy. The main problem now is to get the government departments to stop siphoning off economic rent - real or imagined - out of the fishermen's pocket, and let the fishermen receive the full market value of their catch - minus real capital/operating costs - as income. This is the only way they can be able to generate enough net revenue to provide

for sustainable growth in personal disposable income and accumulation of capital for investment. Government should consider reducing its rent seeking control of the fisheries sector and allow the full entrepreneurial talents and energies of genuine fishermen free opportunity to realize themselves. If a genuine fisherman can earn the sum of 20,000 or 30,000 taka a year, his increased purchasing power will lead to greater regional economic growth. There would appear to be plenty of scope for fishermen and fishermen coops to collectively negotiate better fee structures with DOF and DOR.

Fishermen themselves suggest solutions to this issue: either government gives loans to pay for lease fees, or government should abolish the lease fee system altogether. Many want to do away with the auction/leasing system. They want to fish freely. ["The river was made by Allah"]. Also, if fish stocks are depleted, there is no justification for government to charge a royalty for a resource that doesn't exist. And furthermore, increasing the royalty by 10% annually (thus fueling inflation) when fishery resources are known to fluctuate non-directionally from year to year.

10.4 Inadequate government support for implementation of NFMP

The Government has been too timid in introducing NFMP and has lacked political will. By transferring only a minute percentage of jalmohals to NFMP, it does not challenge and change the leaseholder system, but gives the leaseholders and moneylenders an opportunity to adjust their practices without necessarily suffering any particular loss of benefits. The power of the state still largely backs, supports and actively maintains in place the jalmohal leasing system (ie supports leaseholder status quo). If it would be a straight one-on-one battle between leaseholders and fishermen, the latter would undoubtedly win out. But state partiality and intervention tip the balance in favor of leaseholders, giving them the upper hand.

Fishermen have little faith that the government will help them. Some upazila fisheries officers openly cater to leaseholders, and support leaseholder interests over the interests of fishermen. Fishermen fear that government and rich leaseholders will misappropriate the money intended to assist them. Local politicians may be too weak and/or poor, and don't have enough power to help them.

10.5 Professional organization and economic empowerment of genuine fishermen

There are several constraints on strengthening of fishermen coops (BCAS, 1989):

- lack of motivation;
- lack of prior organization or group homogeneity;
- poor communication among members;
- pressure from local power groups;
- lack of monitoring and evaluation;
- illiteracy
- lack of finance
- poor leadership.

The coops remain loose and atomistic, and thus less effective than they could be. Also they do not incorporate other fisheries sector groups such as women who make nets and process fish, and fish vendors.

Many fishermen say their biggest problem is capital. They must pay too much to government and middlemen. They want loans for boats and nets. Lack of credit is a major impediment for two reasons: 1) fishermen cannot pay the high license fee which is the entry 'ticket' to the fishery, and 2) they cannot buy gear and boats and meet other costs associated with processing and marketing. Thus, NFMP remains a good idea (wishful thinking), but without serious government political will to implement it. Uncertainty of availability of Krishi Bank credit is a major problem for NFMP. Fishermen have to mortgage their boats, nets, immovable property and even catches for loans of more than 6,000/= against one licence. Loan recovery is unsatisfactory. Application procedures are complicated and receptivity is poor. Non-availability of finance means NFMP fishermen have to turn to moneylenders who charge 7-15% interest per month, or aratdars who take delivery of fish for 3% commission and a share of the catch. As long as government does not provide credit to genuine fishermen, it cannot be considered serious in its support for NFMP. Credit is the key and backbone to NFMP.

10.6 Insecurity of tenure and resource mining

Very senior DOF officers in Sylhet have seen catches decline over the long term, mainly due to overexploitation. Leaseholders now harvest piles annually, and in the third year drain the beel completely. This breaks the fishing law regulating pile fisheries. The 3 year lease period is too short. If leases ran for more than 5 years (or better 10 - 12 years) people would have an incentive to develop seasonal beels. Short leases promote overexploitation. The 3 year pile leases are being reduced to 1 year, thus tripling fishing effort. One can identify a 'plunder mentality' among leaseholders. Also, if fishery resources become depleted NFMP fishermen do not renew their licenses.

10.7 Floodplain stocking for carp resource rehabilitation and rotenoning of beels

The ADB stocking and rotenoning programme has become a controversial issue. Not only are the economic benefits unclear (implying that the stocking programme is experimental in nature), the rotenoning of nursery beels will destroy a part of the subsistence food fish resource. All at a very high cost in development resources, which might be put to other more urgent uses (such as implementing NFMP and setting up fish sanctuaries).

The ADB project stocked Hail Haor with 49 tons of fingerling last year: RUI, CATLA, MRIGEL, Silver Carp, and Common Carp. But according to some DOF sources, middlemen are benefitting, not the fishermen communities, as the carp end up in the katha of leaseholders. The ADB project had plans to rotenone 27 beels in NE Region in March 1992.

There is an extremely important economic issue here. If leaseholders are indeed overexploiting the resource (ie major carp brood stock), then the ADB stocking programme is in fact a subsidy to jalmohal leaseholders (as well as private hatcheries) and rewards bad fisheries management behavior and practices. This is clearly the antithesis of sustainable development and will subvert any attempts to put into place a sound fisheries management regime. It is also not clear if the intent of the project is a once only rehabilitation of certain carp stocks and introduction of exotic carp species, or if it is to become an annual stocking service to jalmohal leaseholders.

Until there is greater ownership and control of capture fisheries by genuine fishermen, stocking of carp will likely only benefit status quo capital interests such as leaseholders (making the rich richer). Significantly, there is no intent to stock miscellaneous species which would benefit the poor subsistence fishermen.

Any stocking programme needs to be accompanied by better resource ownership and fishing effort management, otherwise the goals of stocking will be defeated.

10.8 Sedimentation of beels and khals

Many beels, khals and river channels are silting up. Major reductions in mean depth of beels in the northern part of the Sylhet depression have been recorded. It is widely believed that this gradual reduction in water volume is negatively impacting fish production. It is not at all clear what can be done about this problem, apart from expensive re-excavation works. Sedimentation studies are being undertaken by NERP.

10.9 Water pollution

Industrial waste pollution of the Surma and Kushiyara Rivers is having a negative impact on fisheries. Fishermen say the Fenchuganj fertilizer plant is reducing fish catches. Similar criticism is made of the cement plant and the pulp and paper mill at Chatak which pollute the Surma River. Local people refuse to eat fish from the Surma River because of their bad taste and smell caused by contamination of fish flesh. This fish ends up being sent to Kazi Bazar in Sylhet or to Dhaka. Because these rivers appear to be critical overwintering habitats for major carp, large catfish and other commercially important fish species, urgent action is required. Installation of treatment systems at all industrial plants in the region should be considered a priority. Furthermore, environmentally 'clean' technologies should be selected for any future industrial projects.

10.10 Inadequate security

While the status of fishermen is low and their economic power weak, the value of their product is very high. Because of this paradox fishermen are subjected to much abuse and victimization. Around Dabor (Sunamganj District) for example, there are many dacoits in the area. Some are Bangladeshi and others are Indians. They work together at nite and are quite dangerous. Three years ago, 5 policemen were killed by dacoits at the Dabor bridge. There is a big security problem in the area and Bangladeshi security forces are insufficient and corrupted. If genuine fishermen were to get jalmohal leases they would be unable to protect their fish from dacoits who would overpower them and steal the fish. Middlemen hire guards who can fight off the dacoits and protect the fish.

However, BCAS (1989) says that middlemen leaseholders do not and cannot provide protection to fishermen against extortion, net theft and damages by miscreants, dacoits and local influential people. Also, fishermen settle disputes among themselves with help and guidance from elders.

In more remote areas fishermen do not complain about problems with dacoits.

10.11 Overlaps of ministerial jurisdictions within the fisheries sector and weakness of MFL/DOF

MFL suffers from two major dilemmas: 1) its mandate in the fisheries sector is very incomplete and several other ministries possess overlapping jurisdictions, and 2) it is itself a weak technical ministry in comparison to other more powerful ministries.

MFL could benefit by forging alliances (through the agency of joint projects and other collaborative activities) with more powerful ministries. However MFL is in conflict with some key ministries. There is a continuing tug of war between MOL and MFL for jurisdiction over jalmohals. This

would not seem to be resolvable through normal means even though several attempts have been made.

Conflicts also exist between MFL and MIWDFC because of the negative impacts of some FCDI projects on fisheries and the lack of specific fisheries components within FCDI projects. However, an alliance between these two ministries should be considered a necessity and indeed a 'natural' state of interagency cooperation: MIWDFC is responsible for water resources management and development in the broadest sense, while MFL is responsible for management and development of a major renewable living aquatic resource contained within and completely dependent on the quality and quantity of the larger water resource. MFL/MIWDFC cooperation is beginning to take shape in the agreement between DOF and BWDB to give DOF management responsibility in selected waters owned by BWDB. This needs to be extended much further. A key strategic goal must be to forge a powerful interministerial lobby backed by the fisheries sector to bring all water bodies under general MIWDFC water management and DOF fish resource supervision. Clearly MOL is completely unequipped to carry out either of these mandates and its continuing hold over jalmohals is selfserving, exploitive and defeats any attempts to further develop the inland fisheries sector of Bangladesh.

11. PROSPECTS FOR ENHANCING THE FISHERIES SECTOR

11.1 Improving the behavior of FCDI projects towards fisheries

There are several possibilities for improving FCDI projects from the perspective of fisheries production. These include:

- ***Replacing the FCDI concept with a Multipurpose Water Resources Management (MWRM) concept.*** Most FCDI projects do not have a fisheries component. In practice this means that no area(s) within the project is set aside and designated for fish production, and no finance is budgeted for construction of fisheries related structures. Every MWRM project must have a fisheries purpose and component, finance for its construction and execution, and be a joint agency effort (BWDB/DOF) with full collaboration during planning, design, construction and operation. MWRM would also include clearly defined components for navigation, cattle grazing, wildlife as well as agriculture within a project area, perhaps through a compartmentalization approach. Allocation of water bodies/land for controlled flooding for fish production could also be considered.

- ***Increasing dry season hectarage.*** Transformation of seasonal beels into permanent beels where feasible, by building a low embankment around the beel and inflow khal, and installing gates. Submersible embankments around beels would increase dry season water area/volume, and fishermen say it will increase fish production. Theoretical studies indicate that the magnitude of fish production during the annual flood period is sensitive to the amount of water remaining at the end of the dry season in refuge habitats (beels, khals, rivers). Thus increasing the dry season area and volume of beels is of great importance. In theory, a moderate increase in dry season area can compensate for a large decrease in maximum area flooded during the inundation period (as would result from some FCDI projects). These relationships are shown in graphical form in text figures at the end of this chapter, as well as some possible civil works schemes to achieve increased dry season water hectarage. Another measure to consider is excavation of permanent and seasonal beels to increase dry season water volumes, and re-excavation of silted-up beels and khals. Irrigation withdrawals from beels must be rigorously controlled so that a minimum depth required for brood stock overwintering is retained. Beel draining (whether by jalmohal leaseholders or by genuine fishermen) to allow total fish harvests is to be discouraged altogether.

- ***By-pass structures for fish.*** Design, construction and operation of fish ladders, regulators and other bypass structures as required for selected species (ie major carp) to allow unimpeded spawning migrations. Public cuts roughly fall into the category of fish bypass structures. Public cuts should not be seen as a sabotage problem (ie a defeat of the planned purpose of a FCDI structure), but as an attempt by local interest group(s) to modify the operation of a FCDI structure so that it is more compatible with their needs. The location and motivations behind public cuts must be carefully studied and evaluated, and where feasible incorporated into permanent structures. Public needs are often more complex than what the BWDB planning process chooses to respond to. Public cuts with fisheries objectives are of special concern because they are a selfhelp response from the poorest section of society.

11.2 Production enhancement methods

A major possibility for increasing fish production above the natural level is through the use of katha as a biological production system, rather than only its current use as simply a fish aggregating device. Katha can increase biological production in three ways:

- It creates more secure and diverse spawning habitat for some species. Thus reproductive success is increased.
- It creates more secure nursery habitat by lowering predation rates (ie vulnerability of fingerlings to predation is reduced in katha). Fry and fingerling survival is thus increased.
- It creates a large food resource due to the growth of periphyton/aufwuchs on the greatly increased surface area of the katha brush, upon which juveniles and adults alike feed. This is 'free' high quality natural food. Thus, fish growth and condition are increased.

Studies on brush park fish production systems (ie acadja in West Africa) clearly indicate their capability to increase fish production above natural levels. Typical average yields are in the order of 6,000 kg/ha/yr, and under exceptional circumstances up to 26,000 kg/ha/yr has been recorded. A new system is now being developed in Cote d'Ivoire using bamboo stakes in place of brush. Approximately 10 stakes per sq m are required, but bamboo life span in water substantially exceeds that of brush. Current floodplain yield in the Northeast Region is 50-61 kg/ha/yr. If large bamboo katha were to be installed in key beel jalmohals, yields could be significantly increased. The bamboo katha has many other potential applications: in roadside borrow pits, on rice fields, in aquaculture ponds, in irrigation canals and khals, and in certain river stretches.

A second and compatible approach to production enhancement is to plant more hijal gus around beels as this is known to increase fish abundance. Plantation stewardship systems used elsewhere for mangroves should be tested for management and exploitation of this important wetland forestry resource.

11.3 Better fish processing and marketing

There would be significant scope to improve and diversify processing methods with much greater participation and income generation for women. Apart from upgrading sun dried products through better hygiene and preservation, opportunities exist for fermented products, salted and smoked products, semi-wet preservation, and a wide host of other processes practiced at artisanal smallscale level throughout the world.

The employment of women in fish marketing is also considered to be a key potential growth element for the fisheries sector. This would free male labor for more physically arduous tasks in fisheries, and ensure that finance management and capital accumulation is carried out more effectively, as women have demonstrated their superiority in this area in artisanal fisheries in many other developing countries.

11.4 Effective management of fishing effort and protection of natural brood stock

Resource mining and overexploitation of broodstock seems to be the single most serious problem faced by the fisheries sector in the Northeast Region. Solutions are not difficult to formulate but will require serious intent on the part of government to implement. No single measure will suffice, but an integrated multicomponent package of management measures and structural adjustments of

fisheries tenure and jurisdictions needs to be put in place - in a single process, not as piecemeal or timid pilot projects.

An integrated fisheries management programme must include the following elements:

- ***Transfer of fishery resource tenure to fishing communities.*** Fishermen will only be motivated to direct a portion of the fish stock (ie leave it unharvested) into 'bio-capital' savings for investment in future years' fish crops if they are 100% assured and secure that they will be able to harvest those next years' fish crops (ie they will have fishing rights). They need security of tenure over the resources for a multiyear period, as some species need several years to mature. If their production and management practices are efficient, then the assured tenure period should be lengthy (10-15 years) as there can be no good justification for disrupting an efficiently and sustainably operating fishery yielding significant benefits to producers and consumers alike.
- ***All fisheries management authority must be transferred to fishing communities.*** The community-based management approach in fisheries is now gaining wide acceptance in many parts of the world, in both developing and developed countries. Fishing communities must themselves determine and enforce management measures limiting fishing effort and protecting broodstock. They are the only agency capable of carrying out cost effective management. It is the fishing communities who will suffer the economic consequences of bad management and stock depletion, and therefore only they will have sufficient incentive to carry out effective management. Closed fishing communities can be expected to limit entry, determine and enforce closed seasons, delimit prohibited fishing grounds, allocate resource exploitation spaces among its members and test and share new technologies. As a political unit, they will also possess increased lobbying power to pressure government for needed support policies and services. Fishing groups must be given long term responsibility for management and conservation of the fishery resources of their jalmohals, including monitoring, surveillance and control (MSC). Licensed fishermen coops are already setting up their own surveillance system to prevent fishing by unlicensed fishermen or villagers (spontaneous CBM). There is need to establish a new set of customary fishing rules (building on the existing) which everyone will generally accept and adhere to.
- ***Fish sanctuaries need to be established.*** In beels this could best be done by installing sanctuary katha. Fishermen groups should be responsible for looking after sanctuaries so that they will be the real beneficiaries of the scheme. In rivers, critical stretches in mainstreams and tributaries used as spawning habitat need protection. Large rivers such as the Surma, Kushiyara, Kangsa and Baulai are important overwintering habitat for major carp, large catfish and other species. It is likely that currently they may even be the most important overwintering habitat, because of beel mining by leaseholders. Tidally-influenced river stretches are possibly less susceptible to fishing out than beels, but a community-based management approach still needs to be applied. DOF should help finance sanctuaries (which can be viewed as low cost in situ hatcheries) and assist fishing communities with enforcement.
- ***The role of DOF (and other government agencies) must change*** to a supportive role, responsive to the identified needs and requests of fishing communities, rather than the current role of command, control and rent extraction. Public institutions must support the private sector (ie genuine fishermen) and not seek to usurp their political power or economic output.

11.5 An employment policy for the fisheries sector

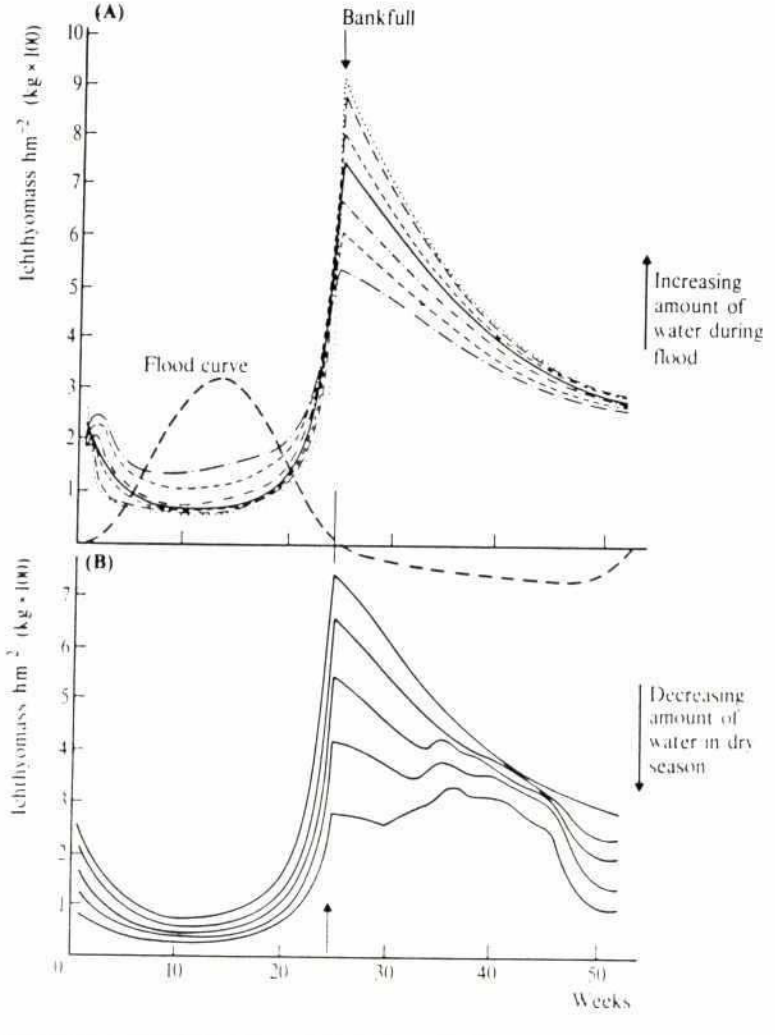
Government must establish real plan targets for employment creation, income growth and improved living standards (literacy, education, health and other services of society) for the production and postharvest sectors. This must be actualized through provision of credit, training and human resource development, supply of social services and productivity increases (output per workers) through investment in better technology. A considerable and uncompromising effort must be made to strengthen the position of women in postharvest sector (processing and marketing) and in net making and repair. Lean fishing period employment needs to be developed (ie handicrafts and vegetable gardening).

There needs to be involvement of NGOs in group formation, motivation and cohesion. Unique homogenous group can partly protect the real fishing community from economic exploitation, which is also a political issue. Formation of groups, collection of savings, literacy and other income generating activities will help fishing communities to achieve better living conditions.

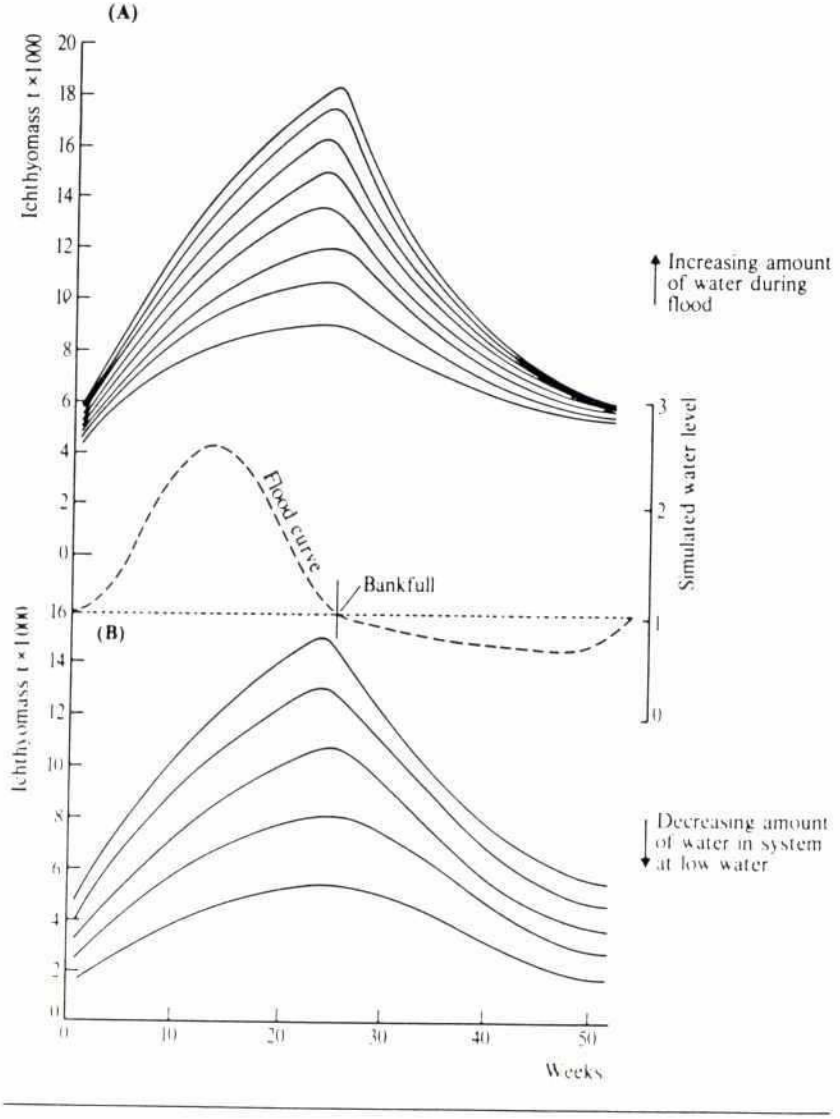
11.6 A fish import, export and consumption strategy

Given the real degree to which government can effectively attempt to stimulate fisheries production in the Northeast and elsewhere in Bangladesh, it seems practically unavoidable that a serious fish supply deficit will materialize during the next decade which will directly and negatively impact consumption. The solution to filling the production deficit may be to use foreign exchange income earned from high priced fish commodity exports (and that requires a focused and effective thrust to increase fish exports) to import cheap and good quality food fish (ie frozen small pelagics). The objective should be to achieve a highly positive nutritional balance of trade (ie import much larger quantities of fish than are exported). The government will need to ensure that imported fish does not destroy market incentives of domestic producers, and that imported frozen species are accepted by consumers (through a concerted effort at market niche development).

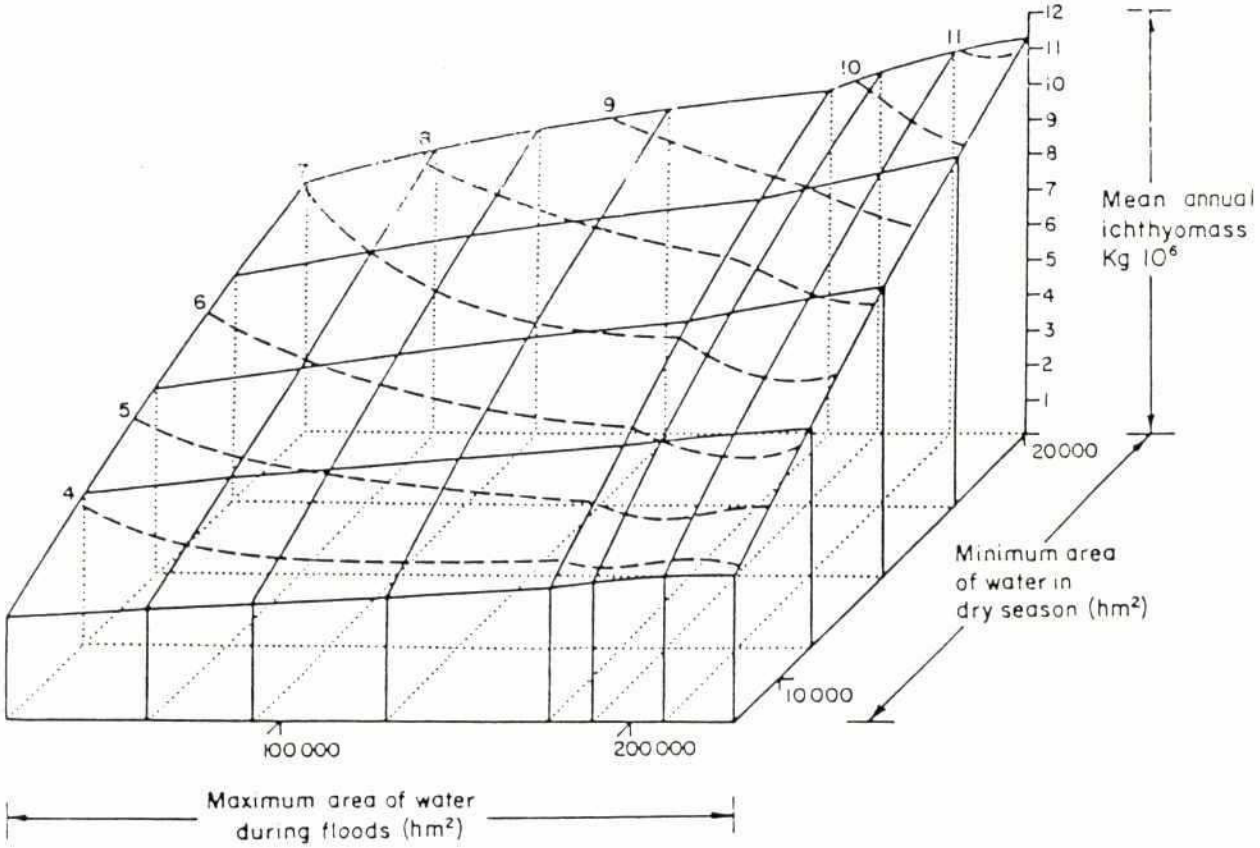
The government's goal nationally over the next decade should be, at the least, to maintain per caput fish consumption at its current nominal level of 7.2 kg/annum. Ideally, a more ambitious goal of increasing per caput supply would be desirable but may be unrealistic in the short and medium term.



Computer generated curves showing changes in population density (kg/ha) with time for different flood regimes where: (A) the low water regime is constant and the high water regime varies; and (B) the high water regime is constant and the low water regime varies. Also shown is a typical water regime (-----). (After Welcomme and Hagborg, 1977)

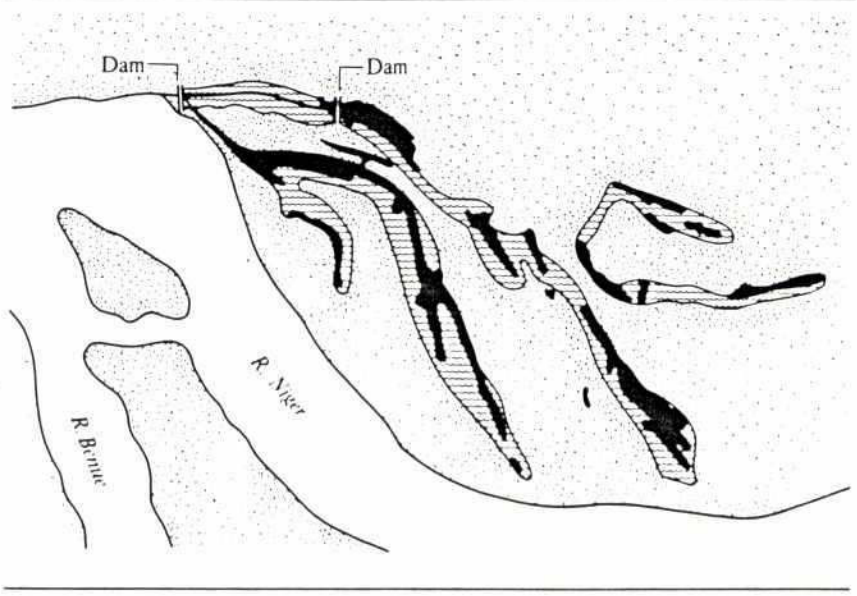


Computer generated curves showing changes in total ichthyomass with time for different flood regimes where (A) the low water regime is constant and the high water regime varies; and (B) the high water regime is constant and the low water regime varies. Also shown is a typical water regime (-----). (After Welcomme and Hagborg, 1977)



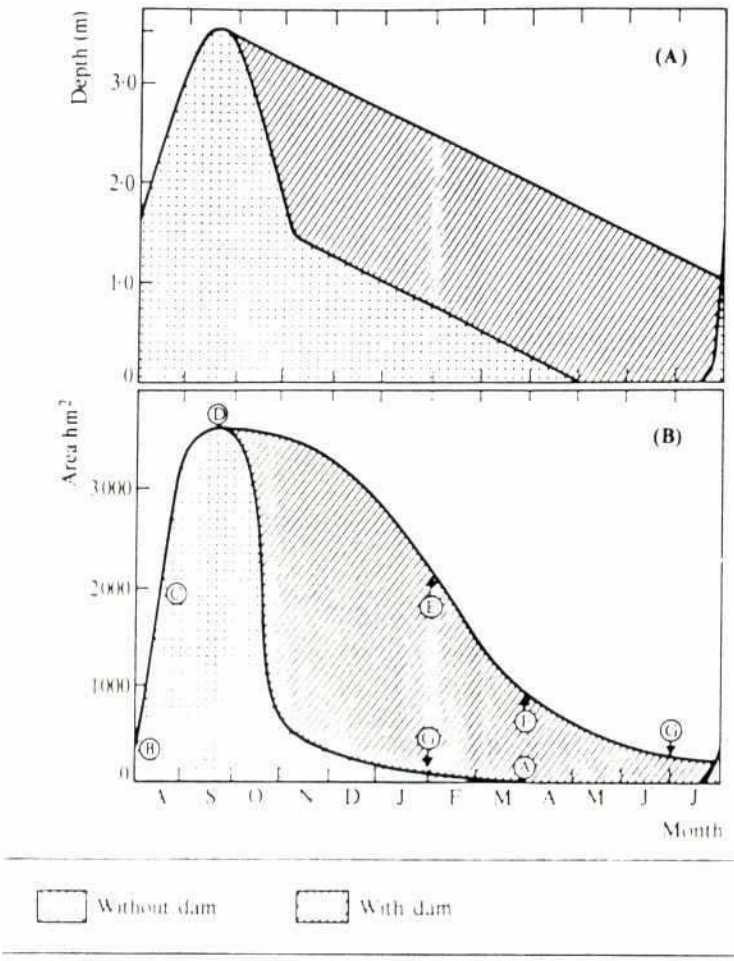
Three dimensional plot of mean annual ichthyomass as related to water regime. Dashed lines join points of equal ichthyomass on the derived surface.

From: Welcomme and Hagborg (1977)



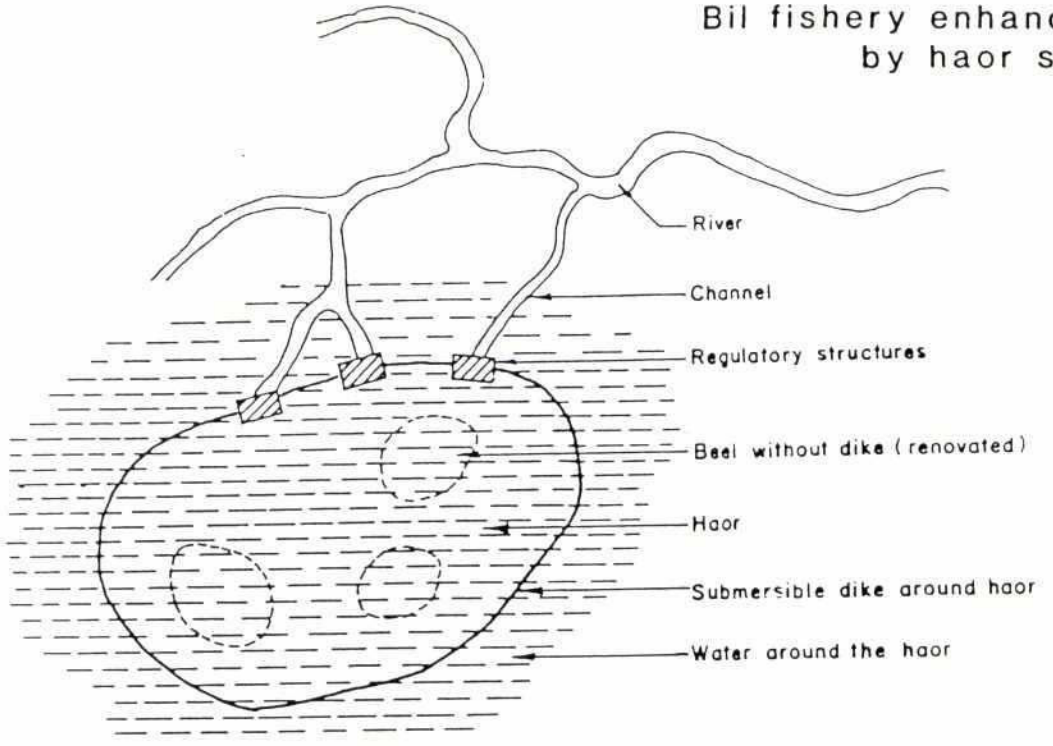
Tracing from aerial photograph of the Niger floodwater retention dams, showing the original water area and the area flooded after the placing of the dams.

From: Welcomme (1985)

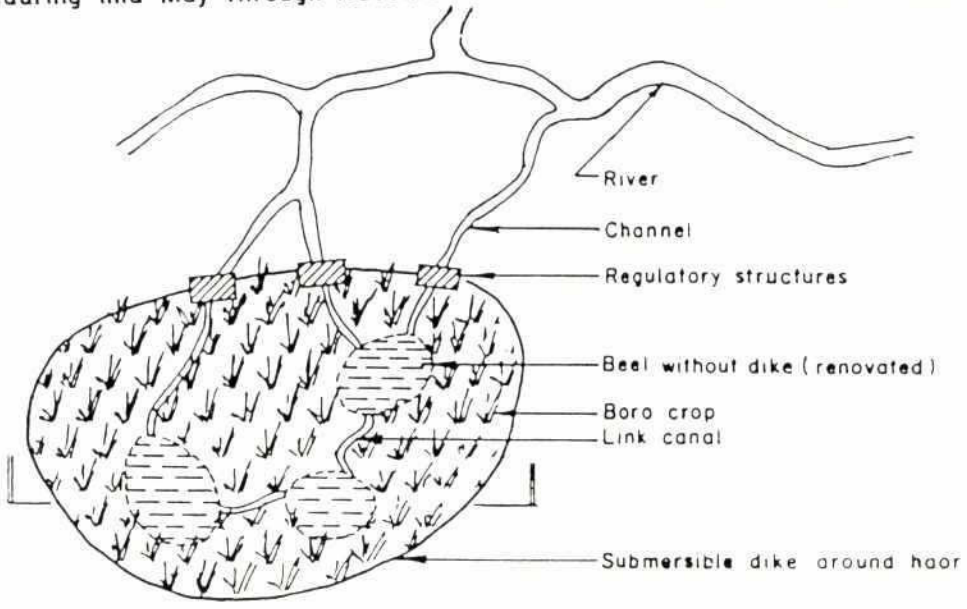


Difference in changes in (A) depth and (B) area of a floodplain pool before and after damming of the main access channel.

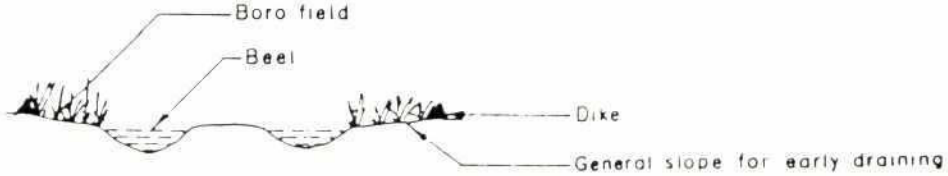
From: Welcomme (1985)



A. Conceptual picture during mid May through November: Water in the entire haor and around

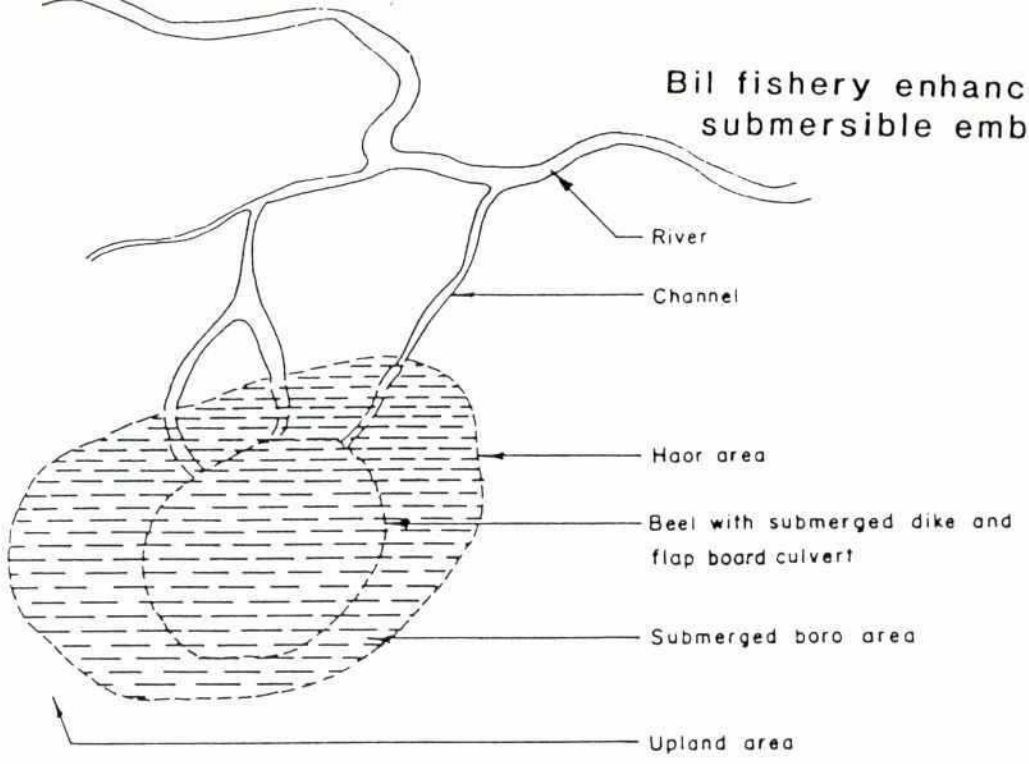


B Conceptual picture during late November through before flood: Water only within the beels

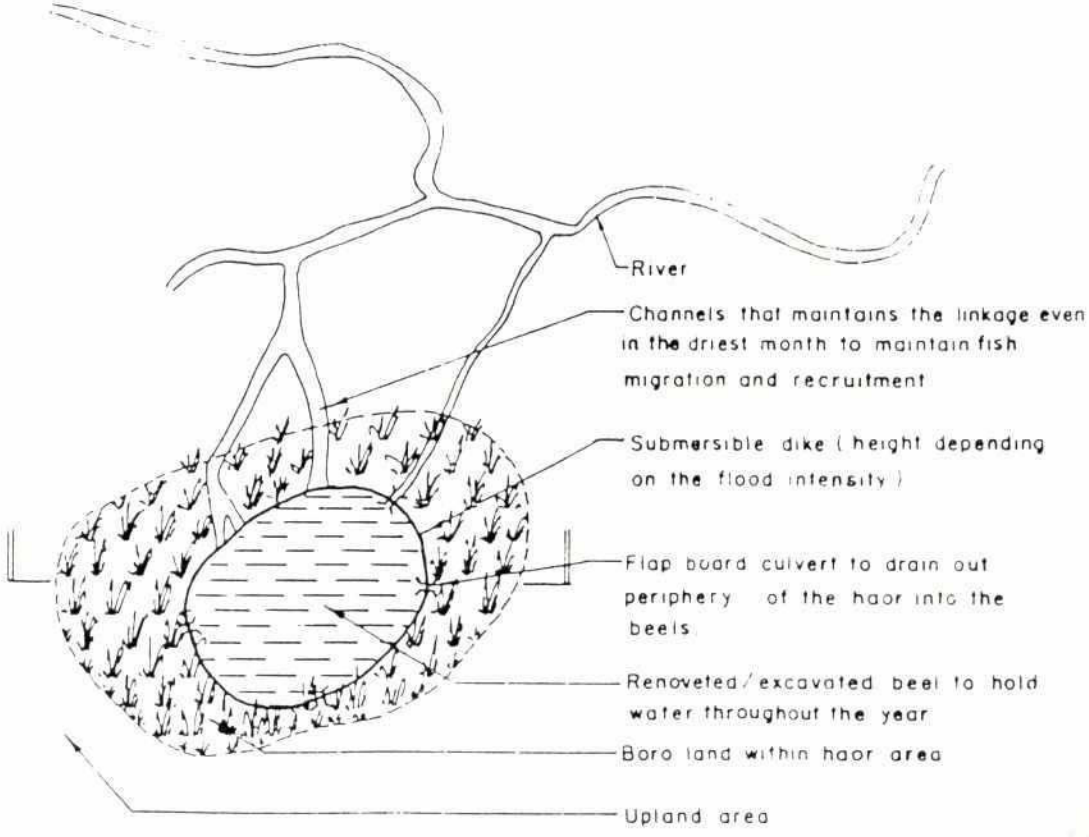


C S OF THE HAOR BASIN

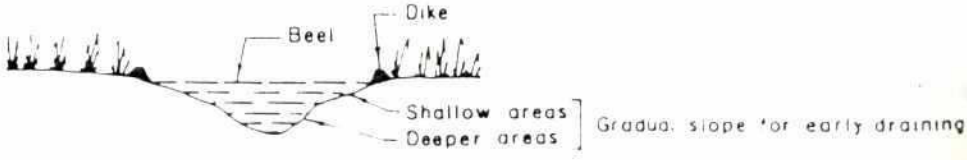
From: NWHC/SAL (1986)



Conceptual picture during mid May through November: Water in the entire haor.

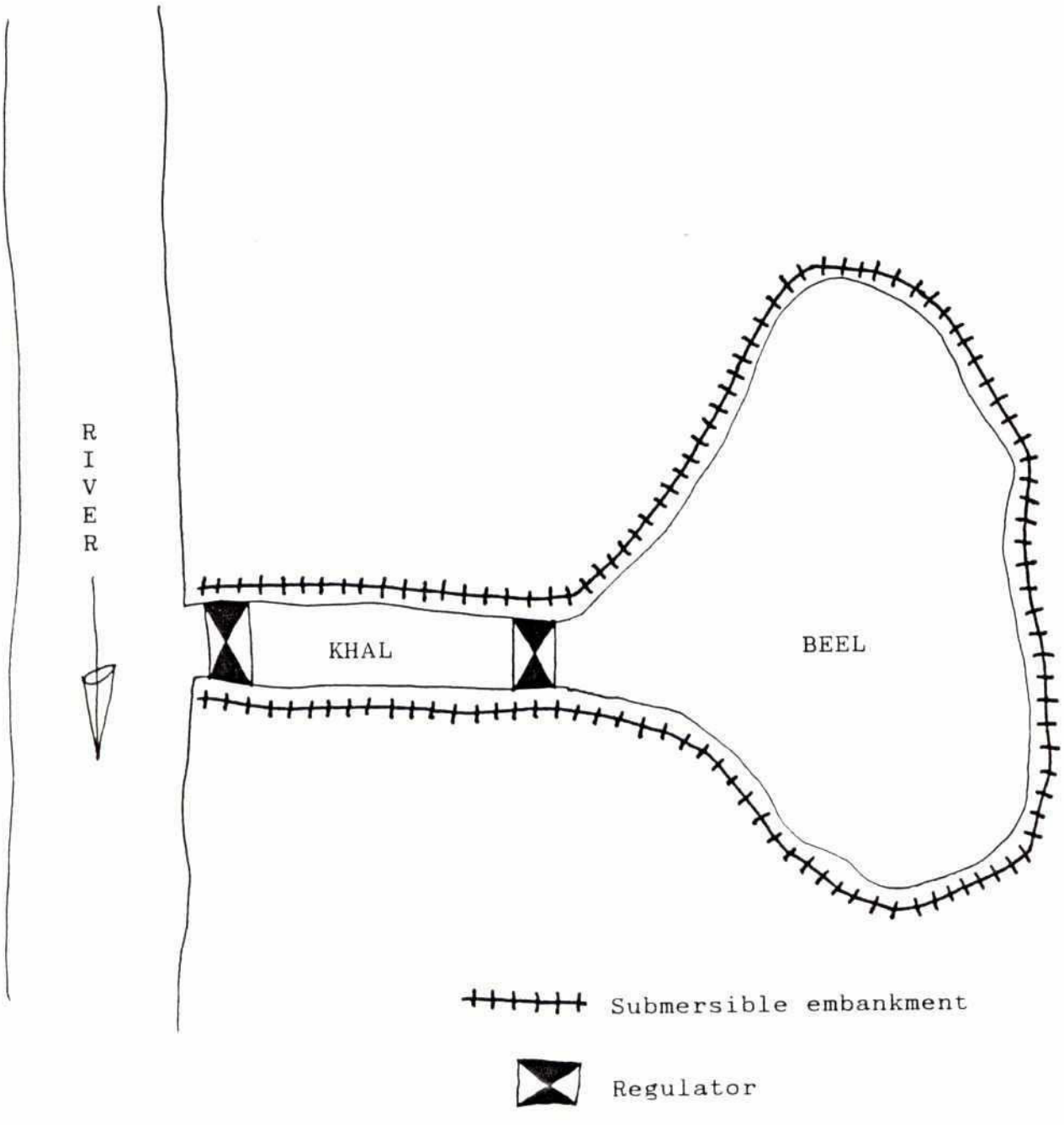


Conceptual picture during late November through before flood: Water only within the beel



C S OF THE BEEL

From: NWHC/SAL (1986)



Structural scheme for transforming a seasonal beel into a permanent beel. Embankment material is excavated from the beel and khal.

12.BIBLIOGRAPHY

Aguero, M., Saleemul Huq, A K Ataur Rahman and Mahfuzuddin Ahmed (editors) 1989. Inland fisheries management in Bangladesh. Department of Fisheries, Bangladesh; Bangladesh Center for Advanced Studies; and International Center for Living Aquatic Resources Management, Manila, Philippines. 149pp.

Ali, M Youssouf 1991. National conservation strategy of Bangladesh, towards sustainable development: fisheries resources of Bangladesh. International Union for Conservation of Nature and Natural Resources - The World Conservation Union, Ministry of Environment and Forest, and National Conservation Strategy Secretariat, Bangladesh Agricultural Research Council, Dhaka. 96pp.

Azadi, Mohammad Ali 1985. Spawning of commercial freshwater fish and brackish and marinewater shrimps of Bangladesh. Fisheries Information Bulletin, 2(2):74pp.

BBS 1991. Report on the household expenditure survey 1988-89. Bangladesh Bureau of Statistics,Dhaka. 201pp.

BCAS 1989. Experimental project for new and improved management of open water fisheries in Bangladesh. Bangladesh Center for Advanced Studies, Dhaka. 313pp.

Catling, H D, M R Martinez and Z Islam 1981. Survey of alga associated with deepwater rice in Bangladesh. Cryptogamie Algologie II. 2:109-121.

Chong, K-C, Nazrul Islam and Monowara Begum 1991. Analysis of the constraints to and potentials and opportunities for expanded fish production in Bangladesh. MFL/UNDP/FAO Institutional strengthening in the fisheries sector Bangladesh, Project BGD/87/045, Field document 91/07: 129pp.

CIDA 1989. Inception report - working draft, Haor Development project, Bangladesh, CIDA project no. 170/13339, September 1989. SL/NWHC in association with EPC/BETS.

CIDA 1990. Inception report, Northeast regional water management project, Bangladesh, CIDA project no. 170/13339, April 1990. SL/NWHC in association with EPC/BETS.

DOF/FAO 1991. Support services for the development, management and conservation of open water fisheries in Bangladesh, project proforma, March 1991. In: Appendix B, Progress report on sectoral planning and project analysis component (period November 1990 - April 1991). Institutional strengthening in the fisheries sector, UNDP/FAO BGD/87/045 project.

Hotta, M 1990. Annex 6 (untitled report on fisheries institutions of Bangladesh). Institutional strengthening in the fisheries sector, UNDP/FAO BGD/87/045 project.

Jhingran, V G 1983. Fish and fisheries of India. Hind.Publ. Delhi.

Jhingran, V G and H A Khan 1979. Synopsis of biological data on the mrigal *Cirrhinus mrigala* (Hamilton, 1822). FAO Fisheries Synopsis, (120):78pp.

Khan, H A and V G Jhingran 1975. Synopsis of biological data on rohu *Labeo rohita* (Hamilton, 1822). FAO Fisheries Synopsis, (111):100pp.

Laureti, E 1991. Fish and fishery products: world apparent consumption statistics based on food balance sheets (1961-1989). FAO Fish. Circ., 821, rev 1, FAO, Rome. 423pp.

Minkin, S F 1989. Steps for conserving and developing Bangladesh fish resources. UNDP, Agricultural Sector Review, Dhaka. 15pp.

MPO 1985. Fisheries and flood control, drainage and irrigation development. Technical report no 17, Master Plan Organization, Ministry of Irrigation, Water Development and Flood Control, 54pp.

NERP 1992. Water resources review report.

Nuruzzaman, A K M 1989. A proposed fisheries policies for Bangladesh. Bangladesh Agricultural Research Council, Dhaka. 34pp.

NWHC/SAL 1986. Bangladesh Water Development Board, Pre-feasibility study for Northeast rivers flood protection. Appendix A, agriculture and fisheries. Northwest Hydraulic Consultants Ltd and SARM Associates Ltd. 72pp.

Rahman, A K A 1989. Freshwater fishes of Bangladesh. Zoological Society of Bangladesh, Dhaka. 364pp.

Sadeque, Syed Zahir 1990. Capture fisheries and other common property resources in the flood plains of Bangladesh. Paper presented at: Second Workshop of European Network of Bangladesh Studies, Bath, UK. 25pp.

Talwar, P K and A G Jhingran 1991. Inland fishes of India and adjacent countries, Vols 1 and 2. TYK Prokason, Dhaka. 1158pp.

Tsai, Chu-Fa and Liaquat Ali 1985. Open water fisheries (carp) management programme in Bangladesh. Fisheries Information Bulletin, 2(4):51pp.

Tsai, Chu-Fa and Liaquat Ali 1987. The changes in fish community and major carp population in beels in the Sylhet-Mymensingh basin, Bangladesh. Indian J Fisheries, 34(1):78-88.

Tsai, Chu-Fa, M Nazrul Islam, Md Rezaul Karim and K U M Shahidur Rahman 1981. Spawning of major carps in the lower Halda River, Bangladesh. Estuaries, 4(2):127-138.

Welcomme, R L 1985. River fisheries. FAO Fish.Tech.Pap., (262): 330pp.

Welcomme, R L and D Hagborg 1977. Towards a model of a floodplain fish population and its fishery. Env.Biol.Fish., 2(1):7-24.

World Bank. 1991. Bangladesh fisheries sector review. Agriculture Operations Division, The World Bank, Washington, DC. 195pp.