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)

FISHERIES MANAGEMENT PROGRAMME

PRE-FEASIBILITY STUDY
FINAL REPORT
December 1994

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

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COVER PHOTO: A typical village in the deeply flooded area of the Northeast Region. The earthen village platform is constructed to keep the houses above water during the flood season which lasts for five to seven months of the year. The platform is threatened by erosion from wave action; bamboo fencing is used as bank protection but often proves ineffective. The single *hijal* tree in front of the village is a remnant of the past lowland forest that used to cover much of the region. The houses on the platform are squeezed together leaving no space for courtyards, gardens or livestock. Water surrounding the platform is used as a source of drinking water and for waste disposal from the hanging latrines. Life in these crowded villages can become very stressful especially for the women, because of the isolation during the flood season. The only form of transport from the village is by small country boats seen in the picture. The Northeast Regional Water Management Plan aims to improve the quality of life for these people.

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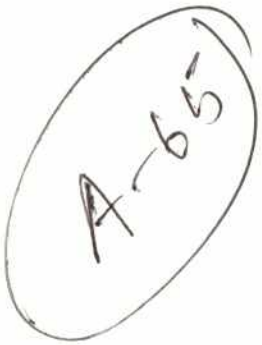

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ACRONYMS AND ABBREVIATIONS

AFI	Ajmiriganj Fish Industries Ltd
BARC	Bangladesh Agricultural Research Council
BB	Bangladesh Bank
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Center for Advance Study
BFDC	Bangladesh Fisheries Development Corporation
BFRSS	Bangladesh Fisheries Development Resource Survey System
BKB	Bangladesh Krishi Bank
BWDB	Bangladesh Water Development Board
CAS	Catch Assessment Survey
CBM	Community Based Management
CJM	Community Jalmohal Management
DC	Deputy Commissioner
DOF	Department of Fisheries
DOR	Department of Revenue
DPHE	Department of Public Health Engineering
EIA	Environmental Impact Analysis
FAO	Food and Agricultural Organization
FAP	Flood Action Plan
FCD/I	Flood Control, Drainage and Irrigation
FCS	Fishermen Cooperative Society
FDS	Fisheries Development Sub committee
FF	Ford Foundation
FEAVDEP	Flood & Erosion-Affected Village Development Project
FRI	Fisheries Research Institute
GOB	Government of Bangladesh
HYV	High Yielding Variety
ICLARM	International Center for Living Aquatic Resource Management
LDB	Laminated Duplex Board
LLP	Low-lift Pump
MFL	Ministry of Fisheries and Livestock
MFM	Mother Fisheries Management
MLGRD	Ministry of Local Government and Rural Development
MOL	Ministry of Land
MSY	Maximum Sustainable Yield
NERP	Northeast Regional Project
NEMREP	Northeast Region Environment Management Research and Education Project
NFA	National Fishermen Association
NFMP	New Fisheries Management Policy
NGO	Non-governmental Organization
ODNRI	Overseas Development National Resource Institute
OSS	Other Sectoral issue Sub-committee
PROSHIKA	(a NGO called PROSHIKA Manob Unnayan Kendra)
PVT	Private
PWD	Public Works Department
RHD	Department of Roads and Highway
RLF	Revolving Loan Fund
UNDP	United Nations Development Program
WB	World Bank

US $1 = Tk 38

GLOSSARY OF TERMS

arat	Wholesale fish market
aratdars	Fish wholesaler
beel	Floodplain lake, which may hold water permanently or dry up during the winter season
boro	Rice grown in Rabi season or winter rice
boromaach	Large fish species
chotomaach	Small fish species
duars	Deep scour hole in river
jal	Net
jalkar	Lease money
jalmohal	A beel, river section, khal or other water body which is registered for revenue collection purpose as a fishery
jatka	under sized Ilish
haor	Depression on the floodplain located between two or more rivers, which functions as a small internal drainage basin
hijal	A floodplain tree species (Barringtonia acutangula)
kandha	Higher elevation land in a haor
katha	Brush used in a pile fishery
khal	Drainage channel running across a haor, connecting a beel to a river
khola	Temporary dry season fishing camp
koibarta Das	Genuine fishermen (Hindu origin)
koroch	A floodplain tree species (Pongamia pinnata)
mohalshamil jalkar	Jalmohals which are under community-based fisheries management.
nikari	Fishermen traders who purchase fish from the fishermen
nitimala	Policy
paiker	Large scale fish trader who supply fish to a certain market
pile fishery	A fishery which uses the katha fishing method and is harvested only once every three years
reserve fishery	A fishery which is harvested only once every 5-7 years. Reserve fisheries may or may not contain katha.
shawla	Algae
shidal	Semi-fermented fish
shutki	Sun-dried fish
thana	Base level of government administration
zamindar	Owner of large area of land

EXECUTIVE SUMMARY

The proposed fisheries management programme is regional is scope. The objectives of the programme are to improve biological management of the floodplain fishery through research and direct interventions in fisheries habitats, and indirectly through assistance to NFMP (New Fisheries Management Policy) fishermen associations, to new community based management (CBM) programmes, and improvements in management of community fisheries (mohalshamil jalkar), while improving equity of benefits. The programme will improve marketing and processing facilities to reduce spoilage and increase the value added in processing.

The programme consists of seven measures targeted on strategic elements of the openwater fisheries production and marketing system:

- Improve biological management of mother fisheries.
- Protect key spawning and overwintering habitats.
- Assist 120 Fishermen Associations under NFMP
- Assist communities to improve management of *mohalshamil jalkar*
- Establish a floodplain fisheries management and fish processing station under Fisheries Research Institute (FRI).
- Construct eight fish landing facilities and wholesale fish market halls at important fish collection centres.
- Construct six municipal retail fish markets in district towns.

It is proposed that the programme be implemented through DOF. The capital costs of the programme are estimated at US$ 27.6 million. In addition, there will be a need to provide US$ 4.4 million as credit facilities.

NERP DOCUMENTS

The Northeast Regional Water Management Plan is comprised of various documents prepared by the NERP study team including specialist studies, the outcome of a series of public seminars held in the region, and pre-feasibility studies of the various initiatives. A complete set of the Northeast Regional Water Management Plan Documents consists of the following:

Northeast Regional Water Management Plan

Main Report
Appendix: Initial Environmental Evaluation

Specialist Studies

Participatory Development and the Role of NGOs
Population Characteristics and the State of Human Development
Fisheries Specialist Study
Wetland Resources Specialist Study
Agriculture in the Northeast Region
Ground Water Resources of the Northeast Region
Surface Water Resources of the Northeast Region
Regional Water Resources Development Status
River Sedimentation and Morphology
Study on Urbanization in the Northeast Region
Local Initiatives and People's Participation in the Management of Water Resources
Water Transport Study

Public Participation Documentation

Proceedings of the Moulvibazar Seminar
Proceedings of the Sylhet Seminar
Proceedings of the Sunamganj Seminar
Proceedings of the Sherpur Seminar
Proceedings of the Kishorganj Seminar
Proceedings of the Narsingdi Seminar
Proceedings of the Habiganj Seminar
Proceedings of the Netrokona Seminar
Proceedings of the Sylhet Fisheries Seminar

Pre-feasibility Studies

Jadukata/Rakti River Improvement Project
Baulai River Improvement
Mrigi River Drainage Improvement Project
Kalni-Kushiyara River Improvement
Fisheries Management Programme
Fisheries Engineering Measures
Flood and Erosion-Affected Villages Development Project (FEAVDEP)
Habiganj-Khowai Area Development
Pond Aquaculture
Applied Research for Improved Farming Systems
Sarigoyain-Piyain Basin Development
Manu River Improvement Project
Narayanganj-Narsingdi Project
Narsingdi District Development Project
Northeast Region Environmental Management, Research, and Education Project (NEMREP)
Upper Kangsha River Basin Development
Upper Surma-Kushiyara Project
Surma Right Bank Project
Surma-Kushiyara-Baulai Basin Project
Kushiyara-Bijna Inter-Basin Development Project
Dharmapasha-Rui Beel Project
Updakhali River Project

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1. INTRODUCTION

1.1 General Information

Haor basin (Sylhet Depression)	6000 sq km
Lowland floodplains	13260 sq km
Piedmont floodplains	960 sq km
Alluvial fans	1490 sq km
Total (Upper Meghna River floodplain)	21710 sq km
Catchment in India	45574 sq km
Total river channel lengths	2150 km
River channel surface area	832 sq km
- Upper Meghna River	336 sq km
- other rivers	496 sq km
Number of beels	6149
Total area of beels	635 sq km

1.2 Scope and Methodology

This is a pre-feasibility study that was undertaken over a period of several months in late 1993. The study team consisted of three fisheries specialists. Additional analytical support was provided by a water resource planner and an economist.

1.3 Report Layout

A description of the biophysical features of the project area is provided in Chapter 2. Chapter 3 describes the current status of fisheries management including a summary of the types of problems faced by fishing communities in the region. Chapter 4 briefly reviews previous studies directed towards management of the fisheries resources and Chapter 5 lists trends which are occurring and which will continue if no interventions are made. Chapter 6 describes the proposed Fisheries Management Programme. The annexes consist of detailed information to support the main body of the report.

2. BIOPHYSICAL DESCRIPTION

2.1 Location

The Fisheries Management and Development Project covers a gross area of 21,710 sq km in the Northeastern part of Bangladesh, between latitude 23° 30' and 25° 15' N, and longitude 90° 00' and 92° 30' E. The project region is bordered by the Indian frontier in the north, east and south, and the Old Brahmaputra River channel in the west.

2.2 Climate

The climate of the programme area is monsoon tropical with hot wet summers and cool dry winters. The highest temperature in the area was recorded at 40.6 C in May and the lowest at 8.9 C in December and February. The lowest monthly temperature is in January when the mean is 18.7 C and the highest monthly temperature is in July when the mean is 28.8 C. The above temperatures were calculated using a 50 year period from 1948 to 1988.

Two monsoon air movements govern the climate of the region:

- The wet southwest monsoon extends from June to September. It originates over the Indian Ocean and carries warm, moisture laden air. It provides most of the annual rainfall. This rainy season is conventionally referred to as "the monsoon".

- The dry northeast monsoon extends from December to March. It originates over snow and ice-covered land masses, and carries dry, cool air during the winter months.

Reversals of monsoon air flows occur in the spring (April-May) and in the autumn (October-November).

Rainfall distribution shows a general pattern of gradual increase from south to north. Average annual rainfall in the region ranges from about 2000 mm in the south near Bhairab Bazar to about 8000 mm in the north near Sunamganj. Mean monthly rainfall varies from 57 mm in January to 4284 mm in June, and mean annual rainfall is 3116 mm. Rainfall in the Meghalaya catchment area in India can exceed 12000 mm (Cherrapunji is one of the wettest places on earth). Within the region, 65-69% of total annual rain falls during the summer monsoon. The winter monsoon delivers only 4% and the region experiences relative drought. The spring reversal yields 21-23% of annual rainfall and is responsible for the so-called *pre-monsoon floods*. The autumn reversal yields 6-8% of annual rainfall. Over the last 30 years there has occurred a trend of increasing annual precipitation in the region.

Potential evapotranspiration is lowest in December at 102.6 mm/month and highest in March at 162.4 mm/month. Evaporation exceeds rainfall during the dry season.

2.3 Physiography

The topography of the Northeast region consists of a large central depression (Sylhet Depression) flanked by lowland floodplains, then gently sloping piedmont floodplains, and bordered distally by alluvial fans, terraces and uplands extending into India. Approximately 25% of the total region area of 24,180 sq km lies below 5 m PWD elevation and 50% lies below 8 m PWD elevation. Four landforms with a total area of 21,710 sq km are liable to flooding, and these compromise the Upper Meghna River floodplain (senso lato). The Sylhet Depression is a bowl-shaped basin. Almost all land is in this unit is below 8 m PWD. The depression is deeply flooded during the monsoon to depths of 5 m. The Lowland Floodplains are the deposition and erosion arenas of the major rivers of the region. Land elevations range between 9 and 16 m on the Surma/Kushiyara floodplain, 9 and 22 m on the Old Brahmaputra floodplain and less than 7 m on the Meghna floodplain. The Piedmont Floodplains are found along tributary streams in the southeastern part of the region. Land elevations range between 9 and 24 m. Alluvial fans are found along the foot of the Meghalaya Plateau in the northern part of the region. Land elevations range from 12 to 16 m in the west and from 9 to 11 m in the east.

The uppermost part of the Upper Meghna River floodplain extends into India as part of the Barak River catchment. It is called the Cachar Plain and has a surface area of less than 1000 sq km.

2.4 Hydrology

2.4.1 Runoff Patterns

Most of the region is a self-contained drainage basin which extends into India. There are 21 Indian catchments which fall into three groups:

- Meghalaya River catchments on the north which discharge into the Kangsha and Surma River. Their drainage area is 13,466 km^2.
- Barak River basin which drains from the east into the Surma and Kushiyara at Amalshid on the Indo-Bangladesh border. Drainage area is 25,263 km^2.
- Tripura river catchments which discharge from the south into the Kushiyara. Their drainage area is 6,845 km^2.

These Indian catchments produce about 60% of the total water supply of the region, mostly in the form of flash floods from April to September. The flash floods of the Meghalaya are particularly ferocious. Mean monthly stream flow entering from India varies from over 7,000 m3/sec in July to a low of about 220 m3/sec in February. Between 25% and 50% of the dry season flow is generated from the Indian portion of the catchment.

The Surma, Kushiyara/Kalni, Baulai, Kangsha, and Meghna Rivers are the main rivers of the region. The Surma and Kushiyara are formed by the bifurcation of the Barak River at Amalshid at the eastern end of the region. The Surma River drains the northern part of the region and most of the Meghalaya tributaries. The Kangsha River drains the western part of the region and joins the Surma River to form the Baulai River. The Kushiyara River drains the Tripura tributaries. It is called the Kalni River down stream of Markuli and it joins the Baulai River

further downstream to form the Meghna River which is the outlet of the region. The western limit of the region is the left bank of the Old Brahmaputra River. This river was once the main course of the Brahmaputra River (about 300 years ago) but has since been largely silted in at its source. This reduction in flows has reduced the inflow via the Kangsha River and other tributaries on the western side of the region.

The total surface area of water in river channels during the dry season is 832 km^2. The Upper Meghna River has a surface area of 336 km^2 and other rivers in greater Sylhet and Mymensingh Districts cover 496 km^2.

2.4.2 Flooding

During the rainy season, all rivers overflow on to the lateral floodplain, except for those portions of the Surma, Kushiyara, Khowai, Manu and Kangsha 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.

The annual flood pattern has two distinct phases in the region:

- The early flood (pre-monsoon) 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 (monsoon) 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.

2.4.3 Drainage

Post-monsoon drainage of the entire region is via a single outlet channel, the Upper Meghna River. Tidal backing-up of the Upper Meghna causes a reduction in current velocity and sedimentation of its channel. This creates a bottleneck at Bhairab Bazar and impedes post-monsoon drainage of the floodplain. During the dry season the Upper Meghna River, the Baulai, the Surma as far as Chhatak and portions of the Kushiyara have larger water depths (although discharge is minimal) and are used by large metal hulled transport boats which come up from Bhairab Bazar. The larger water depths in these rivers during the dry season and the existence of deep scour holes (*duars*), make them important dry season overwintering refuge habitats for the brood stock of some commercially important species, particularly major carps and large catfish. In contrast, the upper parts of the Surma (upstream from Chhatak), Kushiyara and Kangsha conduct little discharge during the dry season and water depths can be less than one metre in some places. It is therefore important to distinguish between tidally-influenced and non-tidally-influenced sections of major rivers. Parts of the river beds are below sea level, especially the *duars*. Preliminary computer simulations indicate that over one-third of the region is inundated annually due to tidal backing-up of the Upper Meghna into the Sylhet Depression. This

has major implications for the long term economic prospects of the region - particularly, that fish production would appear to have an assured and substantial role in the region's long term economic production possibilities.

2.4.4 Water Bodies

Open water bodies
Of the total surface area of the region of 24,180 sq km, approximately 90% (21,710 sq km) is occupied by the four landform units which are subject to annual flooding (Sylhet Depression, lowland floodplains, piedmont floodplains, alluvial fans). Together these form the larger floodplain of the Upper Meghna River. The extent and duration of flooding varies from year to year depending on flood intensity (the result of rainfall and river discharges).

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*. There are some 130 haors in the region.

The total number of beels in the region is 6,149. They cover 635 sq km sq and have a mean size of 10 ha. Some 58% of the beels in the region are permanent, while 42% are seasonal, or temporary. Sunamganj District has the largest number of beels of any district in the region and in Bangladesh. About half are large (over 8 ha 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.

Closed water bodies
There are about 0.201 million ponds in the region with a total area of 18,700 ha. Many of these are borrow pits resulting from homestead site preparation. The DOF classifies ponds as cultured (49.1% by area), culturable (22.8%) and derelict (28.1%). Another important microfishery real estate are the borrow pits running along road embankments. These are owned by the Roads and Highways Department (RHD) and are leased out for fishery purposes. Their 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. Borrow-pits 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 less than one metre 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 FCD/I construction works are owned by the BWDB and are leased out for fish production through auctions.

2.5 Ecology and Swamp Forest

2.5.1 Floodplain Limnology and Water Quality

Although high turbidity due to silt and clay loads characterizes flood waters during the monsoon, the 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 periphyton also constitute the most important pathway for fixing of atmospheric nitrogen, upon which good yields of rice in the haors are partly dependent. In shallow rivers during the dry season (such as the Surma near Kanaighat), algae grows directly on the sandy river bed, as well as 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 (mat for covering 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 much time wallowing in borrow pits. Their dung undoubtedly directly contributes to the fertility of water bodies. Cattle graze on fallow rice fields and pasture lands of haors during the dry season and cattle fattening is an important economic activity. The importance of cattle dung for increasing the productivity of flood lands is limited because much of it is collected and dried for use as fuel.

Some water quality problems exist in the region. Serious problems of water pollution exist in the Surma River due to discharge of effluent from the bleach kraft pulp mill at Chhatak. Increasing use of insecticides may be reducing environmental quality and affecting fish catches. Moderate 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. Excessive eutrophication and deterioration in water quality due to these factors has also been recorded (see Section 3, Fisheries Specialist Study, NERP, December, 1994).

2.5.2 Swamp Forest Trees

Historically, much of the region was covered with inundation resistant tree species and bushes. An Agricultural Officer from Kishorganj has reportedly identified 21 species of flood tolerant tree species. Two species are dominant: *hijal* Barringtonia acutangula and *koroch* Pongamia pinnata. Others common trees are *mandair, mera* and *barun*. These species grow in many haors (especially in Sunamganj District), often in plantations or gardens. In addition to wetland trees, several water resistant herbs and grasses occur in the region: *Nol Khagra* (Phragmites karka), *Tara* (Alpinia sp.), *Chailla* (Arundo donax), *Echor*, *Bon Tulshi* (Lippia geminata), *Phaloi* and *Kashya*. Wetland vegetation is documented in more detail in the *Wetland Resources Specialist Study*.

Information from various parts of the region indicate that *hijal/koroch* trees and plantations serve at least six environmental and economic functions:

- They serve as a wave break to protect homesteads during the flood season;
- They provide shade during the dry season;

- They are a source of fuel during the flood season (straw and cow dung is normally used during the dry season);
- They provide a source of income through sale of branches for katha;
- They create upland by enhancing sedimentation around the planted area; and
- Their presence increases fish production.

Trees and bushes which become submerged during the monsoon apparently act like a natural katha. Beels with *hizal* are known to have much more fish present than beels without. *Hizal* can grow into a large tree, but most examples seen are short with a thick trunk. This is because the branches are coppiced periodically for use in pile fisheries. A pile fishery is a brush fish shelter which is harvested every three years. The brush (katha) is installed as a shelter to attract fish.

Because of the various benefits that flood tolerant trees yield to fisheries, homestead protection, fuelwood and income, there is widespread interest in the region in afforestation at individual, and community levels.

Clearing of land for rice culture has caused massive deforestation of wetland trees in the region. This constitutes a major and severe environmental modification of the region. About 19,968 sq km (83%) of the region is under rice. It is estimated that less than 5-10% of the region is still forested, and a portion of this is not original floodplain/wetland forest. Little relatively undisturbed floodplain forest remains in the region. This massive deforestation has meant a severe reduction in the environmental and economic functions that floodplain forests serve. Of particular concern are the benefits to fisheries. It is difficult to quantify lost production because of deforestation, but it seems likely that this has taken place (given the widespread opinion that fish abundance is higher around inundated tree stands). Shortages of *hijal* branches for *katha* raises the cost of fish production.

2.6 Sedimentation

Because of their steep gradients, the piedmont rivers rising in the Indian catchments carry large quantities of sand, gravel and stone. Stone and gravel is deposited in the alluvial fan zones. Most of the sediment that is deposited on the floodplain is silty washload. Sedimentation is occurring in parts of the region and is creating problems for both fisheries and agriculture. The northern part of the Sylhet Depression and the lower part of the Kushiyara River are the most severely affected. These areas experience rapid siltation as the rivers enter into the deeply flooded central basin and their gradients decrease. Infilling of beels reduces mean depth and cubic meter months of dry season aquatic habitat, and converts some beels from permanent to seasonal status. River duars are also being filled in. It is widely believed that this reduction in water volume and elimination of deeper water habitats is negatively impacting fish production. Management of river sediments is a major constraint in the planning and design of water management projects in the region.

Additional information on sedimentation is described in the report entitled *River Sedimentation and Morphology*.

3. SETTLEMENT, DEVELOPMENT, AND RESOURCE MANAGEMENT

3.1 Human Resources

3.1.1 Land Use and Settlement Pattern

Land Use
The approximate land use for the Upper Meghna floodplain is rice 83%; jute 3%; wheat 2.1%; oilseed 1.9%; pulses 1.3%; and other 8.7%.

Settlements
Villages are mainly found along river levees and along road sides. Fishermen 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 *(Khola)* 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.

3.1.2 Demographic Characteristics

The total population of the Upper Meghna floodplain and adjacent uplands in the Northeast Bangladesh region is estimated to be 17.66 million of whom 48.78% are female. The gender ratio is calculated to be 105 (males to 100 females). The total households are estimated to be 4.92 million within 21,114 villages. The population increased by 23% between 1981 and 1991.

The cohort distribution for males is: 32.5% are below 10 years of age, 61.2% are between 15 and 59 years of age, and 6.3% are above 60 years of age. The corresponding distribution for females is 34.1%, 60.7%, and 5.2%. The average population density is 730 persons per km^2, with density ranging from a maximum of 6019 persons per km^2 in Bandar to 235 persons per km^2 in Companiganj. (Average population densities include the deeply flooded areas). The average household size in the area is estimated to be 5.34 persons.

3.1.3 Quality of Life Indicators

Quality of life is usually determined by several key indicators. Those described here are literacy, access to health, sanitation, and pure drinking water facilities. Infant mortality was not included as a quality of life indicator as there was no separate study on this for the NE Region. The BBS study in 1990 indicates that infant mortality was 94/1000 live births for Bangladesh.

Literacy
In the project area the literacy rate is low. According to the 1981 census, the literacy of the population at 5 years of age and above varied from 31.5% in Palash Thana to 9.0% in Companiganj Thana. The corresponding figures for females were 22.2% and 3.8% respectively for the same thanas. The rate appears to have increased significantly over the last 10 years. According to the 1991 census, the literacy rate for all people of the region is recorded as less than 20% for both male and female. For the above rates literacy was defined as "a person who can read and write with minimum understanding".

According to the 1981 census, school attendance in the project area for all children five to nine years of age varies from 39.7% in Beanibazar thana to 11.1% in Companiganj thana. Attendance for females in this age cohort in these two thanas varies from 36.6% to 8.3%, respectively. Attendance for all youths between the ages of five and 24 is 31.6% and 8.6% for these thanas while the corresponding attendance for females is 26.1% and 5.2%.

Access to Health Services
Each district has a district/sadar hospital and each thana has a thana health complex. Access to health services is generally limited for rural villagers and is out of reach of the poor. According to the Directorate General of Health Services (1992), there is one hospital for every 220,682 persons and one doctor for every 21,596 persons in the region. One hospital bed is meant for 5,256 people. The rate of immunization coverage of children below two years of age varies from 10% in Mymensingh thana to 65% in Golapganj thana (1990).

Rural Water Supply
DPHE (for 1991-92) reports that for the region one working tube well is available for 122 persons. Most tube wells are located in the houses of the rich. This results in the poor having very limited access to potable water.

Sanitation
Sanitary latrines are more widely used in Moulvibazar and Sylhet Districts, the proportion of households possessing sanitary latrines being 33% and 29%, respectively. In most other districts in the region this proportion is less than ten percent.

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 *Kholas* 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 fishing communities are extremely poor. Most fishermen are illiterate. Fishermen often do not want their sons to become fishermen. The value of education for getting better jobs is clearly recognized but often fishing families do not have enough money to send their children to school.

3.1.4 Employment and Wage Rates

Four general occupational categories within the fisheries production sector are recognizable:

- Professional fishermen, who earn their livelihood entirely from fishing. Under the NFMP, these are called "genuine fishermen".

- 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.

Fishing is now practised as a profession by many poor people, particularly during monsoon months when they can fish in open water. Such 'non-traditional' fishermen are increasing and they are larger in number in the low lying beel areas.

Production support industries include boat building and net making (artisanal hand weaving, factory mechanized weaving). In the post harvest sector employment categories include fish vendors/traders (wholesale and retail), processors (artisanal sun-drying, export factories), and transporters (collector boats, insulated trucks). Business investment interests include jalmohal leaseholders and moneylenders. During the dry season when there is no free access to fishery resources, many genuine fishermen have to work as fisheries wage labourers. In Hakaluki Haor, the fishermen work for leaseholders as wage labourers, getting paid Tk 20-25 per day. Fishermen receive no share of the catch. But this employment is only during the dry season. Sometimes the leaseholder brings fishermen labourers from far away villages (possibly to undermine any strengthening of local labour organizational power). During the rainy season, when the entire haor is flooded, 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 labour absorption capacity peaks in fisheries. During four months of the flood season, a fisherman can earn about Tk 40-50 per day selling his fish. During the dry season which lasts six months, fishery wage earning work for leaseholders is not continuous and pays only Tk 20-25 per day.

No reliable data exists on the numbers of persons employed in the fisheries sector in the region. Studies 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 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 region participate in some type of fishing activity. Furthermore, the production sector creates employment both upstream (boat building and net making) and downstream in post harvest (processing, transport, marketing). Studies elsewhere indicate that for every job in the production sector two to three jobs are automatically created in the post harvest sector. Direct employment in fisheries in the region might be in the order of 345,000 - 460,000 persons (or 6.8% to 9.0% of the regional labour force of 5.1 million). Self-provisioning subsistence fishing might be carried out by several million individuals in the region. Expansion of the labour force will increase the demand for employment. The labour 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 labourers. 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:

- processing
- marketing and transport
- net making and repair
- boat building and repair
- construction works supporting fisheries (such as embankments around beels, excavation of borrow pits and ponds, and fish pass structures)
- pond aquaculture (nursery, rearing)

Little direct information is available on income levels within the fisheries sector of the region. At an estimated average current retail price of Tk 60 per kg, the total value of fish production from the region is about Tk 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 Tk 5.2 billion is shared out among the 500,000 persons estimated to be directly employed in the fisheries sector. Mean per capita income is therefore Tk 10,400 per year. 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 labour 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, Tk 3,129
  - owner farming, Tk 3,696
  - owner-cum-tenant, Tk 2,737
  - pure tenant, Tk 1,968
- 21.1% are agricultural wage labour households, Tk 1,565
- 1.6% are fishing households, Tk 2,068

Although these figures may not be accurate for the region, they do indicate that fishing is more remunerative than agricultural wage labouring or tenant farming. Genuine fishermen are apparently now better off than before NFMP. In Habiganj, NFMP fishermen are said to earn up to Tk 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 Tk 57 and Tk 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.

3.1.5 Situation of Women

The role of women in the fisheries sector 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. Specially in the late monsoon, women are involved in fish drying. Unlike some other countries, women do not work as fish vendors or traders. Because women do not often receive any money for their efforts, they rarely achieve a position of economic strength or capital accumulation within the fisheries sector. Some Hindu women are more active in the fisheries sector (mainly observed in the *khola*, a temporary fisher camp erected for the dry season).

3.1.6 People's Perception

Numerous interviews were conducted with fishermen, fish traders, leaseholders and DOF officials at district and thana levels. A fisheries seminar was held in Sylhet in September, 1993. Participants at the seminar included Union Parishad chairmen, fishermen, representatives from fishermen cooperatives, Fisheries Research Institute, DOF, and BWDB. Generally it is believed that fish resources in the region have declined over the last 10-15 years. Some of the reasons for the decline were discussed at the seminar and are included in the list below. The only species which appears to be increasing in production is Ilish. The region-wide decline in production is attributed to several factors:

- Siltation of river beds and deeper beels.
- Over exploitation of fishes, particularly use of fine-meshed net in tributaries affecting small fish species and fingerlings (March-April), and harvesting of boromaach broodfish in rivers (March-May).
- Annual fishing of the beels by complete de-watering (the present short term leasing system motivates lease holders to seek short term returns).
- Deforestation in the haor area. Only in two areas (Hakaluki haor and Tangua haor) have large *hijal* plantations been started.
- Industrial effluents at Fenchuganj and Chhatak affect fish breeding.
- Poisonous plants used in India cause fish mortality in Sharighat and Juri River.
- Barriers to fish migration during the breeding season caused by FCD/I projects.
- Transfer of jalmohals to non fishermen.
- Use of LLPs for irrigation during the boro crop season.
- Conversion of land to agriculture which results in reduced fish habitats, and the use of insecticides in the paddy fields.
- Fish disease

3.2 Fisheries Resources

3.2.1 Fish Biodiversity

Of the 260 species of freshwater fish known to inhabit Bangladesh, over 130 native plus 8 exotic introductions are known or suspected to inhabit the water bodies of the region. 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 (*Ilish*) are also important. Miscellaneous species are of the highest importance for subsistence and self-provisioning. It is significant that even these species are attaining market importance and entering commercial networks.

A widely used popular terminology groups fish species into two categories:

- *Boromaach,* or large fish. This includes major carp, large catfish, *Chital,* Gangetic stingray, *Gazar, Shol* and *Ilish*. All *boromaach* are commercially important species. Most boromaach carry out longitudinal spawning migration. Thus, the group is defined by both ecological and economic factors.

- *Chotomaach,* or small fish. This includes the vast majority of species. Most are important for subsistence consumption, although a few are commercially in demand (such as *Rani*). Most *chotomaach* do not carry out spawning migrations, or at most move short lateral distances into shallow water.

A description of major carp, catfishes and other fish species in the Northeast Region are presented in Annex E.

3.2.2 Migrations and General Floodplain Fish Ecology

In general, during the pre-monsoon and early monsoon period fish migrate into shallow areas. During flood recession fish migrate to deeper areas. Migrations are usually countercurrent during pre-monsoon and early monsoon. If rain falls in the upper catchment area (in India), rivers rise and water flows from the river to the khals and into the beels. Fish will tend to swim from the beels to the khals and to the river. If rainfall is localized on the haor, the haor will drain into the beel and then water will flow from the beel to the khal and into the river (but this is a less common event). In this case, fish will tend to swim from the river up the khal to the beels.

The **"fish year"** can be divided into four seasons:

The overwintering dry season (December to March): Broodstock and juveniles approaching recruitment size are concentrated in river duars and beels. No migratory movements take place at this time. These habitats (especially beels) are fished heavily during this season, and whatever fish survive enter the next season.

The spawning migration season (April to June): This season usually begins during the pre-monsoon flood phase of the hydrological year and can continue into the first part of the full monsoon flood phase. Fish generally move from deeper waters (such as duars) to shallower

waters. Breeding takes place in shallower waters. Almost all fish species can be separated into two distinct groups:

- Species which breed in the river: Among *Boromaach* this includes the major carp *Rui, Mrigel, Catla* and *Kalibaus*, the knifefish *Chital* and the large catfish *Baghair* and *Air* (see below for *Pangas* and *Ilish*). Among *Chotomaach* this group includes *Katchki, Batashi, Kajuli, Baim, Rani, Bailla*, and some others. Regardless of where these species have overwintered (and many of them are not very selective in this regard), most will attempt to migrate to river channels. Those individuals that overwintered in rivers are not inconvenienced. Those which overwintered in beels will have to swim out of the beel, to the khal (this will generally be a countercurrent migration, as mostly river water will already have begun to spill into the haor via the khals), and out into the river. Once in the river, it is assumed all species will swim upstream (countercurrent) until they reach spawn grounds which they find suitable for their requirements. The specifications of suitable spawning grounds varies from species to species. Major carp apparently prefer river bends. *Chital* prefer submerged structures such as trees and artificial structures such as submerged canoes. *Air, Guiza* and *Rita* make pits on the river bed as breeding "nests". The common requirement for all these species is that they need to be able to swim out from beels into the rivers (ie countercurrent). Bypass structures in FCD/I project embankments need to allow this to happen.

- Species which breed on the floodplain: The great majority of *Chotomaach* breed on the floodplain once inundation starts during the pre-monsoon floods. There is evidence that some *Chotomaach* species breed several times during the monsoon flood. Thus they migrate only a short distance laterally, from the beels (where they overwintered) out on to the floodplain. However there are also some *Boromaach* which breed on the floodplain, specifically *Boal* and *Ghonia*. Those individuals who overwintered in beels also only have to carry out a short lateral migration on to the flood plain. However *Boal* and *Ghonia* (and some *Chotomaach* species as well) which overwintered in rivers have to swim up the river (ie countercurrent), until they find a khal they can enter (ie then changing to swimming with the current) to get to a beel and up on to the now expanding floodplain. The requirement for these species is that they need to be able to swim from rivers into beels/floodplains. Bypass structures in FCD/I project embankments need to allow this to happen.

The nursery/grow-out season (June to September): This fish season corresponds to the hydrological height of the monsoon flood season. The fingerlings of those fish which bred on the floodplain are already on the nursery grounds so they do not have an access problem. But the fingerlings hatched from river breeding species need to get up on to the floodplain, and this can only happen in one of two ways: either they are passively swept on to the floodplain when the river overflows its banks (or overtops a submersible embankment) or are passively swept through a bypass structure such as a regulator when it is opened to effect controlled flooding of a haor. This is the season of rapid fish growth. Habitat hectarage increases enormously. In the region the dry season (river plus beel) water surface area is 1,467 sq km. During the height of the flood season this expands by a maximum factor of 15 to 21,710 sq km. Food availability probably increases by a similar factor. However fingerlings suffer a high mortality rate from piscivores, insects, snakes, frogs, otters, turtles, birds, disease, parasites and fishermen. Not withstanding this larvicide, the full flood season is still the best period for fast fish growth. Though fish movements may not be entirely random on the floodplain, there is little evidence of

the mass migrations of the previous season. Schooling behaviour is more likely related to feeding tactics or a defence against predation.

The flood recession season (September to December): Flood waters start receding (ie draining). Drainage starts as sheet flow and eventually transitions to channelized flow by the end of this season. As water hectarage shrinks, fish move into deeper waters, navigating along khals and river channels, and with the currents which flow along these bottom topographies. The migrations are thus concurrent with the objective of leaving shallow water areas so as to avoid being stranded and killed by desiccation. A few species are able to aestivate (ie Koi, Channa spp), but the majority migrate to deeper water during flood recession. A fish moving from the floodplain laterally to a deep beel does not encounter much of a problem. A fish moving from the floodplain out into a river will normally move along a khal. FCD/I embankment bypass structures need to allow this to happen. The flood recession/crowding season holds some fairly severe events for the fish stocks. Juvenile fish continue growing but their numbers decrease tremendously. This is because predation by piscivorous fish species such as *Boal*, *Air*, *Kaikka*, *Guizar*, as well as dolphins, now reaches a maximum. Most of the forage fish have not yet grown large enough to escape predation. There is a fairly direct correlation between predator and prey size. A prey species can escape the danger of being eaten by a particular predator once it grows large enough in size to pass outside of the prey size range limits of the predator. As flood water recession gradually changes from sheet flow to channelized flow, and water volume becomes reduced, the density of predators (both in terms of number per water area and number per water volume) increases and crowding together of prey results in extremely heavy predation. There occurs, therefore, a massive natural mortality of fish during this period, which is augmented by fishing mortality. The carrying capacity of the overwintering grounds is limited and sharply defined, and any "excess" ichthyomass will be eliminated.

The overwintering dry season (December to March): The annual cycle comes full circle. The floodplain has dried out and the only water left is in rivers and beels, where the entire fish population of the region is lodged. Prey species have generally grown large enough to avoid being eaten by predators. Juveniles mature into adults and gonads begin ripening in anticipation of the coming breeding season.

To summarize, for the majority of fish species in the region, the following principal fish migrations take place (in chronological order):

- Active breeding migration of broodstock from overwintering grounds to breeding grounds;
- Passive hatchling/fingerling migration from breeding grounds to nursery/grazing grounds;
- Active migration of juveniles and broodstock from breeding and/or grazing grounds to overwintering grounds.

A special "problem" which has not yet been definitely resolved is the question of homing behaviour in *boromaach,* in particular major carp. One underlying assumption behind the use of the three year katha pile harvesting system (and a belief held by many fishermen) is that individual fish return to the same duar or beel (and the katha installed there) each year during flood recession to overwinter. Harvesting katha only once every three years allows the *boromaach* to grow to adult size and breed at least once before being caught. The homing

hypothesis was tested by the leaseholders and fishermen of the Rangchapur and Tangua Haor fisheries. Fish were "marked" by cutting off one lobe of the tail fin and then returned the fish to the water. Three years later these marked fish were recaptured in the same place at the time of the pile fishing. The implications of possible homing behaviour in *boromaach* for fishing practices and fisheries management are fairly profound:

- If *boromaach* home back to the same duar or beel year after year, it becomes worthwhile for the katha owner to delay harvesting until the third year, because the price per kg of adult size *boromaach* is significantly higher than for juveniles of the same species

- On the other hand, if *boromaach* do not home back to the same katha, the incentive to delay harvesting is reduced, because any individual fish not caught in a particular year might overwinter in another beel or duar the following year and be harvested by some other *katha* owner or fisherman.

A *boromaach* tagging program needs to be carried out to establish definitively whether or not homing exists. In the event of a positive result, homing should be incorporated into the regional fisheries management strategy. To observe the migratory routes, breeding grounds, and behaviour of different species, tagged fish would have to be recovered in the breeding and non-breeding seasons.

A second fish migration problem that requires attention is the movement of *boromaach* stocks across the border into India. Such movements can be expected to take place in all three catchment areas of the region (Meghalaya, Barak River, Tripura). Fishermen of the Amalshid area maintain that *boromaach,* particularly carp, migrate towards the Barak River during the month of April-May and are caught by the Indian fishermen. It was also claimed that in the upper reach of the Barak (near the proposed Tipaimukh dam site), there is a spawning ground of carp. The movement of migrating broodstock up lateral tributaries of the Meghalaya and Tripura catchments is also important because some of the rivers are selected as spawning grounds due to their high water quality. Some of the boromaach stocks of the region should therefore be designated as internationally shared fish stocks which use Bangladesh waters as overwintering grounds and the Upper Barak (in India) and smaller tributaries (in Bangladesh and India) as breeding grounds. Bangladesh fishermen regard the broodstock of carp as a common property of both countries and suggest that a bilateral program is required to maintain and manage these stocks.

3.2.3 Spawning Patterns and Locations

Except for major carp, *Pangas* and *Ilish*, most fish species breed more or less everywhere in region. The species can be separated into two groups based on their preferred breeding habitat:

- Floodplain and beel breeders: *Boal, Ghonia, Sarputi, Shingi, Magur, Koi, Bheda, Puti, Icha, Chanda, Mola, Ghonia, Boal, Sarputi, Gulsha, Tengra, Laso, Kholisha, Along.*

- River breeders: *Chital, Ghagot, Kalibaus, Catla, Rui, Mrigel, Chital, Air, Rani, Pabda, Pangas, Basa, Ghagot, Garua, Shilon, Baspata, Kajuli.*

Floodplain and Beel Breeders: Breeding begins during the pre-monsoon flood. Depending on the rain and water volume in the river and floodplain, most of the catfish, live fish and other

species (*Magur, Singhi, Koi, Tengra, Pabda, Air, Boal, Gazar, Shoal*) start breeding at the end of March and early April. Piscivorous species (*Boal, Shoal, Gazar*) breed earlier than the non-piscivorous species. The optimal meteorological conditions for fish breeding are tempestuous. Flash floods, heavy continuous rain and thunder together stimulate fish breeding, particularly for *Boal, Ghonia, Pabda, Koi, Batashi, Puti* and *Laso*. When the first pre-monsoon flood water *(goola)* enters into the beels, fish begin moving against the current to search for suitable spawning habitat. *Ghonia, Boal, Foli, Pabda, Shoal, Gazar, Lati, Cheng, Koi* and *Laso* prefer to breed on newly inundated grassy areas on kanda where the current is slow, water depth is low (about 0.5 m) and bush/reeds (*Chailla bon, Nol Khagra, Bon tulshi, Parua, Binna bon, Hugol bon*) are present. These species are called *Jangal* breeders. *Boal, Pabda* and *Ghonia* also breed in the canals connected with beels. During the spawning period, the following species form groups or schools which are called *Jaak dhora: Boal, Ghonia, Kangla, Laso, Koi, Puti, Shingi, Magur, Tengra, Cirka, Batashi, Kholisha, Bheda, Pabda*. The migration of a typical *jaak* toward a spawning place is called *Uijja*. At the time of mating, many fish behave incautiously and can even be caught by hand. However, different fish species exhibit different behaviour patterns. During mating many species exhibit no aggressive behaviour. The mating pair bend against each other when expelling eggs and milt. Normally the schools are segregated by species. Usually the schools move at night during the new or full moon phase. Except for the snakeheads, most species do not have parental care of their offspring.

River breeders: Reproductive patterns are more diverse among river breeders. *Air, Rita, Ghagot* and *Guizza* make pits in the shallower part of the river in April and May. They are also known to breed around katha. Each pit is about 1 m in diameter and 0.6 m in height. They choose an area with clay soil and excavate the pits with their mouths. A single female uses one pit, but one male can service 3-5 females. Local fishermen know their behaviour and brood fish are caught by the anglers with bait. They exhibit parental care. *Chital* and *Foli* prefer to breed in shallower parts of the river over hard structures such as stones, bamboo or submerged tree branches. A sunken boat under a katha is an excellent artificial breeding site. Eggs are sprayed over the structures and adults carry out brood care. The breeding period of *Chital* and *Foli* is May and June. A number of *chotomaach* breed in rivers, including *Batashi, Bashpata, Chela, Kachki, Bailla* and *Baim*. Shallow areas are selected and breeding takes place in April. *Rani* prefers to breed in the rivers particularly in any quiet undisturbed shallower place where water current is weak and the river bed consists of course sand. They shelter in the holes of bamboo *(chong)* during the breeding period. The occurrence of substantial jatka schools in the Upper Meghna, Baulai and Kushiyara Rivers suggests that *Ilish* probably spawn in the region. Spawning probably takes place in the rivers during the pre-monsoon (March) and monsoon (August) floods. Spawning sites in the region have not yet been identified.

Major carp are thought to spawn mainly in rivers. The breeding period of most species is in early April to June and depends upon rainfall. From June to September, large numbers of fry, fingerlings and juveniles are present in the beel areas (5-13 cm size). *Kalibaus* is more abundant than *Rui* and *Catla*, while *Mrigel* is becoming rare. There are vast fishing areas where spawning, nursing, grazing and overwintering sometimes takes place. No spawn has been caught in these areas but local fishermen consider that these areas contain spawning grounds. Areas suspected to contain carp breeding grounds are as follows:

- Tangua haor,
- Pashuar haor,
- Laudi and Bawa beels of Companiganj area,

- Erali beel,
- Hakaluki Haor,
- Luba River,
- Sarigowain River,
- Old Brahmaputra River.

Specific areas where fishermen of the region have caught carp spawn are as follows:

- Kawnai River near Daulatpur and Milanpur (Dharmapasha thana),
- Boroiya River near Shanbarir bazar (Dharmapasha thana),
- Baulai River near Mukshedpur (Dharmapasha thana),
- Alamduarer baak in Tanguar haor,
- Surma River near Sunamganj town,
- Dhanu River near Ranichapur and Dhalimati (Kaliajuri area),
- Kalni River near Markuli (Derai thana),
- Khoiltajuri River near Dighirpar (Companiganj area).

3.2.4 Mother Fisheries

Discussions with fishermen revealed the existence of several major centres of fish production and dispersal within the region. These areas are called mother fisheries by the fishermen. The concept (or phenomenon) of a mother fishery does not appear to been previously identified or its importance recognized in floodplain fisheries literature. Functionally, a mother fishery exerts a controlling influence on fish abundance over a wide area. Thus, if fish abundance is high in a particular mother fishery in a particular year, fishermen expect fish abundance also to be high in the surrounding areas. The reverse would also be expected: low fish abundance in the mother fishery would result in low catches in the surrounding areas. The concepts of mother fisheries are described in more detail in the Fisheries Specialist Study, NERP, December 1994.

Structurally, a mother fishery could consist of a single beel, or duar or spawning locality. For example, there are 25 important jalmohals in Purbadhala thana. Out of those, six jalmohals are considered important as mother fisheries: Mora nadi jalmohal, Bonduk khali (in the Kangsha River), Rajdhala beel, Bais dar duba (in the Kangsha River) and Bagruar duba (in the Kangsha River).

But the concept of mother fishery is more commonly used in the region to describe a larger geographical area possessing a dense concentration of diverse high quality fish habitats and supportive flora (deep river duars, clear tributary streams, deep beels, sediment-free khals, wetland forest stands, reedbeds, floodland with wetland grasses). There appears to be a general consensus among the many individuals involved in the field that there currently exist four important mother fisheries in the region (Figure 1):

- Tangua Haor
- Hakaluki Haor
- Kaliajuri area
- Companiganj area

Previous to the construction of the Manu River Irrigation Project, Kawadighi Haor was also a major mother fishery. Unfortunately, this FCD/I project has damaged Kawadighi Haor as a mother fishery.

Because of their importance as fish production and dispersal centres within the region, mother fisheries need to come under special resource and environmental management planning and implementation regimes, which will be necessarily more complex and comprehensive than for single site refuge localities.

3.2.5 River Duars

The recession of flood water after the monsoon leads to a large reduction in water surface area during the winter dry season. Almost the entire fishery resource of the region becomes crowded and confined to two major habitats: rivers and beels. Because shallow beels and the upper reaches of rivers are prone to partial or complete desiccation, most fish (and broodstock in particular) seek out deepwater habitat locations to overwinter in. Only two such habitat location types exist in the region: *duars* in the larger rivers and the deeper permanent beels in the haors. The concentration of commercially valuable fish in a limited and circumscribed number of locations during the winter is well known to fishermen and has given rise to the existing pattern of intensive dry season fish harvesting. In particular, the *katha* harvesting method is a technical response to the overwintering crowding of fish. The extremely high vulnerability of broodstock to fishing mortality during overwintering means that the winter season is a critical period during the annual fish life cycle and that the river *duars* and deeper beels are critical fish habitats. Protection of overwintering broodstock and regulation of harvesting in overwintering refuge localities must figure as central elements in a regional fisheries management strategy. Field studies undertaken by NERP during the first phase of their work indicate that *duars* are more important than deeper beels for survival of the region's broodstock during the winter. The combination of sedimentation, boro irrigation, de-watering and annual *katha* harvesting has resulted in the virtual elimination of beels as secure overwintering refuge habitat for broodstock in most of the region. River *duars* are thus by default the only important overwintering refuge habitat in the region for broodstock. The sustainability of fish production in the region is thus almost entirely dependant on the degree to which natural and fishing mortality act on broodstock overwintering in the region's *duars*. While they are not invulnerable to certain threats, most *duars* are fairly stable morphological structures, and are more difficult to fish out due to high current velocities and turbulence, and great depth.

3.3 Fish Production and Utilization

3.3.1 Fishing Gears and Vessels

A great many different types of nets and gear are used in the region and are testimony to the ingenuity of the region's fishermen in devising means to harvest virtually any life stage of any species. The specifications depend on target species, hydrological conditions, portability, labour intensiveness, capital costs, gear material availability, and profitability. 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. The more commonly observed fishing gears are described in the *Fisheries Specialist Study, NERP, December, 1994.*

3.3.2 Specialized Fishing Methods

Certain special fishing methods and practices have developed in the region which are more complex than the simple deployment of fishing gear in a routine manner. These have been developed in order to achieve higher levels of productivity.

Katha: By far, the most widespread and common special fish production method used in the region is the *katha*. This structure consists in its simplest form of a pile of tree branches and bushes (hence the quasi-synonymous term "pile fishery") set on the river or beel bottom. Fish are probably attracted into katha by the shelter provided and by the increased food supply (bark and periphyton). During the dry season, fish can become densely amassed in a *katha* and thus become easier to catch once they have taken refuge there. To harvest a *katha* a blocking net is set around the *katha* (often raised up to 2 m above the water surface to prevent carp from jumping out), the branches are removed and blocking net is closed up. Final harvest may be with a beach seine or castnet inside the blocking net. The preferred furnish for *katha* is the branches of *hijal* because of their hardness and resistance to rot. *Hijal* branches can last three or more years in water without decomposition. *Koroch* is also used but the wood is lighter in weight and more buoyant and the bark is thin and not liked by fish. At least one species is not used because it releases a toxic chemical into the water.

Katha fishing in running waters (open rivers) is not legal according to the Fish Act. This regulation is intended to protect broodfish which have moved from haors into rivers to seek over-wintering grounds. Instead of moving into the *duars*, the broodstock instead take shelter in the *katha*. However the Fish Act's provisions are ignored by leaseholders who use *katha* in rivers exclusively as a trap for broodfish. This results in heavy mortality of brood stock in rivers in the winter. Another negative impact of the installation of *katha* in rivers is increased deposition of silt which is trapped by the reduction in current velocity caused by the *katha*.

De-watering: Beel de-watering is practised in seasonal beels and roadside borrow pits. It is done by baling water out using manually operated low lift mechanical devices or low lift pumps. The objective is usually to achieve a complete harvest of the fish stocks (to maximize profit from the leased water body) and therefore is quite destructive of fishery resources. A possible justification for de-watering for fishing of seasonal water bodies is that the fish would die in any case when the water body dries out. However other approaches (excavation of refuge pits, construction of bunds to increase water storage volume) would probably yield greater returns over the long term.

Donga is a method for fishing seasonal beels. The *donga* is a pond excavated in the outlet khal of a seasonal beel. Several *katha* are installed in the *donga*. Bamboo screens and 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.

3.3.3 Collection of Nominal Fisheries Statistics

Prior to 1983/84, fish production estimates were based primarily on fish consumption data generated by the Nutrition Surveys of Rural Bangladesh for 1962-64, 1975/76 and 1981/82. Adjustments were made for intervening years by incorporating the 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 by 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 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 where it is processed. BFRSS requires further development and strengthening. Shortcoming of the system include small samples and too few sampling villages. The last river fishery frame survey was done in 1981/82, with FAO support. 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, and enhancement of, BFRSS outputs. 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 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 re-aggregate BFRSS statistics to exactly conform to the NERP region, they are used here in unmodified form.

3.3.4 Production Trends

Nominal BFRSS statistics for the six year period 1983/84 to 1988/89 show the following apparent trends in the region:

- Overall fish production in the region has shown an average annual growth of 3.8%, increasing from 95,895 to 114,273 tons. Species composition of capture fisheries production is dominated by miscellaneous species, which increased from 48,018 tons to

58,331 tons. Ilish and livefish production also increased. Carp and catfish production decreased over most of the period, but recovered in 1988/89. Large shrimp declined.

- Rivers are the most important harvesting habitat in the region, accounting for 31.6% of overall production in 1988/89. Mean annual growth was 3.2%.

- Beel production constitutes 29.3% of overall production. Mean annual growth in output was 3.7%.

- Commercial fishing on floodlands is substantial. BFRSS collects production data but has never included it in its annual statistics report. FAP 17 has analyzed this data set and concluded that its inclusion would approximately double the floodplain catch figure.

- Subsistence fishing on floodlands constitutes 23.3% of overall production, and has grown annually by 5.7%.

- Closed water (pond) culture production grew by 9.7% per annum, from 12,340 to 18,075 tons. Ponds contribute 15.8% of overall production.

In contrast to the nominal BFRSS production trend, there is agreement among fishermen and others employed in the sector within the region that fish production is declining. This decline in production and MSY and yield estimates are described in the *Fisheries Specialist Study*.

3.3.5 Effects of Fishing Effort on Fish Production

Catch-versus-effort models of multi-species floodplain fishery indicate that total catch reaches a broad plateau that is sustainable over a wide range of fishing effort before finally collapsing. These models of catch-versus effort would predict that the floodplain fisheries of the region will move beyond the plateau level of sustainability if the level of fishing effort increases beyond a critical threshold. Unfortunately, no reliable estimate of the level of fishing effort is available or can easily be developed for the region. It is not clear to what extent the current level of effort approaches the critical threshold, although population growth in the region certainly suggests that the situation may become critical within perhaps a decade. The observed relative increase in proportion of miscellaneous species (which are mostly chotomaach) would appear to be in agreement with conventional wisdom which predicts that FCD/I 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 FCD/I (except in cases where FCD/I increases the catchability of fish stocks). Tsai and Ali (1985, 1987) presented evidence that major carp stocks in beels in the region were being severely depleted by overfishing. "Fishing out" of larger slow growing species certainly appears to be taking place everywhere in the region and affects both predatory species (ie large catfish) and non-predators (ie major carps). This is likely 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 FCD/I 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).

3.3.6 Effects of Environmental Variables on Fish Production

Significant 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 major part of this variation can be attributed to annual variation in flood intensity. Using hydrological and fisheries data sets spanning the 1960s, 1970s and early 1980s, Welcomme[1] determined that there was a strong positive correlation between annual flood intensity and fish catch from the Kafue flats floodplain in Zambia, the lower Shire River floodplain in Malawi, and the Central Delta floodplain of the Niger River in Mali. A three dimensional computer generated model of a floodplain fishery was constructed by Welcomme and Hagborg[2] using maximum area flooded and minimum dry season water area as the independent variables. Fish abundance was positively correlated to both maximum area flooded and minimum dry season water area, indicating that years with higher rainfall and flood intensity would produce larger fish catches. The importance of the water area remaining during the dry season was also demonstrated; greater dry season water area would also produce greater fish abundance during the following flood phase. These studies also found that the best correlation with flood intensity was with the catch of the following year (or the mean catch of the same year plus the following year), as large fish species require one year (or more) to grow before they are recruited into the fishery.

In the region, there is good evidence that fish production is controlled by flood intensity. Lack of sufficient water on the floodplain during the 1992 monsoon resulted in a shorter grazing period and facilitated overfishing. Overall fish production in the Chamraghat area, for example, was at least 30-35% lower than the previous year. Most of the retailers in the ghat stated that fish were on average 30-40% smaller compared to the same time (September) in 1991. Similar slow growth was observed in Shanir Haor in 1992. AFI report low water levels and reduced fish production in 1992 for the Kaliajuri and Ajmiriganj areas. Further evidence of a causal relationship between flood intensity and fish production is the region-wide recovery of carp catches in 1988/89, which was probably due to the heavy flooding in 1987 and 1988. This implies that even if carp stocks and other fish stocks are over-harvested, they have a capacity to recover during periodic heavy flood years.

Several environmental factors of anthropomorphic origin have significant effects on floodplain fish production:

Sewage: Population increase is leading to an increase in the production of domestic sewage. Almost all of the sewage enters the aquatic environment. For some urban areas there are increases in nutrient loadings which can lead to over eutrophication which in turn can lead to decreases in fish production. However, in the flood plain, population density is a lot less and nutrient loadings likely result in a general increase in primary and secondary production, and in turn fish production. This factor should therefore be generating a continuous increase in fish production.

Fertilizer: Intensification of agriculture is leading to increasing application of fertilizer in the region. A portion of this fertilizer enters the aquatic environment, either directly or as nutrients

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

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

from decomposing or otherwise transformed crop wastes (more precisely, that portion of wastes representing the marginal increase in crop production due to the application of fertilizers). The increase in nutrients from fertilizers can be expected to result in increases in fish production. High rates of application of nitrogen fertilizers might however over-eutrophicate the aquatic environment, leading to a depression of fish production.

Pesticides: Agricultural intensification invariably leads to increasing use of pesticides and residues in the environment. Lethal and sub-lethal impacts of pesticides will reduce fish production.

FCD/I projects: When operating according to design, these major environmental engineering works alter the hectare-months of inundation to create an artificial environment conducive to agricultural production. Submersible embankments reduce flood duration but do not change area flooded. Full flood embankments significantly reduce area flooded and flood duration. In both cases, the result quasi-mimics natural variation in flood intensity caused by variations in river discharge and direct rainfall, but the effects are much more severe in the case of full flood embankments. The reduction in hectare-months of inundation can be expected to lead to a decrease in fish production. However, the inadequate level of operation and maintenance of projects and frequent public cuts of embankments act to mitigate some of the negative effects on fisheries production.

Sedimentation: The high level of sedimentation in the region can be expected to have a negative effect on fish production. Increased sedimentation is the result of deforestation in the upland catchment. FCD/I projects alter the pattern of sediment deposition on the floodplain, and especially severely affect prime fish refuge habitat through infilling of river duars. High turbidity reduces primary production (photosynthesis) and deters fish migrations. Sedimentation has only come to be regarded as a significant problem in the last few decades.

Industrial effluent: Inadequately treated effluent discharges from the Chhatak pulp mill and the Fenchuganj fertilizer plant cause lethal and sublethal toxicity in fish in the Surma and Kushiyara Rivers, respectively. These losses in fish production began abruptly at start-up of each plant and will continue until such time as there is an improvement in effluent treatment or the plant(s) close.

Fish disease: Severe outbreaks of epizootic ulcerative disease and massive fish mortalities appear to be induced by deteriorating water quality under stagnant water conditions in some beels, khals and borrow pits during the late monsoon and the dry season. This results in a loss of fish production. Deteriorating water quality takes place in full flood protection FCD/I projects, and to a lesser extent to partial flood protection projects. For full flood control projects there is very limited flushing of water into the project area. Generally there is some water logging and excessive aquatic vegetation growth. Stagnant water conditions, coupled with increased fertilizer application, leads to massive proliferation of aquatic macrophytes. The subsequent death and decomposition of this heavy load of organic plant material leads to severe changes in water chemistry (acidification, oxygen depletion, heavy metals release from sediments) which weakens fish and reduce their ability to resist infection.

Construction of a predictive model which incorporates all eight of the above natural and man-made environmental parameters would be a difficult task because of the complexity of the interactions (many of which are not discreet but interdependent). The poor quality of the available data would introduce a very high statistical error which would likely reduce the efficacy

of the model (or even invalidate it entirely). A fisheries model has been prepared to analyze the fishery impacts of structural initiatives. Details of the model are described in the individual NERP pre-feasibility reports on flood control and drainage projects. However, comprehensive feasibility studies will have to take into account the non-FCD/I impacts which may come about as a result of an FCD/I project initiative and these cannot be readily evaluated by quantitative modelling.

3.3.7 Economics of Fish Production

It is very difficult to get economic production data on river duars and beel fisheries. Some information was collected by interviews with fishermen and leaseholders during field visits in Ajmiriganj, Kaliajuri, Sylhet, Gowainghat, Companiganj and Dwarabazar areas. This information was used to make a preliminary estimate of the economic value of production.

Fisheries in river duars: Generally individual duars are not leased out separately for harvest. Instead, discreet river stretches are leased out as jalmohals and any existing duars are included in the river stretch. Katha are usually installed around the duars. Harvesting continues for 1-2 months (depending upon water current and rainfall) from December to February. River systems with duars are important overwintering grounds for brood fish. It is estimated that *boromaach* constitute about 50-60% of landed weight and *chotomaach about* 40-50% of the landed weight. In value terms, *boromaach* constitute 70-80% of the total catch. Based upon this data it is possible to roughly estimate the overall production capability of a particular river system where important duars as well floodplains exist.

An example of the production capability of a river duar is the Dwarabazar duar near Dwarabazar market on the Surma River (in the vicinity of Konoskai beel and Dekker haor floodplain). This is a breeding ground for many fish including carp:

- Average yield is 2500 kg fish (Boromaach 1500 kg and chotomaach 1000 kg).
- Reproductive capacity: Assume 40% are female (600kg) and 60% are male (900kg) fish (boromaach). Out of 600kg of female fish, assume that 50% would be capable of breeding in the following year (which means 300 kg matured brood).
- Spawn production is 1 kg from an 8 kg female. Thus 300 kg active females yield about 37 kg spawn (0.2 million spawn = 1 kg; 37 kg = 7.4 million).

Floodplain fish productivity (survival and production) may be calculated as follows:

- Spawn to fry (10%) = 0.74 million
- Fry to fingerling (30%) = 0.22 million
- Fingerling to adult fish (40%) = 0.08 million
- Expected average fish weight = 0.75 kg
- Total production = 66,600 kg
- Value of production = Tk 4,000,000 (at Tk 60/kg)

Thus, each river section having a good overwintering ground would be capable to produce about 66 tonnes of fish valued at about Tk 4 million, as well as a large quantity of economically important *chotomaach*.

Katha fisheries in beels: Medhol beel and Rui beel (total dry season area of 283 ha) are located on the Mehol Haor floodplain on the west side of the Sylhet-Jaintiapur road. Both beels are maintained under the pile fishery management system. Economic data provided by the leaseholder of the beels indicate a total income of Tk 1.15 crore, net income of Tk 0.76 crore and a rate of return of 193%. The yield was 692 kg/ha/three year pile.

3.3.8 Fish Processing Methods

It is estimated that over 90% of the fish production of the region is utilized in fresh or live form (although in more remote beels a large proportion of the catch may be processed). Typically, fresh fish is sold wholesale in ungutted form. Limited use of ice is made to preserve fish destined for local markets, but all fresh fish (except livefish) destined for distant markets is iced. Ice plants are numerous. There are about 40 cold stores in the region.

The main processed products are sun dried and semi-fermented fish. Smoking or salting is apparently not practised. Sun-dried fish *(shutki)* is the most common form of processed fish product. Sun drying is mainly done by women. 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 fish are dried on tarmac road surfaces. Sun drying is typically used for large catches of chotomaach, as occurs when a beel is harvested. Some species (for example *puti, kaikka, kachki*) are not considered to be very tasty in their fresh form, and also spoil rapidly. Hence they are sold in a dried form. Other species which may be sold sun-dried are *pabda, boal, baim, itcha, tengra, chanda, bailla, chapila, gonia, tepa* and *cheka*. Fish are also sun-dried 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 sun-dried fish. Product quality is variable but is often poor as sun-drying imparts no preservative into the product (unlike salt or smoke drying). The organoleptic properties of sun-dried fish are said to be appreciated by consumers. Fermented fish *(shital)*, is produced in low lying beel areas of Kishorganj and Netrokona. Both *shukti* and *shital* are produced by women in the *kholas* (temporary seasonal fishing camps). For example, at the Khaliajurigoona *Khola* in the Kaliajuri area, about 2500 kg of dry fish and about 2000 kg of semi-fermented fish were produced in the 1991 fishing season. The species used for *shutki* were *batashi, boal, tengra, gulsa, kaski, along, chapila, air* and others. The species used for *shidal* were *puti, pabda, bashpata, along* and *chanda*. For dried products, 40 kg of fresh fish yields about 10 kg of dry fish (about a 75% weight loss). For semi-fermented fish, 40 kg of fresh fish yields about 50 kg of product (about a 25% weight increase).

There is scope for further development in artisanal level fish processing in the following areas:

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

A small portion of the total regional catch (large prawns, major carp, large catfish, Chital, some chotomaach) is destined for export and undergoes high quality processing in factories. There are two such export processing plant situated in the region:

- Ajmiriganj Fish Industries Ltd, Ajmiriganj
- Kuliarchar Cold Storage Ltd, Kuliarchar

Another large fish receiving facility (owned by the BFDC) is at Dabor, but this plant is not functional at present.

3.3.9 Fish Marketing

Fish marketing is relatively well organized in the region, as elsewhere in Bangladesh. There are three levels of traders:

- *Nikari,* who are small scale fish traders (wholesale and retail);
- *Aratdars,* who are large-scale well capitalized wholesale fish traders;
- *Paiker*, who are small-scale urban fish retailers.

In general *Nikari* are active in directly buying fish from the fishermen. Typically, they go to a *khola* (fishing camp) or *ghat* (fish landing or assembly place) and buy fish from the fishermen or *jalmohal* leaseholders, either by auction or bargaining. Sometimes the competition between *Nikari* is so intense that they wait in boats near the fishing grounds and buy catches almost as soon as the fish are netted from the water (or "floating fish markets"). If the *Nikari* has purchased the fish from his own capital, or has borrowed capital without a sales contract, he has two main options: 1) transport the fish to a local retail market *(maach* bazar) and sell it himself, or 2) transport the fish to a local wholesale market *(arat)* and sell to an *aratdar* or *paiker*. Historically, the *aratdar* profession arose as a response to the large seasonal landings of *ilish* from major rivers (Jamuna, Padma) in June to September. These caused gluts on the local market and led to the establishment of marketing networks to transport iced *ilish* to remote areas. *Aratdars* now deal in all species of fish. Most have contracts with jalmohal leaseholders to purchase their fish production. They often finance *Nikaris* to go to the *kholas* to procure fish and transport it back to the *arat*. Assembly (or *arat*) boats are used to collect fish from the fishermen. The fish are packed in baskets with ice. The *aratdar* then puts the fish up for sale at the wholesale market, where it is bought by *paikers*. The latter transport the fish to retail markets for sale to consumers. *Nikari* and *paiker* traders are sometimes related to professional fishermen.

Large consignments of high value fish destined for Dhaka may pass through a hierarchy of 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. Fish are transported by road or rail to Dhaka. Fishermen may on occasion 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, in theory, now go directly to markets and sell their catch for higher net income. Women do not work as fish vendors in markets. Much of the fish coming out of the haors of the Sylhet Depression from the Sunamganj side goes to Dhaka. The most important commercial wholesale fish markets in the region are Kazibazar in Sylhet, Kuliarchar, Ajmiriganj, Purbadhala, Mohanganj, Dharmapasha and Mymensingh (for pond production).

The BFDC opened a large fish marketing centre at Dabor in May 1991, which is complete with auction hall, 50 ton cold store (*himagar*) and 20 ton per day ice plant (*boraf 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 was planned to bring *Ilish* from the coast to sell locally. Fish auctioning would be an "open market", but contradictorily this meant that prices would be fixed by GOB. The Dabor centre is still far from meeting its objectives because it has been unable to buy fish locally and Sylhet wholesalers are reluctant to transfer their operational base to Dabor.

The most important retail markets in the region are:

- Bandar Bazar in Sylhet
- Sherpur roadside fish market
- Central Market in Moulvibazar
- Chota Bazar in Netrokona
- Purantana Fish Market in Kishorganj

Market supply varies seasonally:

- Lean: April-May (livefish and other small species)
- Medium: June-November (all small species)
- Maximum: November-March (all species)

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. If the trend to increasing commercialization of fish continues, expansion and improvement of retail fish markets in all urban centres in the region will be needed. 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 region is not especially large compared to overall production in the region. Local fish prices are highly stratified. The major carps, large catfish, *chital* and *Golda chingri* are usually the most expensive, although some *chotomaach* such as *Rani* and *koi* can command high prices. Prices in the region are somewhat lower than Dhaka prices. According to wholesale marketers in Srimangal, the price of fish has increased by 400% over the last 10 years. This is due to:

- Higher income levels due to increased employment abroad during the last decade;
- Increased demand due to high population growth;
- Reduced fish abundance due to overfishing, fish disease, reduced fish grazing area because of increased paddy cultivation lands (HYV) and siltation of river beds;
- Indiscriminate use of insecticides in paddy fields which may sometimes cause large losses of fish and spawn particularly at the time of early rains (as many paddy fields are adjacent to beels and rivers).

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 and have to resort to drying it. Another factor affecting the price of some species is fish size. Thus small *rui* sell

for about Tk 40 per kg, while large adult *rui* sell for Tk 100 to 150 per kg. Retailer trade margins vary between 6% and 33% which is not especially large compared to other developing countries.

3.3.10 Fish Imports and Exports

International fish trading is of importance to the Bangladesh economy. Aside from very small quantities of highly priced canned fish, there is no significant retailing of imported fish products. However, the export of fish commodities is a major foreign exchange earner. The most important export commodity is frozen shrimp from the coast. There are 106 fish processing plants in Bangladesh. Half have closed permanently and will not reopen because machinery is deteriorated beyond repair. Only 10-12 plants are operating at a profit.

Exports from the region are frozen prawns (only about 2% of total Bangladesh crustacean exports), frozen *boromaach* and *chotomaach* (about 10% of total Bangladesh finfish exports, including marine fish) and frog legs (although this commodity is now proscribed). The international export of high value prawns and *boromaach* from the region is important to the regional economy. There are grey market exports of beel fish and *Ilish* to India (Assam). It is very difficult to estimate how much fish actually enters India, but a figure of about 30-40% may represent the upper range during the beel harvesting period.

There are two functioning fish processing factories in the region which target export markets: Ajmiriganj Fish Industries Ltd and Kuliarchar Cold Storage Ltd. A third plant, Saidowla (PVT) Enterprises Ltd of Sunamganj, went bankrupt in 1989, and is at present attempting to start up again. However, it has to offer too high a price for raw material in order to compete with the Sylhet market.

Ajmiriganj Fish Industries Ltd: This is a substantial fish processing plant. Freezing capacities (per day) are:

- Plate freezer: 2 tonnes
- Air blast freezer: 2 tonnes

The ice plant has a capability of 10 mt per day. The cold storage capacity is 150 mt (in two rooms). Of the total supply of raw material, about 55% is harvested from their own leased jalmohals (for example: Kaliajuri fishery), about 15% is purchased from open water fishermen in the Kaliajuri and Ajmiriganj areas and about 30% is purchased from fishermen in the Sylhet area. These proportions however vary from year to year. It is stated that the plant can handle only 15% of the area's total production (Kaliajuri, Ajmiriganj, Sullah, Derai and Baniachong thanas). The plant exported 94,272 kg of *Golda chingri* and 168,077 kg of finfish in 1992, having a total value of Tk 4.28 crore. Prawns are exported to USA, Japan, Canada, UK, Italy, France, Belgium, Germany, and so on. Freshwater fish (Rui, Boal, and so on) go mainly to the UK. There is very good demand in the UK from the expatriate Bangladeshi community, as well as in the Gulf States (Kuwait) and Saudi Arabia. Despite good market demand, finfish exports have declined. In 1990, 150 containers of freshwater fish (2250 t) were exported. In 1991, only 85 containers (1530 t) were exported. In 1992 not more than 50 containers (900 t) went out. AFI describes a number of factors which negatively affect international trade performance:

- The decline in exports of freshwater fish is due to the decline in raw material. In 1992 there was very little water in the haor area. Normally water levels are about 4.5-5.0 m, but in 1992 the level was only 1.0-1.3 m. This depressed fish production. *Golda chingri* production is also down, from 130 containers (2340 t) in 1991 to 80 containers (1440 t) in 1992. In 1991, 10 containers (180 t) were exported to the USA. In 1992, 25 containers (450 t) went to the USA.

- Internationally standard packing material (laminated duplex board, LDB) is not available in Bangladesh. The locally produced packing material (simple printed and waxed duplex board) is of very poor quality.

- Importation of equipment and supplies (plastic fish boxes, rubber gloves, and so on) have high duty. Locally produced items do not meet international standards.

- Sea freight costs from Bangladesh are high. Reportedly, a 40 ft container to London or New York costs about US$6000. Out of Bangkok the same container costs US$3000.

- Export of fresh (= chilled) fish on ice is possible, but the cost of air freight (Tk 50 per kg) is too high.

- The price of finfish exported from Bangladesh is too high compared to regional competitors. Bangladesh *Magur* is priced at Pounds Sterling 1.20 per lb, while Thailand is selling *Magur* at only Pounds Sterling 0.65 per lb. India sells *Rui* at Rupees 45 per kg (equivalent to Tk 60 at an exchange rate of 1.33). However AFI has to purchase *Rui* raw material at Tk 50 per kg from fishermen for a fish weighing 3 kg or more. As a result, AFI is currently exporting at a loss, and there is no profit in freshwater fish because the price of raw material is too high. There is a strong possibility that over the next two years Bangladesh may be squeezed out of this market. The high domestic fish price is due to a general decline in production. Many species are now in very short supply or locally extinct: for example, star *Baim, Rani, Bheda, Sarputi, Nandina, Mohashol, Gutum*.

- Reportedly about 60% of all *Ilish* caught in Bangladesh is exported to India. *Ilish* caught near Chandpur exits the country via Comilla. This aggravates the supply shortage and dietary protein deficiency.

- The logistics of loading transport boats at Ajmiriganj are not good. Because of sedimentation, the plant is now one kilometre from the river. The containers warm up too much while being carried from the plant to the river. Intense sedimentation of the river bed has resulted in very shallow water depths. This has reduced the allowable draught of transport boats. While the boats should carry up to 30 tons of cargo, they now carry only two tons. The carrying cost to Chittagong (where the containers are transhipped) is now higher than the product value. In 1979-80 when the factory was built, the water depth was 13-15 m in front of the factory (because there was a duar there). Only country boats can pass there now. River excavation is badly needed in the area.

- The raw material bought at Ajmiriganj is sometimes tainted by pollution from Chhatak and Fenchuganj. Fish from parts of the Surma River have a bad smell. Species affected

are *Boal, Air, Rui* and *Chital*. Kushiyara fish as far downstream as Ajmiriganj also had a bad smell from the Fenchuganj fertilizer plant effluent (the plant was closed in 1993, construction of a new plant is planned).

- Because of the shortage of fish supply in Bangladesh and high domestic prices, it is more lucrative to import cheap fish from outside. But the 70% customs tariff is preventing fish imports from expanding. The tariff is a protective tariff designed to support BFDC fishing operations and marketing. Over the next three to five years, AFI predicts that Bangladesh will have to start importing fish from India to meet food requirements. Bangladeshis generally do not prefer frozen fish.

Kuliarchar Cold Storage. The capacity of the cold store is 300 mt. Exports in 1991 were Tk 281 million. The major export items are prawns (65%) and table fish (35%). The areas of origin of prawns are Bajitpur, Bhairab, Astagram, Nikli, Itna, Kaliajuri and Kuliarchar. The peak season for prawns is late May to early November, and for table fish November to February. In 1992, 3,371 kg of prawns (headless) were purchased.

3.3.11 Fish Consumption

The role of fish in the Bangladesh diet is substantial. Approximately half of all dietary animal protein is derived from fish. The current national per person supply is calculated as 7.2 kg per year. However the accuracy of the FAO estimate is not clear as there are two major possible sources of error:

- Subsistence and commercial floodland production may be much higher than nominal BFRSS statistics suggest;

- Substantial grey market exports are not taken into account. This illegal practice of exporting fish to neighbouring India possibly includes (1) carp and other boromaach from the Sylhet Depression/Haor basin going via Jantiapur into Assam in India; (2) Hilsa from the Meghna and Jamuna Rivers going via Comilla into India.

It is of course possible that these two errors might approximately cancel each other out. Only a rough approximation can be made of the quantity of fish consumed in the region. For the year 1988/89, it may be assumed that of the total regional production of 114,273 t about 85% is consumed within the region. A per capita supply of about 6 kg per annum is estimated for the region. The historical trend in fish consumption for Bangladesh as a whole has been one of decline. In 1961, per capita supply was a respectable 14.4 kg/yr (compared to 9.1 kg/yr for the world) But this had decreased by 50% to 7.2 kg/yr by 1989 (while world supply grew to 13.4 kg/yr). Given that the region has a net outflow of fish (to Dhaka, other larger Bangladesh urban areas, India and international markets), an increasing population and declining production (according to most sources) it is quite probable that regional per capita consumption is also declining.

3.4 Fisheries Tenure and Management

Four types of fisheries tenure exist in the region:

Open water monsoon flood fishery: This is the open access system which applies to the floodplain when it is fully flooded during the monsoon (from about June to November). Virtually all fishermen (about 115,000) and about 65% of rural households (1,900,000) in the region take advantage of this fishery, for both commercial and subsistence fishing. At least 57,000 tons (50% of total fish production from the region) comes from the monsoon flood fishery, with a market value of approximately Tk. 3.4 billion.

Jalmohal lease fishery: This is a restricted system which applies to medium and large size beels during the dry season (although they are confluent during the monsoon flood season with the rest of the inundated floodplain, beel areas are still considered restricted for fishing) and river stretches. Lease holders are usually wealthy individuals or businessmen who licence or subcontract fishing rights to genuine fishermen. Most professional fishermen participate in this fishery, either on a contract basis to catch fish on behalf of the leaseholder (who then markets the fish), or on a fee-paying fishing permit basis (with the fishermen retaining the catch). Production of about 34,000 tons (30% of total production) comes form the jalmohal leasing system, valued at Tk. 2.0 billion.

Nitimala fishery: This system - also known as New Fisheries Management Policy - was recently introduced with the intention of replacing of jalmohal leasing system. It is a restricted system which applies to medium and large size beels and river stretches. Only groups of genuine fishermen can participate and they are required to pay licence fees which are equivalent in total value to the previous lease fee. Currently there are 76 jalmohals in the region under Nitimala, with about 10,000 participating licensed fishermen. Production of about 11,000 tons comes from the Nitimala system, valued at about Tk. 0.7 billion.

Community jalmohal fishery: This is a restricted system which applies to small beels, khals and river stretches. Typically it is semi-open access to local communities for subsistence fishing purpose. There are about 1,000 tons of subsistence catch, with a shadow market value of Tk. 0.6 billion.

Four principal types of fisheries management systems/practices exist in the region, which come under one or more of the above tenure systems:

- Pile fishery: A fishery which uses the katha fishing method and is harvested only once every three years.

- Reserve fishery: A fishery which is harvested only once every 5-7 years. Reserve fisheries may or may not contain katha.

- Mohalshamil jalkar: Jalmohals which are under community-based fisheries management. Typically, closed seasons and various bans (ie dewatering; complete harvesting, destructive fishing gears) are enforced by the local community. Harvesting in some jalmohals is carried on a periodic basis by the whole community.

3.4.1 Subsistence Fishing

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 generally freely open to the public. This is in sharp contrast to the dry season when individual beels emerge and important

and valuable fisheries *(jalmohals)* operate in the beels during the dry season under a highly restrictive leasing tenure system. Subsistence fishing is of great importance for maintaining the nutritional health of the rural population. About 76% (838,000) of all rural households in greater Sylhet carry out subsistence fishing, and 57% (1,072,000) in greater Mymensingh.

During the flood season, there is open access over the entire flooded area, except for the areas around leased beels (which are patrolled by *Paharadars*). No fishing licenses are needed. However, because the stocks are dispersed over a large area, catchability is low. People can catch fish including species such as *rui, catla,* and *boal*, at this time of the year. During the dry season fish are under private control and a costly license is required. During the dry season when stocks are concentrated and catchability is high, open access is restricted to local beels under 1.2 ha. 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 are installed to harvest fish 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 *Tela jal* (pushnets) 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.

3.4.2 Jalmohal Leasing System

All rivers, khals and beels (with a few exceptions) are the property of GOB 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 region, are recorded in the revenue registers of district government. There are about 5,000 beel fisheries units.

GOB is interested to collect revenue from fisheries. In the past it did so primarily by leasing out under MOL individual fisheries, usually through open auction. Deputy Commissioners are the custodians of all *jalmohals* 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 three year terms. Some beel leases may run for six or, exceptionally, nine years.

Beels over 8 ha (20 acres) are owned by MOL, and were leased out to the public by open auction in the Additional Deputy Commissioner's (Revenue) office. At the time of auction, the highest bidder for a particular jalmohal unit must immediately deposit 50% of the lease fee with the revenue accounts. Generally there is competition among the lessees. Money lenders take advantage of this situation. Usually, fishermen become the representatives of the rich money lenders and on behalf of them they go to the auction. Sometimes leases contain conditions for development investment in the fishery (such as the system of operation, tree plantations around the beels, and so on), but usually there is no monitoring to see whether such activities are being

performed or not. In case of default, GOB does not usually exercise the right to cancel the lease agreement. Some beels between 1.2 and 9 ha have been transferred to the revenue collection systems of thana parishads for a token rent to MOL (in order for MOL to retain ownership). This is so that thanas can lease them out and earn revenue for their own use. Beels under 1.2 ha 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 RHD, and FCD/I borrow pits are leased out by BWDB.

Because lease fees for large beels may run into several lakh taka, lease holders are usually richer individuals who are not fishermen themselves. They act as middlemen *(jalmohans)*. They may either hire fishermen as daily labour to carry out fishing operations on their behalf, or may sublease to fishermen (ie sell individual fishing rights for a fee). Daily fishing labourers are paid in cash and/or receive a small share of the catch. Most of the sale value accrues to the leaseholder. Nationally, government collects about Tk 460 million from jalmohal leasing, and this constitutes an important source of revenue for national and local governments.

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 region is covered by a single continuous sheet of water, the *jalmohal* system is de facto cancelled out because of the difficulty of enforcing private access rights to geographical boundaries that no longer exist. 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 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."

The leasing system promotes over-exploitation. Not only does the leaseholder believe it is his right to harvest all fish in the *jalmohal*, the fisherman is also driven to maximizing catch. If fishery resources become depleted fishermen do not renew their licenses. The over-exploitation of fish stocks has resulted in investors showing a declining interest in bidding for *jalmohal* leases. Indeed many leaseholders have lost money in recent years. GOB has recently stopped the public auctioning of leases and is now instituting a sealed tender bidding system. The DC office publishes tender notices to lease out *jalmohals*. Tender schedules costs Tk 200-500 to purchase. NFA is firmly opposed to tendering because it further decreases public accountability of *jalmohal* leasing.

3.4.3 New Fisheries Management Policy

Beginning in 1986, MFL had begun a major new initiative to overcome problems of exploitation of fishermen and resource mining. This is known as *Nitimala* or 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. The NFA draws up a list of genuine fishermen at thana level. This is first approved by the thana NFMP committee and then is sent to the district NFMP committee for approval. 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 genuine fishermen to enable them to purchase gear. Resource conservation is to be achieved through installation of permanent kathas and similar fish trapping systems (sometimes known as FADs) in designated 'sanctuary areas' within NFMP jalmohals. Closed seasons for certain species were also to be enforced.

The national NFMP committee has identified some 300 *jalmohals* out of the 10,000 in Bangladesh for inclusion in NFMP under the direct supervision of the DOF, but only 250 of these have actually been handed over from MOL. NFMP is managed by three hierarchies of committees at national, district and thana levels. All committees have (in theory) two NFA representatives. Corporate members of the national NITIMALA committee are NFA, MFL, DOF, MOL and Krishi Bank. New jalmohals are in theory brought under NFMP based on recommendations of the local *Nitimala* committee. At present the transfer of *jalmohals* from leasing to NFMP is very slow. The DOF does not consider itself well equipped to "manage" all *jalmohals* and therefore is not presently actively seeking their transfer. The basic premise is that it is the DOF (and not the fishermen) who are supposed to be the managers of the fisheries. MOL exerts pressure on GOB to return *Nitimala jalmohals* to MOL jurisdiction when license tenure periods come up for renewal.

In Habiganj, under NFMP, typically a fishermen society (with about 300 members) gets a beel fishing license at an annual starting fee of Tk 1-300,000 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 Tk 257,000 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 between Tk 10 - 12,000. The fee for the large Tangua Haor near Sunamganj is Tk 70,000.

Many fishermen say their biggest problem is capital. They want loans for boats and nets. Lack of credit is a major impediment for two reasons: fishermen cannot pay the high license fee which is the entry "ticket" to the fishery, and they cannot buy gear and boats and meet other costs associated with processing and marketing. 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 Tk 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. A major problem with implementation of NFMP has been failure of banks 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.

NFMP in the form presently implemented by GOB does not appear to present any great impediment to the rent-seeking aspirations of ex-*jalmohal* leaseholders and money lenders. If the license fee is too high mostly middlemen and moneylenders can afford to pay. Poor genuine fishermen cannot pay 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. In some cases, NFMP reflects existing power relationships in fisheries rather than instituting a new trend. Some of the NFMP have been over-priced and fishermen have been unable to pay the required licence fee. As a result GOB revenue is declining.

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 labour, 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.

Many of the 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 do not play an effective role in obtaining leases of *jalmohals* or in fisheries management. Lacking politically strong cooperatives, fishermen could not take on a continuing lease of the *jalmohals*. Moreover, politically committed persons or organization are needed to help build up real fishermen organizations. If these organizations have no socio-political commitments, then they can be manipulated. There are several constraints to 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;

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- lack of monitoring and evaluation;
- illiteracy;
- lack of finance;
- poor leadership.

The coops do not incorporate other fisheries sector groups such as women who make nets and process fish, and fish vendors.

The National Fishermen Association was formed in 1946 but only received a certificate of registration in 1992 (because of GOB pressure). Its primary objectives are enhancing socio-economic development of fishing communities and increasing fish production. It has remained politically neutral as an organization and is not linked to any political party. NFA is not an NGO as such, but is registered as a non-profit association. The national officers are not working fishermen, but have fishing community backgrounds. They work for the NFA on a volunteer basis. NFA is the agency which represents fishermen at national, district and thana level NFMP committees. It is empowered to carry out registration of genuine fishermen. The NFA considers itself to be the only organization looking after the interests of the 10 million fishermen of Bangladesh. It therefore attempts to carry out a policy dialogue with the DOF/GOB. NFA activities and office overheads are financed on a subscription basis, and this severely restricts its programme. The NFA is opposed to the tender leasing system. It is in favour of nominal license fees and greatly extending the tenure period.

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 of jalmohals in favour 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.

DOF officials maintain that genuine fishermen under NFMP are now better off than before NFMP. Annual earnings of a fisherman may reach Tk 4,000 (US$100). If a fisherman's family has 5.3 members this amounts to a per person income of US$19. The family will have other sources of income. But as NFMP sets out to develop career professionalism in the fisheries sector it is important to recognize that the benefits accruing to fishermen are low. The new system is still far from attaining its goals because the key driving force from the government's perspective continues to be revenue-seeking. License fee rates (cum loan interest) in some cases can almost equal a fisherman's annual salary. NFMP still has a long way to go before it can make genuine fishermen and their families economically stronger.

The leasing out of natural resources appears to be obstructing the successful implementation of NFMP. The MOL leases *jalmohals*, RHD leases their borrow pits, and BWDB leases its borrow pits. Typically, leases are won by wealthy individuals (investors). In practice therefore the leasing (or analogous arrangements such as group licensing) of land, water and other natural resources by the GOB prevents the poor from having access to these resources. Thus, if offered first choice of leases, the poor must go to money lenders for the cash, who in turn end up effectively owning the lease and using the poor as cheaply paid labour. The major benefit goes to the money lenders. In this way it is difficult for the poor to escape from their poverty trap and substantially benefit from the exploitation of these natural resources. The marginal increase in aggregate demand which would accrue to the region's economy by changing the fisheries tenure, revenue collection and credit systems from leasing to fully liberalized NFMP are very substantial, given that the number of fishermen in the region may be as high as 500,000. It is

considered that fully liberalized NFMP will lead to the fastest regional economic growth with the greatest equity possible in the fisheries sector. GOB and DOF may be willing to hand tenure of *jalmohals* over to fishermen and introduce community-based management, but have not yet given up revenue collection from the fisheries production sector. However revenue collection remains a constraint to sound management, income equity and economic growth in capture fisheries. It appears in the nation's best economic and social interests for GOB to withdraw from economic rent-seeking in the fisheries production sector. More progressive GOB taxation points from which foregone revenue can be recovered are:

- From within the fisheries sector, but further downstream from the point of production (ie from marketing) after value has been added,

- From diffuse sources within the general regional economy. All consumer items that fishing household need will be in greater demand and producers will respond by increasing supply. This will expand the regional economy and general taxation base on sales.

The approach should be to collect revenue post-production, and not pre-production, in the fisheries sector. To impose a heavy tax right at the starting point of the production process against the poorest segment of the sectoral hierarchy preempts any possibility for equity and economic efficiency. Sustainable development objectives of economic production, growth and equity have to come first.

3.4.4 Community-Based Fisheries Management

The *Zamindari* system was introduced for land taxation to collect revenue. This leasing system was also applied to water bodies. Previously, in the Jointiapur Kingdom of Sylhet some water bodies were given to the village people (which are adjacent to the village) for common use and resource exploitation. Usually these were minor beels, and the intention was too placate village people so they would stay away from larger *jalmohals*. These community *jalmohals* were used for bathing, fishing and dry season irrigation. No taxes (or in some cases only token taxes) were charged to the villagers. *Jalmohals* were managed by the community which enforced some rules for sustainable use of water and fishing (such as restriction on complete de-watering, complete harvesting of fish, detrimental gears and community harvesting once or twice in a year). These types of *jalmohals* were called *Mohalshamil jalkar,* and some still exist today under village people (or in some cases exclusively under fishermen communities). In some cases management structures have come under pressure. Examples of *mohalshamil jalkars* are:

Bijna River, Devpara, Nabiganj: A section of the Bijna River near Baasdor and Devpara villages was given for a token annual lease of Tk 1 to the local fishermen group. The fishermen have been managing the river section successfully since 1973/74. There is a fishermen management committee which meets once a month. Problems are discussed and savings are collected (Tk 10 per person). Group savings are spent on *jalmohal* management (cost of *katha*). No conflicts are reported among the fishermen.

Khoiltajuri beel, Bonni village, Companiganj: This beel has a dry season area of 5-6 ha. It produces mainly smaller species of fish, and few carp. Reportedly, due to some conflicts among the villagers (rich and poor), the majority of people have not been getting the benefits of the *jalmohal* since 1988.

Beels in the Rouchunni haor, Gowainghat: Mohalshamil beels are now given up for leasing to the leaseholder of the adjacent Rouchunni beel as these all are under the common floodplain of the Rouchunni haor. Village people meet together and decide how much money they will charge for the lease and then bargain with the lessee. Lease money is equitably distributed among the villagers. Some money is set aside for repairing of village roads and other development works. This system has been in place for more than five decades.

Kalibarir duar, Parashkhila, Atpara: This *duar* has been kept as a fish sanctuary under fishermen community management for a long time. The fishermen believe that they must protect part of the brood stocks to ensuring sustainable production in the floodplain and the rivers. The fishermen themselves protect the duar.

Nandina River, Khola Chandpur fishing village (adjacent to Shanir Haor): The portion of the Nandina (Abua) River adjacent to the village was permanently allocated for the use of Khola Chandpur fishing village by the Deputy Commissioner office, Sylhet in 1961. This order was issued when the fishermen leader appeared before the court and claimed customary as well as community rights over the fishery. This took place during the hearing of a case filed by the lessee to evict the fishermen from the fishery. The fishermen have tenure over the river stretch, and there have been no conflicts either within the fishing village or with outside fishermen. The area is, however, too small compared to the number of fishermen who are entitled to share the fishery. This fishery is part of a larger fishery which is leased out to a leaseholder. Fishermen who fish in the remaining part of the fishery need to pay about 1000 times more than the fishermen of Khola Chandpur who fish within their allocated stretch. The government fixed the rent at Tk 4.75 and Tk 2.25 per anum for large and small nets, respectively. The poor fishermen who are not able to pay the leaseholder's fee normally fish in the allocated area. There are no internal rules or regulations for management because of the continuous flowing nature of the river and the through migration of the fish stock. This village has better living conditions than other fishing villages in the region. Free access to this small portion of the Nandina river provides survival and a livelihood to the fishermen of this village, but villagers are afraid of the future status of river as it is undergoing excessive siltation.

During the present century, the region's fisheries have undergone a major change in ethnic and tenure structure. Currently there is little user group management and conservation of fish stocks, and a general prevalence of resource mining. Previously there was greater effort to conserve stocks and respect for customary/traditional fishery management practices.

3.4.5 Reserve Fisheries and Pile Fisheries

Given the restricted fisheries tenure system historically prevalent in the region, the most important methods of biological fisheries management and fishing effort regulation practised in the region have been in the past (and to a lesser extent, still are in the present) reserve and pile fisheries. A reserve fishery is one where fishing is carried out only once within a medium term period of five to seven years in order to allow a build-up of the stock. Thus, there is a conservationist element built into the management regime which rejects smaller short-term gains in favour of larger medium-term benefits. *Katha* were normally installed in a relatively small area of the reserve fisheries. The term 'reserve fishery' generally refers to a permanent waterbody which contains one or more jalmohals. A mother fishery is a larger area which includes spawning, grazing, and overwintering grounds (floodplain, rivers and beels). A reserve fishery may be a part of a mother fishery.

A condensed form of reserve fisheries are conventional pile fisheries with a three year harvesting rotation schedule. *Chotomaach* harvesting is carried out every year while *boromaach* are harvested only once every three years when the *katha* is disassembled. Conservation objectives are less in pile fisheries as compared to reserve fisheries. However, pile fisheries are still superior to annual fisheries (where the katha is harvested totally each year) in terms of production and conservation functions.

An interesting "hybrid" practice which combines elements of both reserve and pile fisheries results when a three year pile harvesting rotation schedule is practised within a longer term tenure or lease period (9-12 years). The history of Sunamganj jalmohals is illustrative of this practice. During the British colonial period most of the Sunamganj *jalmohals* were under the Lakkansree *jalmohal*. About 80 years before there was no leasing system in the area and *jalmohals* were mainly managed by the *Koibarta Das* and the *Zamindars*. During that period, piles were very strictly maintained as it was believed that it would not be possible to derive sustainable production from a particular *jalmohal* without creating a productive fish habitat. At that time *jalmohals* were auctioned for 9-12 years duration. This system was continued up to the end of the 1970s. As a result piles were maintained properly by the leaseholder. During the start-up years, no piles were harvested, in year 3, 4 and 5 only a single pile was harvested each year. In year 6, two piles were harvested. After this start-up phase was completed, from years 7 to 12, a three year rotating cycle was followed which specified the harvest of one pile in each of the first two years and two piles in the third. Thus over the longer term (assuming lease renewal), four piles would be harvested in any three year period, and the schedule was arranged so that any one pile was harvested only once every three years. After the liberation of Bangladesh, lease periods where shortened to 3 year terms due to certain socio-economic and political conflicts. The harvesting schedule took on a different form, with no piles being harvested in the first two years, and all 4 piles being harvested in the third year. Although the rate of harvesting over a multi-year period is the same in both cases, the 12 year lease allows the realization of income from fish sales in each year, while the three year lease only yields income (and supply to markets) triennially. In the latter case, because there is no assurance that another three year lease will be obtained after expiry of the three year lease, there is no incentive to invest in infrastructure or hizal plantations. This has apparently led to widespread failure to maintain piles properly. Furthermore, the need for an annual income has led to harvesting piles annually, thus increasing fishing intensity by a factor of three and preventing maturation and reproduction of *boromaach*. As a result fish production in the area has been reduced tremendously. Extreme reduction of broodfish (as well as destruction of forests and accumulation of silt) are the major causes of fish decline in the area. Fishermen and leaseholders in many parts of the region have asked that certain jalmohals (which are relatively deep and not threatened by siltation) be returned to reserve fisheries status.

3.4.6 River Fish Sanctuaries

A fish sanctuary is a critical habitat locality within which fishing is perpetually and completely prohibited. Because of the threats posed to floodplain fisheries by over-exploitation and environmental degradation, there has been historically a perception amongst fishermen and government alike of the need to protect certain fishery areas in order to conserve fish stocks. The creation and maintenance of fish sanctuaries in the region, and in Bangladesh as a whole, is a tried and tested approach to stock conservation which has been shown to be useful in meeting its objectives wherever it has been effectively implemented.

Most commonly, fish sanctuaries are established in specific areas to protect overwintering broodstock in river duars and deep beels, or to protect spawning grounds of boromaach. Usually, a fish sanctuary consists of a single beel, duar or river reach, but may also consist of aggregates of key localities.

The DOF Integrated Fisheries Development Project has established five river sanctuaries in the region:

Ubdakhali River: This sanctuary encompasses 90 ha and includes the reach from Kalmakanda ferry ghat to Makarkhali khal near Montala village. It also includes Hogla Beel, in Kalmakanda thana of Netrokona District. Rapid sedimentation is resulting in declining productivity. The river has three duars which act as refuges for *Boal, Air, Ghagot, Rui, Kalibaus, Baim* and other *chotomaach*. The sanctuary program appears to be not working well.

Sari and Luba River: This sanctuary encompasses about 300 ha, and is located near Kanaighat. The purpose is to protect migrating *Rui, Catla, Gonia* and *Kalibaus*. Since the sanctuary was established, no protection or any other management practices have been implemented by the DOF aside from hiring a fish guard. In the winter season, 60% of the sanctuary area dries up. All important freshwater fish species, including rare *Mohashol, Pangas Nowraj* and *Pakhiranga*, occur in the river and its tributaries. Small *Ilish* (*Jatka*) also occur in the Luba.

Sarigowain River: From Sarighat up to the Indian Border.

Surma River: Located near Sunamganj, this sanctuary covers about 300 ha.

Kali River: Located in Kuliachar thana of Kishorganj District.

Uniformed fish guards have been appointed to prevent fishing for migrating or overwintering carp and other stocks in sanctuary areas. As part of the new system, fish guards have at their disposal mechanized country boats.

In addition to specifying fish sanctuaries, the government (through the ordinance entitled *The Protection and Conservation of Fish Rules, 1985*) has prohibited catching of certain fish between April 1 and June 30 of each year. Thirteen protected areas are listed in the region where capture of carp (*Rui, Catla, Mrigel, Kalibaus* and *Ghonia*) is controlled.

A natural fish sanctuary has been created after the massive erosion of Katakhali village by the Jadukata River. Due to that erosion, some large trees have fallen into the river and a deep scour hole has formed. The scour hole now serves as a protected overwintering ground for *boromaach* and local people do not fish in that area due to the inundated trees.

The Luba River serves as a good example of the problems of managing such a fish sanctuary encountered by central government. The sanctuary is 7.2 km long and about 100 m wide. Five *duars* exist within the river of which Barar *duar* and Mainrir *duar* are very important. These *duars* are 30-35 m deep during the rainy season and act as refuges for *boromaach* broodstock: *rui* (25 kg), *kalibaus* (15-20 kg, the most abundant), *catla* (25 kg), *boal* (80-100 kg), *baghair* (100-150 kg), *mrigel, mohashol* (30 kg), rare and threatened throughout Bangladesh), and *chital* (rare in the Luba). Some *chotomaach* also use the *duars*: *bacha, tengra, puti, baim, chapila, pabda* (most abundant), *shoal* (rare), *guzar* (rare). Of very great importance is the fact that at

least three other species of *boromaach* use the Mainrir *duar* as a refuge which are now extinct elsewhere in the region: the rare carp *ghora* Labeo pangusia (5-7 kg) and two other fish species known locally as *Nowraj* (60 kg) and *pakhiranga* (30-40 kg) (these species have not yet been identified by their scientific names). In the winter season, in some parts of the sanctuary there is no water (60% of area dries up). All important fresh water fish species including Mohashol, Pangas and small Ilish) occur in the river and its tributaries. A fisherman of Laksmiprasad village caught a 150 kg *baghair* below the confluence of the Luba and the Surma River in March 1992. The Luba/Surma confluence is well known for large fish. During April and May when rain water discharge inundates the shallow areas of the river, a large quantity of *boromaach* (*rui,catla, mrigel, kalibaus, baghair, ghagot* or *air*) are caught and these fish are full of eggs. *Mohashoal* and *chital* are present at this time but no *pangas* or *nandina*. A sand bar in the middle of the Surma River just below the confluence is a good breeding site. There are 3-4 shallow bends which are also suitable for breeding. During April and May new flood water inundates the shallow areas and fishermen harvest a large number of adult fish which are full of eggs. Both male and female were observed at the same time as fishermen note the occurrence of yellow (i.e. eggs) or white (i.e.milt) discharges from the fish. In some cases just after capture the fish liberated eggs or milt. Some local people have tried to stock the eggs in ponds but they failed (probably the eggs were not fertilized).

After declaring fish sanctuaries and protected areas, no additional protection or management practices have been taken up by the DOF. Although the Luba is declared a fish sanctuary illegal fishing continues. Last year the local DOF official seized one large net used for illegal fishing. During one field visit four groups of fishermen were fishing with *utar jal* at the Surma/Luba confluence. They use this net during the low water period. Usually they do not go to the Luba due to the restriction, though fish catch is higher than in the Surma. No fishing was observed in the Surma upstream of the Luba confluence.

A new threat is dynamite fishing in *duars*. Because of ongoing road construction in India, dynamite is easily procured (or stolen) by miscreants, who cross into Bangladesh and throw dynamite into the Luba River sanctuary *duars* in order to kill the broodstock fish taking refuge there. This reportedly happens on a regular basis. The destruction of overwintering brood stock, some of which are rare or endangered species, requires immediate and forceful intervention.

3.4.7 Conflict in the Fisheries Sector

Conflict over access to rich fishery resources would appear to be not uncommon in the region, and can lead to violence and loss of life. A recent example from Tangua Haor is very instructive. Due to bumper levels of fish production (reportedly about Tk 30 million in 1991) each year many influential individuals try to get a share of the resources by raising various tenure claims. This leads to frequent clashes between rival groups. In the winter of 1992/93, fishing in Tangua haor became impossible because of conflicts between two rival groups. Starting from late October 1992, each tried to claim fishing rights by establishing temporary shelters in two parts of the haor. Many fishermen (who are working on a daily wage basis) have been killed, injured, or lost property due to the conflict. The reasons for the conflict are as follows. The haor was leased out to a company. One of its directors was granted the power of attorney to manage the haor on a share basis as he was known to be skilled in haor management. Later he was accused of depriving the other directors of their share of business profits. A law suit was filed in the District Court at Sunamganj in Oct 1992, in an effort to evict the Director from the

company and from the haor. The Court passed an injunction ordering a moratorium on fishing in the haor. In ensuing gun battles, several people were shot and killed. As a result local people are at risk within the haor. Hired fishermen are the main victims suffering from this conflict.

4. PREVIOUS STUDIES

4.1 UNDP/FAO, 1985, Open Water Fisheries (Carp) Management Programme in Bangladesh

The study maintains that the major carp stock of the Upper Meghna basin has been seriously depleted and that the fishery is threatened. The main causes of depletion are overfishing of juveniles in beels, and overfishing of juveniles and adults in rivers. The main factors promoting overfishing are the short-term revenue-oriented fisheries policy of GOB (jalmohal leasing) and the increasing numbers of fishermen due to population growth. Tentative fishery management measures recommended are:

- In riverine carp fisheries, establishment of a minimum legal size of 30 cm (12 inches) throughout the year;
- In riverine carp fisheries, prohibit fishing at katha in two neighbouring sections of river in the same year;
- In riverine carp fisheries, limit the length of drift gillnets, fixed gillnets, cages and other contrivances to less than half of the width of waterways (river, canal, khal);
- In riverine carp fisheries, prohibit the erection of fixed engines in the main channel of waterways;
- In riverine carp fisheries, limit the number of drift nets and fixed gill nets to the present level;
- In riverine carp fisheries, establish carp sanctuaries in deep pools (duars) in the main stem of the Padma River;
- In permanent beel carp fisheries, convert 20% of the beels into fish and wildlife sanctuaries. The sanctuary area of each beel should include the surrounding shore area to a distance of 1000 m from the edge of the minimum water level in the beel (except private land):
- In permanent beel carp fisheries, prohibit fishing at least for two years, thus each beel will be fished only every third year;
- In permanent beel carp fisheries, establish a minimum legal size limit of 35 cm.
- Extension of the jalmohal lease period.

Assessment of study: Most of the management recommendations are responsive to the regulations of the Fish Act 1950, summarized below:

- Prohibit the catch and sale of carps below 22.8 cm (9 inches);
- Prohibit carp fishing in the Surma, Kushiyara, Katatagonj, Garakhal and Piyain Rivers of greater Sylhet District from April to June;

- Prohibit the construction of bunds, weirs, dams and embankments in water ways;
- Prohibit the erection and use of fixed engines (any net, cage or other contrivance for catching fish, fixed on the earth or made stationary in the water way) in water ways;
- Prohibit the destruction of fish by explosives, gun, bow and arrow, poisoning and pollution.

The enforcement of a size limit (22.8, 30 or 35 cm) is certainly possible at major collection centres and at municipal markets (and this is occasionally carried out), but virtually impossible at rural subsistence level. In any case, it is unlikely that heavy policing of markets would result in a decrease in fishing effort directed towards juveniles. More likely, fishing would continue but any fish not consumed by the fisherman's family would be sold informally within the village or neighbouring village. Moreover, size limit enforcement at markets would unfairly penalize pond producers, unless pond fish could be certified as to origin. But this would likely act as a loophole through which undersize wild fish could be marketed. From a biological viewpoint, given a large enough carp broodstock in the region, the abundance of 0+ juveniles will likely in any case be far in excess of the carrying capacity of overwintering refuge habitats. They would suffer high natural mortality during the post-monsoon flood recession period. The juvenile carp population could thus sustain a certain amount of (subsistence) fishing mortality during the monsoon flood period without endangering the abundance of broodstock in succeeding years. A more potent incentive for fishermen to allow juvenile carp to grow to adult size is the existence of a price (Tk/kg) spread between juvenile and adult fish. Given a longer jalmohal tenure period, fishermen have a clear incentive to allow fish to grow to some optimal size which maximizes net present value, and this would be the optimal economic size for harvesting. Economic factors might be better incentives to promote honouring of size limits than enforcement.

The placement of katha in rivers to catch adult carp which would otherwise overwinter in river duars is highly detrimental to the status of the carp stock. Enforcement of a complete ban against placement of katha in rivers would not be difficult if the DOF possessed a river patrol force. The study's proposal to prohibit fishing at katha in two neighbouring sections of river in the same year is a half measure which would still require a patrol force to implement. Limiting the length of nets, fish fences and other gears to half the width of waterways would appear to be a sound measure, but requires a patrol force to enforce. Fish fences which completely span rivers and khals are common and should be strictly controlled. Because of the currents, depths and navigational traffic, the placement of fixed engines in main channels is not particularly frequent and is not a major problem. Attempts to limit or control the number of drift nets and fixed gill nets would be difficult and is not considered realistic.

The establishment of carp sanctuaries in river duars would appear to be desirable and possible (but again requires the formation of a river patrol force). However, given that there are over 350 duars in the region, it is necessary to select those duars which are the most important to protect. As a general region-wide measure, the proposal to set aside 20% of all beels as fish and wildlife sanctuaries is not considered feasible because of the difficulty of enforcement and the expected widespread non-compliance by disenfranchised fishermen. Such a measure might be imposed successfully at a mother fishery if all fishing effort were consolidated under a single tenured fishing company, and the latter, as a condition of tenure, were only allowed to harvest according to a schedule approved and monitored by the DOF. A more workable general region-wide approach might be to install sanctuary katha alongside production katha in major beels, so that

at least 20% of the total katha area is sanctuary. Since in the long run the sanctuary would function as a source of seed for the commercial katha, there is a clear incentive and benefit for tenured fishermen to maintain the sanctuary katha. Such a solution requires extending the tenure period. The proposal to keep a 1000 m buffer zone around sanctuary beels is also unrealistic (except in mother fisheries) in view of the intense pressure on land for rice cultivation. A more effective buffer around beels might be embankments or bunds, which could also increase storage volumes and be planted with economically and environmentally beneficial floodplain tree species *(hizal, koroch, barum, mera)*.

Regulating beel katha harvesting to once every three years is a sound measure given that it would allow most carp to mature and spawn at least once. Enforcement would be problematic but probably unnecessary if tenure periods are lengthy and the length-based price spread persists.

4.2 ODNRI, 1987, The Handling, Processing and Marketing of Fish in Bangladesh.

Three major groups of problems are identified in the post-production sector in floodplain fisheries: 1) isolation of beel fishing communities from their wholesale landing facilities, coupled with poor transport and lack of ice, 2) poor physical facilities for marketing of fish (ie landing centres, wholesale and retail markets), and 3) widespread ignorance of the factors affecting fish quality and ways of overcoming them. Measures recommended to solve these problems are:

- Assistance targeted at remote beel fishing communities in the Northeast Region, including: building of roads; instruction in improved methods of handling and curing fish; assistance to acquire motorized collector boats, mini ice-plants and processing facilities; strengthening fishermen organizations; and improving managerial capabilities.

- Construction of modern landing facilities and wholesale markets at major landing and trading centres.

- Training and extension in improved handling and processing for fishermen, traders, processors, export packers and municipal authorities.

- Research in the post-harvest fishery sector, especially improved methods of handling and processing of fresh fish to reduce post-harvest losses.

Assessment of study: The recommendations of the study have three general objectives: 1) to strengthen the position of the fishermen in the marketing chain so that a larger fraction of the retail value will accrue to them; 2) to improve the quality of marketed products so that both volume and average unit price increase; and 3) to improve the infrastructural environment within which the post-production sector operates so as to lead to greater efficiency and productivity. The measures proposed are generally compatible with these objectives, and are likely to lead to their realization if implemented.

4.3 BCAS, 1989, Experimental Project for New and Improved Management of Open Water Fisheries in Bangladesh.

This major and voluminous study monitored the functioning of four different management regimes for open water fisheries. In the Northeast Region the study sites were:

- Kalner Haor, an FCD/I project haor northeast of Sunamganj, near the Indian border, under DOF intensive management (ie NFMP);

- Karcha Nadi, a beel inside the Karchar Haor FCD/I project, west of Sunamganj, under MOL jalmohal lease to a private party for 6 years;

- Roail Beel, a beel lying lateral (to the west) of the Baulai River, in the Kaliajuri area, under NGO management (PROSHIKA);

- Arial Khan, a dead spill channel of the Old Brahmaputra River, west of Bhairab Bazar, under DOF management with existing resources (ie NFMP).

Comprehensive monitoring was carried out for environmental parameters, biological and technological aspects, sociological aspects, economic performance, marketing aspects and management efficiency. The study found that:

- Current jal and other illegal small mesh nets are in widespread use and have negative effects on fish production, especially *ilish;*

- Women are involved in net making and repair. In the *haor* basin, women also take part in fish drying and processing;

- Most fishermen are landless and poor, but 98% own homesteads;

- Fishermen are not well organized socially and this subjects them to both formal and informal dominance of power by government and leaseholders;

- Fishermen lack formal leadership structures. Decisions are taken by leaseholders groups of elders;

- Fishermen cooperatives are controlled by middlemen power elites;

- Fishermen under NFMP at Kalner Haor have organized themselves to undertake surveillance and prevent fishing by unlicensed fishermen and by villagers;

- Fishermen under NFMP express support and appreciation for direct licensing of fishermen under NFMP;

- Under MOL leasing fishermen become victims of various forms of oppression by leaseholders, money lenders and rural power groups, including robbery, and extortion. Local influential people demand free fish for home consumption.

- A class of brokers acts as agents for obtaining institutional loans for fishermen;

- If institutional credit is not available, fishermen borrow from money lenders and are charged 8% to 15% interest per month. Pressure tactics and force are used to recover loans;

- A marked increase in relative economic gain (catch value, gross income and pure profit) to fishermen was attained under NFMP licensing compared to MOL leasing. This was achieved by elimination of exploitation by middlemen leaseholders and the affordable licence fee rates charged by the DOF;

- Non-disbursement and irregular disbursement of Krishi Bank credit was the most significant problem to proper implementation of NFMP. Reasons for this are: 1) complex procedures for granting loans; 2) inability of fishermen to produce collateral; 3) hesitation and/or reluctance of bank field officials; 4) inadequate publicity and awareness of the provisions for granting loans to fishermen; 5) non-placement of funds to bank branches in time; and 6) reluctance and/or hesitation of fishermen to visit local bank branches as they consider the length of time needed and difficulties involved not to be worthwhile.

- Lack of bank credit disbursement forces fishermen to borrow money from local moneylenders at very high interest rates;

- At Roail Beel under PROSHIKA NGO management, the local PROSHIKA officials secured the lease in the name of the Monica Fishermen Cooperative Society. Local fishermen around the beel were not involved in its fishing, but fishermen were hired from other districts. Though the lease was granted to the Monica FCS, all fisheries management activities were executed directly by the local PROSHIKA officials;

- At Karcha Nadi, the MOL leaseholder charged exorbitant rents or fees for different fishing gears belonging to fishermen. They also took away the bigger share of the catch from the fishermen. The role of the leaseholder is exploitive and the actual fishermen working in the fishing grounds remain deprived and perpetually poor. The system encourages overfishing of stocks as both fishermen and leaseholders are motivated to maximize profit, making it extremely difficult to enforce fish protection and conservation measures.

The following recommendations were put forward:

- Implementing a programme of research on floodplain fish stock assessment and biology;

- Enforcement of the various rules and regulations of the Fish Act 1950;

- Implementation of a carp fishery management programme (as proposed in the UNDP/FAO Study 4.1 above);

- Gradual change of all inland fisheries from leasing to licensing system;

- License fee levels to be set to allow maximizing benefits to fishermen, and recovery of GOB investment and operating expenditure;

- Organization of viable fishermen associations (with possible involvement of NGOs);

- Institutional credit to be provided without collateral, but linked to renewal of licenses.

- Possible disbursement of credit through NGOs;
- Strengthening of fishermen cooperatives;
- DOF's management to be extended into the marketing network, in order to increase benefits to fishermen;
- Fishermen cooperatives to include smallscale fish vendors and women involved in net making and repair;
- Fishermen associations to function as service cooperatives for input acquisition and sales of produce;
- The policy of issuing licenses to fishermen directly for harvesting of fish under NFMP should be continued and sustained. This policy should be introduced in all GOB-owned inland water fisheries in a phased manner;
- The delays and difficulties in credit disbursement are properly monitored at different levels within the DOF and MFL. Credit supply through NGOs with active coordination with DOF officials should be explored. Possibilities of extending credit to licensed fisheries through the Bangladesh Rural Development Board should also be examined;
- Fish traders should be motivated to adopt gradually modern post harvest practices. Changes to the fish wholesaling system of *aratdars* should be done carefully;

Assessment of study: A massive quantity of useful new field data is presented in the report. The recommendations are generally progressive, and equity/efficiency promoting. However a strategy for implementing the recommendations is not presented, nor can an underlying strategy be surmised.

4.4 DOF/BCAS/ICLARM, 1989, Inland Fisheries Management in Bangladesh.

This document consists of papers presented at a workshop on open-water fisheries management. One important critique presented by one author of the debate on licensing versus leasing, is that although the licensing system appears to be 'pro-fishermen' and the leasing system yields more revenue to GOB, neither system has been able to solve the basic problems confronting fishermen and fisheries development in Bangladesh. The author notes that " leasing, which is a blatant form of anti-productive use of the fisheries conforms more closely to the existing socio-economic structure, whereas licensing system is bound to degenerate into all the vices of the leasing system within the existing socio-economic structure. On the other hand, a licensing system has the potential to fulfil the objectives of production and equity in the fisheries sector only after the basic structural reforms have been carried out in Bangladesh." Reform calls for political mobilization of the rural and urban poor including genuine fishermen, but the author does not indicate how this is to come about.

Another paper carries out a conventional bioeconomic analysis of river *ilish* fishing and concludes that there is a prevalence of substantial pure profits and resource rents. High implicit wage rates clearly showed that fishing yields higher returns to labour relative to other economic activities.

The study maintains that fishing activity is undertaken by fishermen because it is relatively more profitable.

The workshop produced the following summary recommendations directly pertinent to management:

- Strict enforcement of the Fish Act, and provision of adequate manpower for implementation of NFMP principles should be ensured;
- Conservation and propagations of resources should be ensured through supplementary stocking and protection by specific regulation (ie closed season, closed area, mesh size, etc);
- The licensing system under NFMP has shown beneficial effects to poor fishermen and should be extended;
- Necessary credit to poor fishermen should be provided from institutional sources. Creation of a separate Fishery Bank is proposed for this purpose with increased NGO involvement;
- Conservation of fish stocks should be better addressed in the NFMP;
- DOF field level management personnel should be given training as well as facilities to strengthen their management capabilities and increase their effectiveness;
- Infrastructure, training, extension and organization of fishermen should be promoted through institutional efforts;
- Direct subsidy and support for poor fishermen should be provided;
- Sharing of benefits within the fishermen group should be more equitable;
- The licensing system should commensurate with scarcity value of the resource.

Assessment of study: The value of the study lies mainly in the analytic findings and some of the concepts discussed, rather than the recommendations (most of which are repetitive of previous studies). The fisheries sector is portrayed as actually (and potentially) profit-rich and thus attracts power elites which fabricate social structures that channel much of this profit to elites. The share of profits yielded to labour (genuine fishermen) is minimized to the extent possible, given labour's opportunity cost and its awareness of fishing as a profitable economic activity. No strategy is presented for altering this situation.

4.5 BARC, 1989, Proposed Fisheries Policies for Bangladesh.

The study describes problems and negative impacts in implementing the NFMP licensing system. These include:

- Fishermen compete to get licenses for more productive fishing gears, and only the richer more powerful fishermen would win out in this competition. Similar competition also took place over strategic locations for setting gear in a given water area. Poorer fishermen tend to become excluded, and end up limited to low-productive gear and inferior locations;

- Seasonal and part-time fishing is not compatible with the provision of licensing for a tenure period of one year with a fixed license fee. Part time and seasonal fishermen enjoyed greater flexibility under the leaseholding system;

- Fishermen have difficulty raising the full amount of the licence fee, which is required to be paid all at once at the beginning of the fishing year before any income from fishing has been realized. This burden is in addition to the amounts needed to invest in fishing craft, gear and other fishing equipment at the beginning of the fishing year. Middle men leaseholders were more flexible with regard to payment of tolls, as fishermen were able to raise the amounts from their day-to-day incomes during the fishing season.

- There is resistance against the licensing system from local influential people and middlemen. This takes the form of non-cooperation with GOB agencies implementing NFMP and closing of credit links and capital financing to fishermen;

- Fish stocks are depleted in some waters, and poor fishermen are unwilling to take out licenses as they do not anticipate catching enough fish to earn an adequate profit;

- Genuine fishermen do not have any effective representation because the various fishermen cooperatives and associations consist almost entirely of landlords, leaseholders, middlemen, *aratdars* and other non-fishermen who opportunistically use these organizations as vehicles to become wealthy.

The report makes a series of management recommendations (stocking of water bodies, implementation of the Fish Act, improved credit, research programme in open water fisheries, direct marketing of fish by fishermen, establishment of fish sanctuaries) which are similar to those of previous studies.

Assessment of study: The report is valuable in showing how professional fishermen and seasonal/part-time fishermen are differentially benefitted or disbenefitted by the leasing and licensing systems, thus underlining the need to expand NFMP to include management measures which address the particular needs of the various categories of fishermen. It also stresses the blockages to access that the license fee and the lack of credit represent to poor fishermen, which undermine NFMP.

4.6 GOB, 1989, Fourth Five Year Plan (1990-95), Fisheries.

The Fourth Five Year Plan (1990-95) describes the objectives, targets, strategies and policies adopted by GOB for the management and development of the fisheries sector. The Plan sets as its objectives increasing fish production for domestic consumption, improving socio-economic conditions of fishing communities, creation of additional employment opportunities, enhancing fish production and management technology, training manpower, increasing foreign exchange

earnings from exports and improving the environment and public health. At the strategic and policy levels, the Plan considers fisheries as a priority sector to generate additional employment opportunities and alleviate poverty of the rural community. A well-defined land and water utilization policy is to be framed on the basis of land topography, monsoon and tidal inundations, water salinity, soil quality and other environmental and economic factors for optimum utilization of resources. Guided by this policy, the low-lying areas, riverine and coastal areas, sweet and brackish water areas including khas lands are to be optimally used for culture of shrimp and suitable fish species. The yearly leasing of inland open waters will be replaced with the licensing system under the New Fisheries Management Policy. Simultaneously, an investment and management oriented leasing system covering at least four years or more is to be adopted to ensure higher production and resource conservation.

A set of 12 strategy and policy measures are put forward to achieve the Plan objectives. Of particular importance to the floodplain fisheries of the region are the following measures:

(i) Biological management of jalmohals by providing fishing rights to the genuine fishermen and gradual replacement of existing leasing system,

(ii) Large-scale stocking of inland open waters, inundating flood lands with rigid enforcement of fish and fish habitat conservation practices,

(iii) Community-based integrated development approach for artisanal fisheries with improvements in technology, processing, marketing and distribution facilities,

(iv) Formulation and implementation of a well-defined land/water policy to avoid wasteful resource conflicts, along with effective measures against dumping of industrial and other wastes into the open water system and use of agricultural biocides of long residual effects.

The Plan lays out a framework of activities based on these strategy/policy measures:

Environment: Coordination among water resources development agencies in planning and designing of water projects for properly managed fisheries would be stressed. This would involve adequate provisions in such projects for losses in the fishery sub-sector in arriving at economic viability and justification. In addition, enforcement of laws relating to treatment of wastes would be emphasized for regulation of harmful discharge of agrochemicals and industrial effluents into the water systems.

Fisheries Management: In order to initiate proper management of fisheries resources, emphasis is to be given on promulgation and proper execution of adequate fish conservation laws through revision of existing laws on the basis of biological studies of commercial fish species. With a view to ensuring benefits to the fishing communities and licensed fishermen, two systems of management — licensing system as per New Fisheries Management Policy (NFMP) and modified leasing system — will function simultaneously. The existing yearly lease system will be replaced by a longer term of at least four year period to encourage appropriate investment, better management and higher production and to allow the fish sufficient time to grow to maturity and breed. Subject to successful implementation, the NFMP will gradually replace the leasing system.

Inland Fisheries Development: Inland open water fisheries will be developed through effective management and conservation measures of riverine fisheries and floodplains. Massive artificial stocking of open waters such as rivers, flood lands, beels, haors, and lakes with fish fingerlings will be done and biological management and fish habitat conservation practices would be strictly observed. Selected species to be stocked will include Chinese and Indian carps as well as Magur, Koi, Punti, Golda prawn, and so on. Short time stocking with miscellaneous species of small fish in the sluices, dykes, floodplains, reservoirs etc. will also be encouraged during the monsoon season. For development of floodplain fisheries the selected areas would be Rajshahi, Khulna and Dhaka Divisions including Sylhet and Mymensingh floodplains. More floodplain areas will be taken up for development during the Fourth Five Year Plan through improved management and conservation practices. The protection and conservation measures will include:

(i) rigorous implementation of fish protection and conservation act,

(ii) establishment of fish sanctuaries,

(iii) exploitation of non-sanctuary perennial beels,

(iv) strict enforcement of the ban on jatka (Ilish fingerling) catch during February-April,

(v) heavy penalization to the users of current jal,

(vi) imposition of penalty on the industrial dumping of untreated and harmful industrial wastes into any open water system,

(vii) fisheries development and conservation in flood control, drainage and irrigation projects etc.

The Plan sets the following targets for the fisheries sector:

- Increase fish production from 847,000 tons in 1989/90 to 1,200,000 tons in 1994/95. Inland capture fisheries production in 1994/95 would increase to 523,000 tons, and inland culture fisheries production to 415,999 tons.

- To export 45,000 tons of prawns and shrimp (head on), 17,000 tons of fish and fish products and 2,000 tons of other aquatic organisms,

- To generate full time and part time employment opportunities for about 1,000,000 people by 1994/95.

Assessment of plan: A key provision of the plan is to replace the leasing system with fishing rights through NFMP licensing to genuine fishermen. However at the same time it proposes to extend the leasing system to four years or more. The plan does not acknowledge any incompatibility between these two measures. It even stipulates that NFMP will gradually replace leasing only if experience shows that the former can be successfully implemented. The implication is that leasing has already passed such an implementability test. Given this proviso for NFMP implementation and the obvious strengthening of the leasing system, there is no indication of a clear intention in the plan by GOB to transfer access, tenure and management of

floodplain fisheries to genuine fishermen. The plan can be seen as an attempt to salvage the leasing system as a vehicle for collection of government revenue. The main support programme to achieve this is massive floodplain stocking.

4.7 WB, 1991, Bangladesh, Fisheries Sector Review.

The report reviews the performance of the fishery sector over recent decades. It presents a national fisheries development strategy that has the following key elements:

- Inland fisheries should be given the highest priority. Development, promotion and conservation programs should be directed at carp and *ilish;*
- The public sector (ie GOB) should restrict itself to construction of necessary infrastructure, R&D of improved fisheries technology, combating fish disease, conservation and rehabilitation of fisheries resources, stocking public waters, and enforcement of the Fish Law. The public sector should not involve itself in activities that can be done by the private sector;
- Fisheries institutions need to be strengthened, and the fisheries administration must become a trusted partner of the private sector;
- The cost of public sector expenditures for infrastructure and floodplain stocking, aimed at stimulating private sector investment, should be recovered and the use of subsidies minimized;
- Special assistance should be directed to fishermen, because they often do not benefit from existing government programmes;
- NGOs should become more involved in the fisheries sector. NGOs need to acquire better training in fisheries, and to gain access to development resources for use in the fisheries sector. Special focus of their activity should be: to organize small fishermen (both men and women) into viable groups; to facilitate their access to fisheries resources, credit, markets and other inputs and services; and to train them in fisheries management;
- The problem of credit should be addressed by setting up special credit programmes through NGOs and the Grameen Bank to cater to the credit needs of fishermen. Bankers dealing with fisheries need special appropriate training, and coordination between bankers and fisheries extension agencies needs to be improved;
- While the public sector should undertake, on a sustainable basis, massive stocking of floodplains with carp, the private sector should be encouraged to supply fry and fingerling for public stocking;
- The types of infrastructure that the public sector should finance for the development of the fisheries sector are: development of polders; rehabilitation of closed public water bodies; the development of fish landing sites, wholesale fish markets, cold storage, ice factories, refrigerated transport vans and auction yards; establishment of research, extension and training facilities;

- There is a need to forcefully implement conservation measures in open water capture fisheries, including protection, rehabilitation and management of existing natural stocks and the reduction of water pollution. There is also a need to develop fish sanctuaries and strictly enforce the Fish Act 1950 (amended in 1982).

- BFDC's scope of activities should be drastically curtailed to those that cannot be undertaken by the private sector;

- Cost recovery of the floodplain stocking programme must be substantially increased. The impact of cost recovery on nutrition, revenues, equity and administrative costs should be assessed. Keeping in mind that commercial fishermen are among the poorest people in the country, it is essential to determine the benefits, beneficiaries and their location before attempting to recover costs.

- NGOs should be encouraged to organize commercial fishermen, and the fishermen groups should be encouraged to participate in both the NFMP licensing system and the MOL leasing system. The latter should be modified to allow their participation and increase the length of the leases.

- Aside from construction of market infrastructure, there is need to undertake market research and market implementation regulations;

- A program specifically formulated to expand the role of women in fisheries needs to implemented. Aside from the present net weaving, women could be involved in purchasing fishing boats and managing water bodies. The program would need to provide credit and extension;

- The number of women on GOB agency staff dealing with fisheries should be increased. This would help generate the information needed to design programmes for expanding the role of women in fisheries.

Assessment of study: The report is objective and critical in its analysis of the fisheries sector, and creative in many of its recommendations. Two important areas are however not adequately developed:

1) There is no clear recommendation on the issue of increasing the number of jalmohals under NFMP. By advocating a 'duality approach' (ie fishermen groups to participate in both leasing and licensing), the report avoids taking a decisive policy and programme stance. The report thus offers no concrete proposal for making new headway in dealing with the issue, or strengthening and consolidating the gains already made to date by the fisheries sector through NFMP;

2) The issue of expanding the role of women into fish marketing is not addressed at all, while the recommendation for women to purchase fishing boats is rather surprising, and though not impossible, is not particularly realistic. Increasing the number of women on fisheries institution staff is an important goal in its own right, and does not need to be justified because of possible linkage with other gender related issues.

4.8 DOF/UNDP/FAO, 1991, Analysis of the Constraints to and Potentials and Opportunities for Expanded Fish Production in Bangladesh.

The study presents a detailed analysis of the fisheries sector. Particularly important is the discussion on the "serious reality gaps (which) exist in fisheries planning in Bangladesh." Comparison is made between the various intended actions and targets of the Fourth Five Year Plan and the actual events and achievements. Fisheries planning in Bangladesh is judged to be frequently idealistic where every idea or potential and opportunity is a priority (a quick-fix approach to problems). "As a rule, quantum leaps in targets or performance are expected." The study argues in favour of a more gradual phase-by-phase or incremental approach to planning. The study also points out that planning in Bangladesh is still carried out sector by sector. Inter-sectoral linkages, interdependence and impacts thus receive inadequate consideration, resulting in multi-resource use conflicts which generate financial losses both within the fisheries sector and among other linked sectors.

The main thrust of GOB public expenditure programmes in fisheries is artificial floodplain stocking. However the impacts of this programme are poorly monitored, and there is no evidence that a positive impact on fish production is being achieved. Stocked fingerlings suffer high mortality rates, either from natural causes or by being fished out/caught a few hours after their liberation. It is not clear why policies emphasize inland open water fisheries through massive stocking of fingerlings when the returns from such investments are not yet economically or financially assessed. The study suggests that the expenditure on stocking 34 million advanced fingerlings in rivers would likely bring a higher return per unit of investment than if stocked in semi-closed waters such as haors.

The report calls attention to the biologically and economically damaging effects of the harvesting of juvenile *ilish* (*jatka* fishing) in rivers from February to May. If the *jatka* were allowed to grow to 1 kg size, an additional 220,000 tons of *ilish* could be harvested. For a small investment in fisheries surveillance from public funds, a disproportionately higher net income and benefit could be realized.

It is noted that a strong correlation exists between infrastructure development and improved income levels of the people where these infrastructures were constructed. "It is obvious that the government has not done enough for infrastructure construction and development in the villages in general and in remote and isolated villages in particular". Post-harvest losses from capture fisheries are estimated to be about 20%, though it is claimed that nothing is wasted. Investments in landing/market infrastructure and improved handling and processing would recapture a large part of this loss.

Fisheries credit programmes should be modelled on Grameen Bank; it is assumed that no liberal credit policy or special concessions need to be extended to ensure their success. The main requirements are that: 1) those implementing the credit programme be fair and honest, 2) the fishermen do not have the perception of being exploited by the programme, and 3) the Grameen credit programme model be adapted and modified to suit the needs of the fishing community.

The study recommends that GOB's main fisheries development thrust should be to actively promote aquaculture and management of fisheries in open waters and the importance of fisheries law and regulation enforcement for stock conservation.

Assessment of study: The coverage of the sector is very uneven. Nothing is said about jalmohal leasing or NFMP. The role of women in fisheries is inadequately dealt with. The coverage of floodplain stocking is however very useful.

4.9 ICLARM, 1991, A Model to Determine Benefits Obtainable from the Management of Riverine Fisheries of Bangladesh.

This microeconomic study constructs an operational model of Bangladesh river fisheries, based on two submodels (bioeconomic production and market). It is used to analyze the performance of river fisheries under different simulated technical, economic, and biological conditions. The architecture of the model follows fisheries microeconomic conventions, and the effects of changing the value of one variable on any other variables can be readily calculated. For example, "a 25% decrease in the cost of harvest would allow aggregate efforts .... to expand by 54%, theoretically increasing the total landings by 33% and total net benefits by 63%....consumer surplus would increase by more than 500%... while producer surplus would increase by only 25% from the Base Model levels. " A large series of such simulation results are presented, including breakdowns by species (*ilish*, prawn, carp, catfish, miscellaneous).

The study concludes that the major concern is the presence of an oversized effort capacity (18% greater than the optimal level of effort) which dissipates part of the potential unrealized benefit that the fishery is capable of yielding. The other portion is dissipated as monopoly profits by the leaseholders who act as middlemen between the resource owner (GOB) and the resource harvesters (fishermen). GOB gets only a token amount of this benefit through open auctions of fishing rights. Solutions to the problem could come about through the intervention of "a management entity capable of controlling the intensity of effort." GOB taxation should be of differential intensity depending on the relative benefit potential of each fishery. The model predicts the highest benefit potential for the prawn fishery, followed by miscellaneous fish, catfish, carp and finally *ilish* as the lowest.

Assessment of study: A major (admitted) shortcoming of the model is that it does not take into account the impact of reduced broodstock on the production of recruits. Thus, model outputs referring to increased benefits arising from increasing effort are unrealistic if the level of effort is already greater than the optimal MSY level. Another weakness is the use of BFRSS data to construct the model as the accuracy of this data is questionable. The model therefore probably has more value as a pedagogic tool than for prediction or policy formulation.

4.10 ICLARM/FF/DOF, 1992, Redirecting Benefits to Genuine Fishermen: Bangladesh's New Fisheries Management Policy.

The report briefly describes some recent experiences with an NGO-led support project for 21 NFMP fishermen associations (of which seven are in the Northeast Region). The objective of the intervention was to solve three outstanding problems identified as negatively affecting NFMP fishermen associations:

- The absence of institutional funding forced licensed fishermen to resort to middlemen moneylenders for supply of equipment and operating capital. This resulted in a disproportionate share of fishing revenue going to middlemen;

- Lack of control over fishing effort to keep exploitation pressures at a level that stocks could sustain, and the absence of adequate assessments of exploitable biomass and allowable fishing pressure;

- Lack of alternative and supplementary income generating sources to divert pressure on direct fishing, which is generally in excess of what is required to sustain the current level of production.

DOF chose to work in partnership with NGOs and fishing communities to solve these problems by: 1) increasing the participation of local fishermen in managing the fisheries; 2) utilizing NGO resources for input support to fishermen in place of middlemen; and 3) mobilize NGO experience in human development training and organization building to create alternative or supplementary income opportunities for fishermen (thereby reducing pressure on the fisheries).

In order to solve the problem of non-fishermen becoming listed as genuine fishermen, a joint committee consisting of various government departments, representatives of fishermen's associations and NGOs was to be empowered to identify and list all persons dependant on fishing as their primary source of income, and approve the issuance of licenses to listed fishermen by the thana fisheries officer (upon submission of proof of payment of a predetermined license fee).

NGOs are to organize licensed fishermen into groups and provide the following services:

- human development training;
- training and motivation to create awareness for conservation of fishery resource;
- group formation;
- organizing savings and collecting of savings fund;
- provision of credit for fishery related and other income generating activities.

Promising trends have been reported at two locations. At Kalner Haor, fishermen have begun practising self-regulation through adherence to a fishing schedule arrived at by consensus. The schedule has the objective of setting the harvesting rate at a level that would maintain the productive capacity of the waterbody. The fishermen have agreed to compensate for the cost of inputs according to their marginal contributions, and any excess income is distributed equally to the group members as dividends from the fisheries stock.

Self-regulation also was being practised by 150 fishermen at Hamil Beel. Through a process of consensus, it was decided to institute a closed season during the early monsoon to allow fish to breed and to allow the young to grow to a marketable and harvestable size. Fishermen groups have also begun artificial stocking to enhance and replenish fish stocks in the beel.

Such emerging trends are expected to continue and lead toward ultimate goals of "empowerment of the fishermen as a class through their increasingly effective control of the fisheries and of inputs which the middlemen used to provide at usurious rates." The study concludes that a process of evolution is underway from what used to be open access, over-exploited fisheries into community-managed common property fisheries which have the potential of becoming sustainable over the long term. Under NFMP fishermen can be motivated to increase their sense of ownership of fishery resources, thus facilitating both the conservation of resources and the protection of community interests.

Assessment of study: Although the report is a brief conference document, it is important in providing evidence (which is not unexpected) that Bangladeshi fishermen will invent and practice rational and effective resource management measures if they have some security of tenure over the resource and freedom from usury credit exploitation for inputs. NFMP is thus capable of being modified to incorporate community-based fisheries management regimes and, in so doing, becomes much more effective in meeting its overall goals of improving incomes of genuine fishermen and managing the fishery resource to sustain high rates of yield over the long term. The involvement of NGOs at field extension level would appear to be of significant utility in making community-based management a workable proposition under Bangladesh conditions.

4.11 DOF, 1993, Wetlands and Fisheries.

This paper describes the general physical, biological and social aspects of floodplain fisheries. Four groups of constraints to development are described.

Biological constraints are described from the perspective of a central agency with management intentions. It is not possible to assess the status of fish stocks at any point in time or determine the optimal measures required for the future, partly because of an infirm database. There is an inability to interpret the complex spatio-temporal changes that are occurring in the fish populations of the river systems.

Environmental constraints are inadequate flows in rivers resulting in critical water levels for breeding and minimum levels of water during the dry season not being met. This is due to a high rate of water abstraction. Water pollution from industrial, municipal and agricultural sources is a second environmental constraint.

Legal constraints centre around lack of appropriate machinery to enforce the Fish Act. Many fishermen are not even aware of the regulations. The regulation of fisheries is made complex by the common property nature of fishery resources, difficulties in enforcing a limited access concept, divergent auctioning and leasing policies and multiplicity of agencies that control the water resources.

Socio-economic constraints are several. "Fishing is considered as a low profession and fishermen are socially, economically and educationally backward, lacking financial resources." Seasonality and unstable catch composition results in many fishermen operating only part-time. Infrastructure and supporting services are inadequate. There is a lack of proper marketing and distribution channels. Institutional finance is not available to riverine fishermen as they cannot fulfil the conventional qualifications for securities and collateral.

Because of increasing demand and shrinking resources at a time of proliferation of new technologies, problems have become more complex and can no longer be solved on a piecemeal basis. Resource managers, resource users, fishery scientists, and political scientists have failed to evolve a harmonious value system for management of a common resource.

A series of measures and approaches are proposed to overcome these constraints:

- Holistic and basin-wide approaches need to be adopted, involving watershed protection, developing industries, planting crops, adopting programmes on health and education and people's participation;

- A judicious water allocation policy for various sectors taking into consideration biological threshold levels;

- A suitable model to predict the physical, biological and economic consequences of effluent discharge from industries and their impact on biotic wealth;

- Conservation of fish biodiversity should be addressed at both technical and policy levels;

- The utmost caution should be exercised in introducing any exotic species;

- Development of infrastructure, technology and human resources for better management should be given emphasis;

- People associated with fisheries management need to acquire through training and technology transfer adequate levels of knowledge, ability and skill to competently carry out their tasks;

- The process of formulating and implementing management measures must involve all concerned groups including fishermen, scientists and administrators. Fishermen are more likely to comply with management measures when they are in a position to see the benefits which will arise from the adopted measures.

- Credit facilities have to be made available to small scale fishermen on terms and conditions in keeping with their weak economic and social conditions.

Because of their high vulnerability to threats, the attainment of sustainable development of wetland fisheries will require drastic changes in policy.

Assessment of study: The report is important in laying out the conceptual strategy of the DOF in dealing with development issues confronting floodplain and wetland fisheries. The strategy is generally well targeted. Lacking however (and possibly it is not within the intended scope of the report) is the description of an operational strategy on how to implement the conceptual strategy.

4.12 Conclusions

Previous studies have revealed a number of factors and trends which are of crucial importance to the further development of floodplain fisheries in the region and which must be taken into account in project formulation:

- The 300 jalmohals that have come under NFMP represent a positive advance in what must be considered an evolutionary process (that will take some time to complete) to establish an equitable and cost-effective fisheries tenure and management regime in Bangladesh. Failures, problems, and shortcomings of NFMP are all correctable and must

be corrected. The positive step forward that NFMP represents must be strengthened, consolidated and secured. There is no way forward other than based on what has already been achieved by NFMP.

- Fishing communities, if awarded security of tenure over adjacent fishery resources, and if freed from usury exploitation by middlemen, will gravitate towards self-regulation and other forms of community-based fisheries management which are characterized more or less by the attributes of development: equity, efficiency and sustainability. Fisheries development projects which do not contain long term tenure, credit and moderate license fees for genuine fishermen as central core architectural elements will not be of significant benefit to fishing communities and will not result in resource conservation, but will de facto serve other interests detrimental to fishing communities.

- Artificial floodplain stocking is unlikely to be an effective approach to reverse the trend of declining floodplain catches. Not only is it difficult to demonstrate a significant marginal increase in production due to stocking, the cost is unlikely to be sustainable or recoverable. Hatchery outputs are better directed to pond culture where containment and intensive management result in high survival and growth.

- The security and expansion of wild broodstock is more likely to be the key to recovery and long term sustainability of the floodplain catch. Sanctuary programmes at carp breeding grounds and overwintering refuge river duars are thus of primary importance.

- A significant marginal gain in production (which requires a relatively minor financial investment) is waiting to be realized if the protective measures of the Fish Act are enforced. Clearing of fixed engines from river channels and control of the *jatka* fishery are the main tasks to be accomplished by an enforcement unit.

- There is at present no real programme to improve, enhance and expand the role of women in the fisheries sector. In the case of women in fisheries, the opposition comes partly from male fish traders and retailers who would be threatened by the movement of women into fish marketing. Social strictures concerning the handling of money by women are changing because of socio-economic developments and changes throughout the country. A greater role for women in fish marketing could be facilitated by appropriate programming.

- The presently installed infrastructure at landing sites, and at wholesale and retail fish markets is not only inadequate to deal with the present volumes of marketed produce, but will be insufficient to handle the expected volumes needed to meet increased demand from urban populations in the future.

The most promising strategic elements and measures of the above studies have been assembled and integrated into a fisheries management programme for the Northeast Region which is described in Chapter 6.0

5. WITHOUT-PROJECT TRENDS (NULL OPTION)

Independently of any management and development in the fisheries sector, certain trends will be occurring in the area:

- Continuing increase in fishing effort: As population increases and landlessness increases, more people will resort to fishing on either a seasonal or a full-time basis. Lack of government enforcement capability and inadequate tenure of key fishery resources by core professional fishermen associations will result in over-running of fishing grounds by various groups of short-run optimizing harvesters. The increasing fishing effort will depress stock abundance.

- Continuing decline in fish biodiversity: Increasing effort will sequentially deplete existing fish stocks to the point of regional extinction of vulnerable fish species.

- More feeble stock recovery: Years of high monsoon flood intensity normally result in strong year classes and a recovery in stock levels. More intensive fishing during 'dry' years will result in a less vigorous stock recovery during 'wet' years.

- Decreasing incomes and taxes from fisheries: Reduced stock abundance will decrease returns to capital and labour interests in fisheries. Lease and license revenue to GOB will in turn also decrease.

- Increasing real fish prices: Regional population growth and rapid urbanization will increase demand in urban markets. In the face of declining supply, this will force real prices up and attract more subsistence fish into the commercial stream. A decline in rural fish consumption will result, and rural dietary protein deficiency will increase. Urban protein deficiency will also increase after a certain time, since dietary need will likely eventually surpass available supply. Pond production will increase in response to increasing real prices, but will not be able to fully compensate for losses in floodplain catch, as pond producers are interested only to supply the top end of the market (ie carp and prawn).

- Increasing imports of cheap food fish: Supply deficits and increasing dietary protein deficiency will force GOB to liberalize (ie reduce import tariffs) the importation of food fish.

6. PROPOSED FISHERIES MANAGEMENT PROGRAMME

6.1 Rationale

The Fisheries Management Programme proposed by NERP provides for a set of management and development inputs to the openwater capture fisheries of the Upper Meghna River floodplain in the production and post-production sectors. It will increase floodplain fish production by a significant amount, provide for a higher degree of equity in the distribution of benefits from the fishery to the producers, help to ensure the sustainability of production over the long term and distant future, conserve floodplain fish biodiversity, develop human resources and improve marketing infrastructure.

6.2 Objectives

The objectives of the project are:

- to provide biological management and development support to some 60 existing NFMP fishermen associations, and to 60 new fishermen communities (CBM);
- to provide management and development support to some 100 rural communities that have tenure and access to community jalmohals *(mohalshamil jalkar)* used for subsistence or commercial fishing;
- to establish and support improved management systems for the five mother fisheries in the region;
- to establish and support a river fishery patrol force to curtail fishing in duars and carp spawning ground fish sanctuaries in rivers, prevent placement of katha in rivers, and control jatka fishing and the use of illegal fishing gears;
- to construct fish landing facilities and wholesale fish market halls at eight important fish collection centres.
- to construct six municipal retail fish markets in district headquarter towns;
- to establish a FRI floodplain fisheries management and fish processing station with mandate to carry out research and training in floodplain fisheries management and freshwater fish processing.

6.3 Project Description

6.3.1 Support to NFMP & CBM Fishermen Associations

Rationale: GOB initiated the NFMP in 1986, but there has not been an effective support project to strengthen the fishermen associations under NFMP. To support the NFMP programme the following is proposed:

Programme activities: Nine activities are proposed:

- Literacy programme for fishermen and women fish processors;
- Business skills and small enterprise management training;
- Biological fisheries management training;
- Formulation of fish harvesting programme;
- Formulation of fishery resources conservation measures (gear restrictions, size limits, closed season, sanctuary katha, surveillance and resource protection);
- Construction of community fishing centre (coop office, meeting hall, gear loft, kitchen, tubewell, toilet);
- Introduction and training in improved post-harvest practices and processing techniques;
- Provision of engine boats with insulated holds for transport of fish to collection centres or municipal fish markets;
- Provision of capital to activate the fisheries credit window of the Krishi Bank under a revolving loan fund scheme for purchase of nets, fishing boats, transport boats, katha and fishing licences.

Required action by GOB: The following actions are required by GOB in order to allow this programme component to proceed:

- Increasing the number of jalmohals under NFMP from the current 60 to 120;
- Revision of the licence fee of each NFMP jalmohal to 1% of its current assessed value of the fish production;
- Increase the length of the tenure period and make it renewable afterwards;
- Arrange that the Krishi Bank activate its fisheries credit window for NFMP fishermen associations.

6.3.2 Support to Community Jalmohals

Rationale: Beels of 1.2 ha or less area and certain other jalmohals known as *mohalshamil jalkar* are under various forms of community access and tenure for commercial or subsistence fishing. The value of these jalmohals to rural communities can be increased through appropriate management and development initiatives. This project component will provide the needed support.

Programme activities: Four activities are proposed at approximately 100 localities:

- Assist in the formulation of fish harvesting rules;

- Education in biological fisheries management;

- Formulation of fishery resources conservation measures (gear restrictions, size limits, sanctuary katha, surveillance and resource protection, water conservation);

Required action by GOB: The following action is required by GOB in order to allow this project component to proceed:

- Legalize and otherwise reaffirm the access and tenure rights of rural communities to designated small jalmohals and *mohalshamil jalkar* in order to prevent leasing or other incursions against community fishing rights.

6.3.3 Management of Mother Fisheries

Rationale: The five mother fisheries of the project region (Tangua Haor, Hakaluki Haor, Kaliajuri area, Companiganj area and Kawadighi Haor) require special local fisheries management systems and initiatives because of their complex ecological nature, high local and region importance and value for fish production, and vulnerability to external threats. In all mother fisheries, the central management objective must be to limit fishing effort to a level which does not undermine the role of the mother fishery in regulating regional fish stock abundance. It is therefore appropriate and necessary that MFL/DOF play a participatory role in their management in order to safeguard the rights of downstream fisheries to a 'share' of the excess production of the mother fishery. Implicit in this arrangement is the fact that downstream fisheries 'give up and entrust' a significant part of their fishery resources to the mother fisheries during the pre-monsoon period when a number of important fish species migrate to the mother fisheries to breed. Mother fishery leaseholders and fishermen thus need to be regarded as custodians of an important and key part of the region's entire fishery resource. The responsibilities of mother fishery custodianship must take into account the fact that mother fisheries are the ultimate sources of fish biodiversity and seed for natural restocking in the event of localized resource depletions or extinctions in downstream fisheries. This function is of high regional priority which must be rendered secure and must over-ride any local harvesting objectives which threaten this trust. This project component will introduce a management system appropriate to mother fisheries. The locations of the five mother fisheries are shown on Figure 1. Details of the fisheries are shown on Figures 2 to 6.

Programme activities: Eight activities are proposed:

- Assist the fishing community in establishing a single consolidated fishing company in each mother fishery;

- Literacy programme for fishermen and women fish processors of the fishing company;

- Biological fisheries management training of the fishing company;

- Assist the fishing company in formulating annual and medium term fish harvesting plans (number of katha and harvesting schedules, beel rotation). Approval by DOF will be a requirement for implementation of the harvesting plans. As a guideline, the total allowable catch for a mother fishery should not exceed 50% of its estimated MSY;

- Formulation of fishery resources conservation measures (gear restrictions, size limits, closed season, sanctuary katha, beel sanctuaries, surveillance and resource protection);
- Construction of a DOF mother fishery management unit office;
- Establish a fish sanctuary programme in selected beels and river stretches to rehabilitate stocks of threatened fish species (*Nandina, Angrot, Sarputi, Mohashol);*
- Assist in implementing various environmental rehabilitation, enhancement and protection works (embankments to protect against sedimentation, control of agrochemicals and industrial wastes, fish passes, tree plantation [for katha branches, shade, allochthanous nutrients and wave break/erosion control], maintenance of reed lands).

Required action by GOB: The following actions are required by GOB in order to allow this programme component to proceed:

- Consolidate all individual jalmohals within a mother fishery into a single unit;
- Require that a single fishing company be formed to hold exclusive access and tenure rights to the consolidated mother fishery jalmohal;
- Establish a DOF management unit (staff, office, boats, equipment) within each mother fishery. The role of DOF within the mother fishery management system will be: 1) to approve the annual and medium term fish harvesting plans formulated by the fishing company, 2) to monitor the levels of fishing effort and catch of the fishing company, and 3) intervene when the fishing effort or the catch exceeds the approved harvesting plan provisions, or when the fishing company's permit provisions are exceeded in any other manner;
- Carry out research to develop methods for artificial propagation of threatened fish species.
- Carry out civil works designed to protect mother fishery environments.

6.3.4 River Fisheries Patrol and Sanctuaries

Rationale: The rivers of the region include two critical fish habitat types: 1) some 350 *duars* which are used as refuge habitat by *boromaach* broodstock during the dry season, and 2) a number of spawning grounds which are used by major carp and some other species for reproduction during the pre-monsoon season. The abundance of these commercially valuable stocks is being severely affected by uncontrolled harvesting in these critical habitats during these time periods. Illegal setting of katha to catch broodstock in rivers is a further threat to fishery resources, apart from inducing sedimentation of the riverbed. Uncontrolled harvesting of undersized *ilish* (*jatka* fishing) during the pre-monsoon and during the late monsoon depresses productivity of this stock. This programme component will establish a River Fishery Patrol force to curtail these harmful fishing practices and protect river fish stocks. River patrol routes are shown on Figure 7.

Programme activities: Three activities are proposed:

- Assist the DOF to establish a River Fishery Patrol force consisting of eight units (manpower training, motor boats, equipment, temporary dwellings);

- Assist the Fishery Patrol units to carry out the following tactical operations:

  - Patrol at 20 river duar sanctuaries during the dry season (November to March) to curtail all fishing in the duars;
  - Prevent the placement of katha in rivers and remove existing katha;
  - Patrol at six carp spawning ground sanctuaries (Luba River, Sarigowain River, Erali Beel, Surma River near Sunamganj and near Dwarabazar, Someswari River) during the pre-monsoon season (March to May) to curtail all fishing on the spawning grounds;
  - Patrol the Upper Meghna, Baulai and lower Kushiyara Rivers during the pre-monsoon and late monsoon to curtail jatka fishing and confiscate illegal fishing gear.

- Public education programme to sensitize fishing communities as to the objectives and benefits of the river fisheries patrol and sanctuaries programme.

Required action by GOB: The following actions are required by GOB in order to allow this programme component to proceed:

- Enact appropriate legislation to establish river duar and carp spawning ground sanctuaries, and prohibit the placement of katha in rivers and the use of certain destructive fishing gears (current jal, jam jal);

- Set up a River Fishery Patrol force consisting of eight patrol units with enforcement powers.

6.3.5 Fish Landings and Wholesale Fish Markets

Rationale: Infrastructure at the major fish landing and collection centres in the region is inadequate. This results in inefficiencies in wholesale market operations and material losses. This programme component will construct upgraded fish landing and wholesale market infrastructure at eight important fish collection centres (Figure 8).

Programme activities: Three activities are proposed:

- Assist the municipalities of Mohanganj, Jaria, Bajitpur, Kuliarchar, Bhairab Bazar, Sherpurghat, Sunamganj and Sylhet to tender and finance the design and construction of fish landing and wholesale marketing facilities. These will include floating dock, wholesale market hall, office, overnight sleeping quarters, tubewell water supply and toilets;

- Assist the same municipalities to establish market administration to operate and maintain the wholesale markets and collect market fees from fish traders.

- Hold training courses in improved fish handling and preservation methods for fishermen and fish traders.

Required action by GOB: The following action is required by GOB in order to allow this programme component to proceed:

- Identify and acquire an appropriate construction site in each municipality.

6.3.6 Municipal Retail Fish Markets

Rationale: Current retail fish market infrastructure in municipal centres is inadequate and unhygienic. Expected future growth in fish supply and demand at urban markets will severely overload these facilities and might put a limit on market growth. This project component will construct modern municipal retail fish markets in six district headquarter towns (Figure 9).

Programme activities: Two activities are proposed:

- Assist the municipalities of Sunamganj, Sylhet, Moulvibazar, Habiganj, Netrokona and Kishorganj to tender and finance the design and construction of retail fish market facilities;

- Assist the same municipalities to establish market administrations to operate and maintain the markets and collect market fees from fish traders.

Required action by GOB: The following action is required by GOB in order to allow this programme component to proceed:

- Identify and acquire an appropriate construction site in each municipality.

6.3.7 FRI Floodplain Fisheries Management and Fish Processing Station

Rationale: Almost no research is presently being carried out to support floodplain fisheries management and development initiatives. There is also no research effort in the area of freshwater fish processing methods and technology. This programme component will assist FRI to establish and operate a floodplain fisheries management and processing station.

Programme activities: Two activities are proposed:

- Assist FRI to establish and operate a floodplain fisheries and freshwater fish processing station;

- Assist FRI to develop a research programme and secure programme finance;

- Hold training courses in fisheries management and fish processing.

Required action by GOB: The following actions are required by GOB in order to allow this programme component to proceed:

- Identify and acquire an appropriate facility for the station (the moribund BFDC facility at Dabor is a possible candidate);

- Establish FRI staff positions for the station.

6.4 Project Organization and Management

During the early part of the feasibility study process, a number of client groups would need to be organised to review the programme. These groups would be composed of local fishermen community representatives, local fishery officers, local public representatives, and relevant departmental officers. The respective groups would ensure that the problems of the fisheries sector of the area are clearly understood and adequately reflected in the feasibility work and that the technical solutions being proposed address the problems in an acceptable manner for the fishermen community. They would be discussed routinely during the feasibility work and their suggestions would be considered in formulating the conclusions of the exercise. These groups will be active during the execution of the project to monitor the progress of work, so that the project target can be achieved in time.

In very general terms the fisheries management programme would include the following:

DOF would be responsible for administrative works of the programme. The primary tasks of the DOF includes identifying/demarcating project locations, designing and planning of project components, selection of NGO(s), approval from central government, and execution of the project.

MOL would arrange for the transfer of property as required by the programme.

FRI would investigate the fisheries resource trend through a research programme and would identify the techniques to restore the natural condition of the fishery in respect of fisheries biology, ecology, fish bio-diversity and improved fish production.

BB/BKB would provide reasonable loans to the fisheries community to pay the revenue/inputs cost through a special program, so that fishermen are bound to pay-back within the scheduled time.

Local government administrative authority would provide all logistic support to implement the project.

The NFA would assist in the organization of fishermen.

NGOs will be active in training programmes and general community development.

Organization and the institutional arrangements for each of the programme components are briefly reviewed below. These proposals will require further review during feasibility level studies.

Support program to NFMP fishermen associations:
Increasing the number of jalmohals under the NFMP would be carried out through the DOF who would be responsible for gear restrictions, size limits, closed seasons, sanctuary katha,

surveillance, and resource protection. DOF would oversee the construction of community fishing centres which would include a cooperative office, meeting hall, gear loft, tubewell, and so on. DOF would arrange for the transfer of other suitable fisheries adjacent to the present one under the NFMP, so that biological management can be ensured. MOL would be responsible for increasing the length of tenure period and making it renewable. MOL would revise the licence fee for the jalmohals to possibly one percent of the current assessed value of fish production. Through selected NGOs, fishermen would be provided with training in biological management, harvesting techniques, fish conservation measures, fish processing and marketing, business skills and banking procedures. Fisherman would also be provided with a revolving loan fund (RLF) through a special credit programme.

The NFMP fishermen association would be subdivided into different working groups (managerial, harvesting, marketing, technical and community welfare) having responsibility to maintain sustainable yield, to ensure increased production and to improve their living conditions.

It is considered that NFMP policy should continue to be implemented through the DOF at a National level. There could be opportunities to strengthen NFMP policy on an area specific basis as part of integrated project development.

Development of Community Jalmohal Management System:
MOL would need to legalize or otherwise reaffirm the access and tenure rights of rural communities to designated small jalmohals and mohalshamil jalkars in order to prevent leasing to other groups outside the local community. This would be followed up by improved biological fisheries management practices and training through DOF.

The CJM group would identify the community jalmohals in association with the local fishermen community. All communities residing around the jalmohal would be entitled to access to the jalmohal. A management committee would be formed to control the resource harvesting pattern as well as improvement of the fishery for the common interest of the community.

Development of Mother Fisheries Management System:
The MFM system would be a special fisheries management system in which harvesting and development would be carried out by a single fisheries company. This system would be developed through a committee, formed with the representation of all professional people (dominated by the fisheries sector) residing in the mother fishery area. The committee will be subdivided into two major sub-committees:

- Fisheries development sub-committee (FDS),
- Other sectoral issues sub-committee (OSS).

Each sub-committee would be formed by representatives from the different administrative, physiographic and hydrological areas to undertake various activities within the mother fishery area.

The Fisheries Development Committee would include representatives from different fishery activities in the mother fishery area. This technical committee would be responsible for maintenance of sustainable yields, conservation of fisheries resources, and rehabilitation of rare or threatened species.

DOF would be responsible to organize all the fishery units into a single mother fishery unit with the cooperation of MOL. The whole program would be implemented under the administrative control of DOF. DOF would establish management units (staff, office, boats, equipment) within each mother fishery. FRI would be responsible to carry out research activities to improve the fisheries. Selected NGOs would be involved to develop the professional skills of the fishermen and to implement social support programs for fishery community development. BWDB would carry out the necessary civil construction works under the project. BB/BKB would provide necessary loans to the fishermen to improve their production level.

To perform all these activities, this committee would be subdivided into small working groups, based on occupational criteria. The other sectoral sub-committee will be responsible to mitigate the inter-sectoral problems or to improve the inter-sectoral relations within the mother fishery area.

It is considered that the formation of the MFM systems would best be undertaken by DOF through a Regional or National level programme. There could be opportunities to develop a specific mother fisheries system as part of a local integrated development project.

River Fisheries Patrol and Development of Sanctuary Management System:
The present Sanctuary program of the DOF would be reorganized. The DOF would initiate the enactment of appropriate legislation to establish river duar and carp spawning ground sanctuaries. The Ministry of Home Affairs would provide support. The DOF river patrols would enforce the legislation. A Sanctuary Management committee would be formed which would include representatives from all villages near the sanctuary. The committee would liaise with the DOF patrol units responsible for controlling the fishing effort. Selected NGOs will be responsible to arrange a regular motivation program for the local people. They would also assist the local communities to identify and develop opportunities for alternative employment during the closed season.

This component would most efficiently be carried out by DOF as part of a Region-wide programme.

Establishment of Fish Landing Centre / Market Management:
The selection and building of fish landing ghats and markets should be carried out at the municipality level involving the private sector, local fishermen, fish traders, and the local municipal authorities. Sites should be considered for the municipalities of Mohanganj, Jaria, Bajitpur, Kuliarchar, Bhairab Bazar, Sherpur Ghat, Sunamganj, and Sylhet. Credit facilities should be made available to the private sector to encourage them to provide a supply of ice and insulated carriers with freezing systems. Facilities provided by the municipalities would include floating docks, wholesale market halls, offices, overnight sleeping quarters, tubewell water supply, and toilets.

The main thrust for the development of markets and landing centre sites should come from the municipal authorities and the private sector. DOF involvement would be small and could possibly include quality control of handling and processing. Land for the market and landing centre sites would be acquired by the municipal authority through the MOL. Market designs should meet the needs of both the fishermen and public. A management committee would be formed with representatives from the local municipality, fishermen, fish traders, ice plant operators and consumers. This committee would be responsible to control marketing of

undersized and brood fish during the ban period and would be responsible for maintaining hygienic conditions at the market.

6.5 Cost Estimates

Total capital costs are estimated at US$ 27.6 million. In addition, there will be a need to provide US$ 4.4 million for credit facilities as a revolving loan fund to support the NFMP fishermen associations.

A breakdown of the capital costs by component are as follows:

	US$ millions
• NFMP associations	7.9
• Community jalmohals	2.2
• Mother fisheries	3.4
• River patrol	1.3
• Retail markets	2.6
• Fish Landing Centres	3.3
• FRI station	0.8
• Monitoring Cost	2.5
• Contingency (15%)	3.6

Details of the programme cost estimate are given in Annex B.

6.6 Project Phasing and Disbursement Period

Ten years are required to implement the project. Two years (year zero and year one) are required for completion of feasibility studies and conducting field surveys. Preparation of detail designs should start in year two and be completed in year three. Land acquisition should commence in year two, be implemented in phases preceding construction, and be completed in year three. Procurement of equipment should begin in year two. Organizational and training activities should start in year one and finish in year ten. Monitoring activities should begin in year two and end in year ten.

6.7 Project Evaluation

6.7.1 Environmental

The key areas of environmental impact for this project are described briefly below. Additional information is given in Annex C, Initial Environmental Evaluation.

Fisheries
Mother fishery areas, carp spawning grounds and river duar sanctuaries will benefit from increased protection and conservation. The removal of katha from river channels will act to remobilize sediments and increase channel depth.

Wetland Habitats and Grazing Area
Similar benefits will accrue to wetland habitats, and of particular importance those key wetlands which are also mother fisheries.

Land Use
Some land use changes will likely result in those parts of mother fishery areas which are currently being used for rice culture. Since mother fisheries will be protected habitats and kept at a higher level of environmental quality, no support to agriculture in the form of flood control will be forthcoming. In the long term this will act to promote cessation of agricultural activity in mother fisheries and alternative use of land areas for wetland products (wetland trees, reeds, medicinal, plants).

Agriculture
A reduction of rice production from mother fishery areas will take place due to increasing flood damage risk. Some shift to other faster maturing crops will take place initially, but in the long term agricultural production is likely to cease completely in mother fisheries and be replaced by natural products harvesting.

Homestead flooding
The project will have no impact on the current level of homestead flood damage.

Transportation/navigation
The removal of katha from river channels will benefit navigation.

Higher flood levels
The project will have no impact on current flood levels, and will have a slight net positive impact on future levels which are following an increasing trend.

6.7.2 Social

The key areas of social impact (or lack thereof) for this project are described below. Additional information is given in Annex C, Initial Environmental Evaluation.

Employment
There will be a modest overall net increase in continuing employment of approximately 750,000 person-days per year. This will be realized mainly in the post-production sector, the combination of the entry of women into marketing and an increased fish supply to markets. The number of professional fishermen is already sufficient to harvest the region's sustainable yield, and under optimal conditions a moderate reduction in the number of fishermen would be prudent as a precautionary measure against over-exploitation. Minor increases in employment will be created in management positions at mother fisheries and river patrols, and in research.

Conflicts
Some conflict is expected with leaseholders who hold improper tenure of NFMP or community jalmohals and who will be disenfranchised. Lack of FCD/I programming in mother fisheries will lead to resentment and political pressure from agriculturalists against fisheries interests. Aaratadars who currently control wholesale and retail fish markets will resist opening markets to producers. Leaseholders and fishermen who currently install katha in rivers, fish in carp breeding grounds during the spawning season, use illegal fishing gears or harvest jatka will offe

resistance. Successful resolution of these conflicts is important to the success of the project. In the long term conflicts are expected to decrease.

Equity
The net equity benefit will be strongly progressive. The project will provide support to NFMP fishing communities which will increase their economic and organizational strength and remove the exploitive practices of some middlemen. It will also allow them to extend their activities into marketing and thus realize a higher part of the retail value of their catch.

Active management of fishing effort in mother fisheries, carp spawning grounds and duar sanctuaries will increase catches and further increase earnings of fishing communities.

Gender Equity
The net gender equity impact will be strongly *progressive*. New employment opportunities will be created for women in marketing and increase their economic strength. Improvements will also come about in the traditional activities of net making and fish processing. Literacy and business training will further increase female resource development and capabilities. Reduced homestead flood damage due to construction of improved flood proof housing in fishing villages will disproportionately favour women, given that most women spend more of their lives within the homestead.

Qualitative Impact Scoring
The qualitative criteria shown in Table 6.1 are scored on an 11 level scale of -5 to +5. The scoring procedure is analogous to that used in the FAP 16 EIA case studies, but simplified to eliminate half-point scores (1.5, 2.5, 3.5, etc). Here, each score sums across five equally weighted logical (true/false) criteria, with each 'true' counting for a value of one and each 'false' for zero. The sign reflects whether the impact is positive or negative.

Table 6.1: Qualitative Impact Scoring

		True=1 False=0					
Qualitative Impact	**Impact Sign**	**Sensitive**	**Magnitude**	**Immediate**	**Sustainable Pos Impact/ Irreversible Neg Impact**	**No Mitigation Required/ Possible**	**Score**
Ecological Character	+1	1	1	1	1	1	+5
Regional Biodiversity	+1	1	1	1	1	1	+5
Flood Levels Outside Project Area	+1	0	0	0	0	0	0
Conflicts	+1	1	0	0	0	0	+1
Socioeconomic Equity	+1	1	1	1	1	0	+4
Gender Equity	+1	1	1	1	1	0	+4

6.7.3 Cost/Benefit Considerations

As described in the preceding chapters the objectives of this programme are necessary, desirable, and of high priority. The proposed programme was initially formulated through the strategic planning process of the Northeast Regional Project and was further developed through these pre-feasibility studies. The cost estimates presented appear the most cost effective way of implementing the programme. No economic analysis was carried out for the project as quantification of benefits are difficult to define at this stage.

Almost all of the benefits of the programme relate to: 1) increased occupational professionalism of fish producers, 2) security of access and tenure to resources, 3) increased fish production due to much improved fishery management and a decrease in overexploitation and improved marketing and 4) increased supplies to consumer markets. The value of the lost agricultural output in mother fisheries is a minor fraction of total agricultural production, and is a minor fraction of the increase in value of fish production. A further benefit is the value of trees and other wetland products that are currently harvested from the mother fisheries.

6.7.4 Summary Analysis

From a multi-criteria perspective the programme is attractive:

Positive aspects of the programme include:

- A substantial increase in fish production.
- An improvement in fish processing.
- An improvement in fish market hygiene and capacity.
- An improvement in incomes and quality of life in fishing villages.
- The socio-economic equity impact is progressive.
- Gender equity impact is highly progressive.
- Programme responds to public concerns.

Negative aspects are considered minor. They include:

- A small loss in regional rice production from mother fisheries areas.
- A possible increase in conflict over fishery tenure and access to markets. In the long term conflicts are expected to decrease.

ANNEX A

FISHERY ANALYSIS

ANNEX A: FISHERY ANALYSIS

a. List of Jalmohals under New Fisheries Management Policy

District: Sunamganj

Thana	Name of Jalmohal	Area	No. of licenses	License fee (1991) (Tk)	% of fee realised
Sadar	Laiya Gazaria	24ha	160	140360	100
	Shapaardara	5km	25	30008	"
	84/8 Surma River	10km	49	88330	"
	Kalner haor	44ha	138	219615	86
	Mohasingh River	13km	290	83160	40
	81/5 Surma River	-	50	45211	36
	Mora Mohasingh	-	191	65591	39
	Digdair Baushi	14km	40	133233	23
	Utharia River	8km	117	84700	Nil
	83/7 Surma River	11km	66	146410	100
Dherai	Shaytankhali 1st	22ha	21	12342	100
	Shaytankhali 2nd	45ha	38	2904	"
	Shaytankhali 5th	67ha	136	73820	97
	Shoatiar River	48ha	270	79618	100
	Kashipur L.Dighi group A	-	173	146410	75
	Shasha R 1st, 2nd	40ha	54	65065	81
	Balibeel Up.bali beel	20ha	70	53155	Nil
Sulla	Ghagtia hoogly potanga beel	58ha	69	68849	100
	Moragang	23ha	72	92565	48
	Shaytankhali 6th	41ha	104	16940	86
	Kashipur L.Dighi group D	54ha	77	62956	67
	Kashipur L.Dighi group C	286ha	24	243210	17
Jamalgang	Chatidhara GF	121ha	80	249634	100
	Upper part of Jaal Baulai	37ha	84	31887	100
	Hari. N. Putia R.	-	100	36300	100
	Noya nadi/Lax. R.	-	179	84700	100
Tahirpur	Tarajan beel	12ha	40	20570	100
Jagannathpur	Kalakhai nagdora and Suraya River	130ha	233	34000	100
Dharmapasha	Boalia/Mokshed purdhighor	93ha	97	56676	100

District: Sunamganj

Thana	Name of Jalmohal	Area	No. of licenses	License fee (1991) (Tk)	% of fee realised
	Ubdakali Gomai R	92ha	68	18150	100
Chatak	Surma River 1st	109ha	298	176660	58
	Alda River	25ha	-	10981	Nil
Dowara	79/2 Surma River	96ha	526	95565	100
	Goarai Khal	11ha	36	5445	100
	Bondayhori GrF.	61ha	485	140683	41
	Borochapra choto chapra.	24ha	175	148225	22
Sub-total:	**36 Nos.**	**4635**		**Tk.3,063,918**	

District: Sylhet

Sadar	6/2 Surma R	121ha	53	77000	100
	7 Surma River	47ha	158	58300	"
Golapganj	5 Surma River	124ha	116	38500	"
Bishwanath	Bashia River	11ha	50	16998	"
	Brahmana River	26ha	165	14520	"
Balaganj	Shadipur River	38ha	37	60700	"
Kanaighat	Dauchai River	24ha	59	71370	"
Sub-total:	**7 nos.**	**391ha**	**638**	**Tk. 337,408**	

District: Mymensingh

Sadar	Brahamaputra R.	40km	522	20937	Nil
	Sreekhalir gang	10ha	25	2750	"
Trishal	Brahamaputra	11km	135	4355	73
Gofargaon	"	3km	141	4455	25
Bhaluka	Khiru nadi	16ha	235	6442	78
Fulbaria	Borabila beel	107ha	175	7330	56
Fulpur	Kharia nadi	41km	189	4840	80
Sub-total:	**7 Nos.**	**228ha**	**1422**	**Tk.51,109**	

District: Netrokona

Thana	Name of Jalmohal	Area	No. of licenses	License fee (1991) (Tk)	% of fee realised
Purba	Jaria nadi	34ha	37	5324	-
dhala	Mora nadi	17ha	20	3388	-
	Rajdhala beel	53ha	49	51387	-
Mohanganj	Shapmara khal	16ha	49	26015	-
	Beel cirail	19ha	62	9680	-
Kalma kanda	1,Ubdakhali and Hoogla beel	60ha	191	80611	F.S
Madan	Boyranala nadi	28ha	73	41343	-
Durgapur	Kongsha nadi	202ha	105	48320	-
Sub - total:	**9 Nos.**	**378ha**	**586**	**Tk. 266,068**	-

District: Kishorganj

Kuliarchar	Kalinadi jalmohal	813ha	338	25622	F.S
Kotiadi	Kutir beel	12ha	44	4000	-
Astagram	Karatia kolkolia	247ha	352	40059	-
Itna	Ujanshimul goura nadir took	195ha	249	246500	-
Tarail	Sutinadi jalmohal	9ha	64	10222	-
Mitamoin	Mois.KandiB.pur	127ha	164	49624	-
Sub - total:	**7 Nos**	**1403ha**	**1211**	**Tk. 376,027**	-

District: Moulavibazar

Sadar	Beri beel jalmoh	60ha	490	171366	97
	Kushiara R 1,2,18 part	42ha	187	41422	100
"	Burburi beel,Burijuri gang	34ha	78	56900	84
Rajnagar	Kushiara R 7P	7ha	31	13276	100
Sub-Total:	**4 Nos.**	**143ha**	**786**	**Tk. 282,964**	

District: Habiganj

Thana	Name of Jalmohal	Area	No. of licenses	License fee (1991) (Tk)	% of fee realised
Sadar	Berry beel	41ha	299	132868	76
Bania	Bhadar beel	43ha	133	177159	100
chong	Beel Firani	11ha	104	81917	100
Ajmiriganj	Gachardohor	99ha	53	393250	Nil
Nobiganj	Berry beel	30ha	214	45738	Nil
Lakhai	Dhaleswari 1st part	117ha	135	75900	66
Sub-total:	**6 Nos.**	**341ha**	**938**	**Tk. 906,830**	

(all amounts are in *taka*)

LIST OF JALMOHALS PROPOSED FOR NEW FISHERIES MANAGEMENT POLICY UNDER THIS PROJECT

Jolmohals	Area (ha)	Location
Nainda Mainda beel & part of Kalamatir	90	Dharmapasha
Kaluma River 1st & 2nd	13+11	"
Updakhali R 1st & 2nd	20	" & Kalmakanda
Dharam beel	69	Dharmapasa
Kaunai River		"
Hurua Pasua Fishery		"
Pichgang Someswari R		"
Ghoradoba beel	33	"
Monai Sunai Nadi	80	"
Deghai beel	36.19	Bianibazar
Magura beel Barobeel	44.35	
	37.95	
Meda beel	121.86	Karchar Haor
Hoogla beel Rui beel	127.28	
Benglachara doda Maijchar	620.91	Bajitpur
Jalmohal	54.96	
Jawar Makram beel	56.68	Tarail
Karati beel	53.44	Karimganj
Patlai R part 3	15	Tahirpur
Patlai R Gr Fishery	36	
Gholaghat gr Fishery	90	
Halia Kalma Gr Fish.	397	
Baulai river	53	
Rakti River Part 3	23	
Boigani gr. Fishery	442	
Badekanamuia GF	198	
Abua Nadi		
Nandina River		
Baulai River part 3	10	Jamalganj
Nayahali Nadi 1st& 2nd	46	
Bhutiarpur Nadi	170	
Balahar Nadi	27	
Beheli R 1st & 2nd	20	
Daulata Nadi	16	
Bangia Nadi Gr	24	

Jolmohals	Area (ha)	Location
Kamarkhali Nadi part 1 Kamarkhali Nadi part 2	29	Jagannathpur
Joypurhatni Fishery	162	Derai
Kashipur Lairadigha Gr fishery	162	Derai
Bardai Kastaganga Gr F	410	Sunamganj
Kalabhanga beel	74	Barhata
Barang & Tamasa beel, Ranchi beel, Chenguni kalapani beel, Pulubhanga beel Pinglar chepti beel Barajalla Farjalla beel Pliaula beel	150 69 115 143 227 483 207	Hakaluki haor
Gunga beel Roail beel		Khaliajuri (near Ballavpur)
Patasingra beel	194	Maulavibazar
Phatakuri Laukuri beel Rauti beel Burohingai beel Panichara beel Dulainhaori beel	300 60 80	Companigonj
Gajaria beel		Mohanganj
Patachatal beel, Maijal beel Karacha gr. fishery Harin Petya gr Fishery Dubria gr fishery Kalasara beel	88 139 68 57 156 58	Balaganj

a. Proposed Fish Landing Centres

Although the northeast region is a "fish mine", it does not possess any improved landing centre to maintain a supply of quality products to consumers. BFDC had taken an initiative by developing a modern fish landing centre in Dabor. Due to its wrong location and other government limitations, it is not used. Most of the prominent and important landing centres are, however, properly used, though most of these lack facilities of floating dock, water supply, drainage and sanitation. Considering the significance of the fish resources and its supply, the following fish landing centres are proposed for necessary improvement:

i) **Mohanganj, Netrokona**

Mohanganj has been used as a fish landing centre for many years. It is famous for handling the catch of *beel* fishing. The town was connected with many other important cities of the erstwhile Bengal including the port city of Calcutta. However, proper landing/handling facilities for fish never developed in this area. No specific land was allocated for a fish landing centre and no government initiative was taken for the development of processing facilities. But even at present, about 150 tons of raw fish are transported daily to other parts of the country through Mohanganj during the peak season (December to April) and about 70 tons daily in the lean season (May to November).

There are 50 *aratdars* who have their own *arat* on the railway land having 12 to 15 *nikari* (link traders). The aratdars get the supplies from the *nikaris*, the latter also having backward linkage with 50 to 60 fishermen each. The supply comes from remote areas, usually from within a radius of 50 km. About 16 small private ice plants can cover about 60% of the total fish during the peak season.

Most of the fish is carried to the market by road during the dry season (peak season for *beel* fishing). The two main roads are (i) Mohanganj to Jayasree via Dharmapasha and (ii) Mohanganj to Gaglajur Bazar. These should be developed for better communication. During the monsoon, fishes are carried by boat through the Kangsa river. After proper icing, fishes are loaded to the train for supply. Since establishment of the train communication, no improvement has been made.

ii) **Jaria, Netrokona**

Fish transportation was one of the main objectives to establish Jaria railway station, where at present, about 10 aratdars are involved in fish transportation having two ice plants of 3 tons capacity. The fishes caught in this region are mostly riverain large fish. The main season of fish is the monsoon (April to October) when most of the fish are harvested from the river comprising 70% big fish. There is no landing shed or landing facility for fish adjacent to the railway station where most of the fish are landed. At present aratdars process their fish on the land of one landowner.

About 10 t/day of fish are supplied to other places by train during the peak season (April to October) while in the lean season (November to March) about 2 t are supplied. Each aratdar is linked with 35-50 nikari who maintain linkage with other small fishermen to collect fish from the Kangsa river basin area and its tributaries. Most of the fish are carried to the landing centre by boat. Transport facilities to supply fish are deteriorating.

iii) Bajitpur, Kishoreganj

Bajitpur is an important landing centre in the western part of the region from where fishes are supplied to Gaffargaon, Katiadi, Pakundia and Dhaka. Bicycles are use for transportation of fish locally. Many people are engaged in fish trade, particularly in transportation. Fish are collected from the *haors*. But there is no proper facility for landing, processing and marketing. The people of the locality and the fishermen want to shift the market to Dighirpar (about 4 km to the haor side) which would provide better landing and processing facilities.

At present seven *aratdars* having six ice plants are involved in the fish trading. Every day each *arat* handles at least 1.5t of fish during the peak season (December to April) and 0.5t during the lean season (May to November). About 175 bicycle riders are involved daily (on average) in the transportation of fish to other places covering a distance of up to 100 km. The Bajitpur-Mothkhola-Kapasia-ZIA Airport is one such route which is regularly used by bicycle riders. As much as 30-40 Kg of fish can be carried easily on a bicycle. During the peak season, two truckloads of fish are transported to Dhaka everyday. It has been reported that the *aratdars* do not get an adequate supply of ice during September-October.

iv) Kuliarchar, Kishoreganj

Kuliarchar landing centre is located in the eastern side of the Kuliarchar market on the bank of the river (extended part of the *Ghora Utra*). The centre is shifted further to the riverside during the dry season when the maximum fish are supplied to the market from the Sylhet depression. There is no government land for the landing centre. Private land is rented for this purpose at the rate of Tk 2000 per month for a 18ft X 18ft piece of land during December to March while Tk 500-800 per month for the rest of the year. There are 17 *aratdars* at this marketing outlet. Among them, 8 possess their own land for *arat*.

About 3 tons of fish are supplied daily, 20% big and 80% small, to each *arat* during the peak season (December to March), while 1.5 tons are supplied during the rest of the year. About 50 to 60 engine boats are engaged daily to bring fish to the landing centre. About 400 traders are engaged in the marketing, each having a link with about 20 other fishermen. Ice needed for fish preservation is supplied from six ice factories and five icecream factories. *Kuliarchar Cold Storage Ltd* alone supplies ice for about 30% of the fin fish and 100% of shrimp supplied to the market. The landing centre is well linked with road and railway networks. However, these need improvement.

v) Bhairab Bazar, Kishoreganj

Bhairab Bazar fish landing centre is located in an unique place on the right bank of the *Meghna*. The landing centre is isolated from the main Bhairab town and is connected by a bridge over which very light vehicles are allowed to cross. It has been reported that, despite the land being *khas*, it has been occupied by a powerful person for a long time. Each *aratdar* pays Tk 8000 to 12000 annually as rent for the use of the land. At present, fish is only supplied to the market through waterways. About 70 to 80 mechanised boats carry fish from the *beels* during December-March and 35-40 boats during the rest of the year.

There are 58 permanent *arats* controlling the market and there is little scope for expansion due to a shortage of land. During the peak fishing season, each *arat* receives about 2 tons of fish per day. The supply drops down to 0.7-1.0 ton per day in the lean season. Fifteen to twenty fish suppliers are linked with each *arat*. They maintain a linkage with leaseholders of *beels* for the supply of fish. Fish is transported mainly to Chittagong, Dhaka, Chandpur and Noakhali. About 35 to 40 icecream producing plants meet the demand for ice in the market.

vi) Sherpur, Moulvibazar

Sherpur is famous for large fish where seven *aratdars* are involved in fish trading. The main landing centre is located on the bank of the *Kushiyara*. The centre does not have any landing facility but has enough space for development. A small shed is commonly used for price negotiation. Fish is brought from the *haors* by mechanized wooden boats. About 4 tons of fish are brought to each arat during the peak season and 1-1½ tons during the lean season. No fish is available in the months of June and July. There are three ice plants in this market.

About 150 *nikaries* are engaged in the marketing chain who are paid in advance to ensure a supply to respective *arats*. The bulk of the supply is transported to Sylhet, Chittagong and Dhaka by truck. At least 150 local traders from other adjacent local markets get their supply of fish from Sherpur. About 20% of the large fish are sold to passengers who pass through Sherpur. The *Poush Sankranti* (traditional fish festival) is held every year at a place only half a km away from the landing centre.

vii) Kazirbazar, Sylhet

Kazirbazar is located in Sylhet city and covers about 0.4 ha of land. It receives supplies by road from different parts of Sylhet and Sunamganj districts. Fish are transported from here mainly to Dhaka, Chittagong, Feni and a few other districts. There are 50 *aratdars* who control the landing centre. Ice is supplied mainly from three ice plants in Sylhet city, located in Sheikhghat industrial area and Kalibari. The supply of ice is adequate. There is no shed in the market for common use. Ten labourers have been engaged on a regular basis to carry fish and to clean the market.

About 40 tons of fish are brought in the market daily during the peak beel fishing season (December - March) and 4-7 tons during the lean season. Although the landing centre is located in the heart of the city, it does not have any water supply or sanitation facilities.

viii) Waiskhali, Sunamganj

This is the main fish landing centre of Sunamganj district and is located in Sunamganj town on the bank of the *Surma* river. There is an ice plant in the market, but there is no appropriate landing facility. The *aratdars* do not have any permanent shed in the market. About 10 tons of fish are brought here daily during the peak season and 3-4 tons during the rest of the year. Fish are transported by bus and truck mainly to Sylhet, Chittagong and Dhaka.

b. Municipal Retail Fish Market

Most of the retail markets were established more than 100 years ago. Facilities at these markets have not developed while the volume of trade and the number of users has increased several times. As a result, the overall conditions, particularly the state of drainage and sanitation, have deteriorated. Besides, there has been fast growth in many retail markets responding to the need of the consumers. There are no proper drainage systems or other infrastructural facilities.

i) Poura Machh Bazar, Netrokona

The market is located in the centre of the town occupying 0.36 ha of land. About half of the land is occupied by retailers of commodities other than fish. The market has been auctioned for Tk 154,000 for the current year. No development work had been undertaken for many years. There is no statutory authority to look after power and water supply, and no drainage facilities. The market also lacks storage and parking facilities. There are 60 permanent sheds for retailers. Among these, 6 sheds are used by floating traders and the remaining 54 sheds are used by about 200 permanent retailers in shifts. Each retailer serves about 40 consumers (about 250gm/consumer on the average). Most of the live fish are transported to outside the town accounting for about 15-20% (about 0.75 ton) of the total supply. There is no ice crushing facility in the market.

ii) Bara Machh Bazar, Kishoreganj

The market is located in the centre of the town on the western side of the *Narsunda* river covering about 0.2 ha of land. This is a very important outlet for dry fish marketing. Marketing is held two days each week. In each market day during the dry season (from November to March), about 50 tons of dry fish are marketed. More than 50 permanent dry fish *arats* are involved in this business. Dry fish traders have their own sheds in the market, but there is no facility for moisture-proof storage which is needed to maintain the quality.

There are 36 sheds for trading of fresh fish. This is inadequate in terms of demand and supply. Two more markets developed in other parts of the town cater to the need of the traders and consumers.

iii) Bara Machh Bazar, Moulvibazar

This is the main fish market in the district headquarters having a small area of 0.04 ha. There is no shed for the traders. No initiative has been taken to improve this main market. The municipal authority, however, constructed a new fish market near the bridge over the *Manu* river. But few people go to the new site for marketing.

Though only 45 retailers can be accommodated in the main market, about 150 traders crowd there every day. About 7-8 tons of fish is marketed daily during November to March, 3-4 tons from April to June and 5-6 tons from June to August. About 5000 buyers use the service everyday. There is no arrangement for water supply, sanitation and storage in the market.

iv) Lalbazar Fish Market, Sylhet

This is the central retail fish market in the district headquarters of Sylhet and is located at Bandar Bazar. It has an area of about 0.06 ha. There are 72 permanent sheds in the fish market. The market does not have water supply and drainage facilities. Each retailer pays Tk 72 per day to the market committee and Tk 2 per day to their *samity*. About 200 people are involved in the fish trade in this market. About 6-7 thousand buyers are served by this market daily. During November to March, about 10 tons of fish per day is sold and about 4 tons per day during the rest of the year.

v) Machh Bazar, Sunamganj

This is the main fish market in the district headquarters of Sunamganj. There are about 45 identified spaces for the retailers where about 125-150 traders sell fish. There is no facility for water supply, drainage, sanitation and storage. Every day about 2-3 thousand people come to buy fish in this market. About 3-4 tons of fish is marketed daily during November to March and 2-3 tons per day during the rest of the year.

vi) Chowdhury Bazar, Habiganj

There are three fish markets in Habiganj district headquarters. Previously, the *Cinema Hall fish market* was the main fish market in the town with 56 retail shops. Now this has lost its importance due to the shifting of the town. At present, the *Chowdhury Bazar fish market* has an area of about 0.07 ha in the main market which caters to the needs of the local people. There are 30 retail shops for fresh fish and 18 shops for dry fish. Fridays and Tuesdays are the main market days. About 7-8 thousand people visit the market in each market day and fish is sold by about 80 to 100 retailers. About 1-2 tons of fish are sold in each market day during the peak season.

c. Mother Fisheries

The concept of mother fishery has not been adequately addressed so far in the literature of floodplain fisheries. Functionally, a mother fishery exerts a controlling influence on fish abundance over a wide area. Thus, if fish is abundant in a particular mother fishery, fish would be available in abundance also in the surrounding areas. The concept of mother fishery is more commonly used in the Northeast Region to describe a larger geographical area having a concentration of high quality fish habitats and supportive flora (deep river duars, clear tributary streams, deep *beels*, sediment-free *khals*, wetland forests, reed-beds, floodland with wetland grasses and so on). Because of their importance as fish growing and dispersal centres within the region, mother fisheries should come under special resource and environmental management regimes. This is essentially a more complex and comprehensive subject in comparison to a single site refuge locality. During the study period, five important mother fisheries have been identified:

- Tangua Haor
- Hakaluki Haor
- Kawadighi Haor
- Khaliajuri
- Companiganj

i) Tangua Haor Mother Fishery area (Tahirpur)

Tangua Haor is considered to be the single most important mother fishery in the region. The area of the *haor* is about 8000 ha. There are only a few villages and the proportion of cultivable land is low. The *haor* is located just adjacent to the Indian hilly terrain from where organic nutrient is carried to the haor with monsoon runoff. Unlike many other *haors*, no major *khal* or river is connected with the Tangua Haor. There are many *beels* in the *haor* which are connected with each other by small canals. About 25 *beels* are used as over-wintering grounds by fish. Among these are the *Tangua beel*, *Rauar beel*, *Tangur beel*, *Umedabad beel*, *Batakal beel*, *Naoria beel*, *Pana beel*, *Kalma beel* and *Arabiakona beel*.

The entire *haor* is mainly fed by back flows of water which carry a small amount of silt and is low turbidity hillside runoff. Due to limited agricultural activities, the negative impacts of agro-chemicals are almost non-existent. Clear water without silt is favourable for higher survival rates of fish spawn. There is little subsistence fishing as there is a small population within the *haor* area. Natural reeds and other vegetation provide a natural ecological balance. A low siltation rate helps to maintain the natural fish habitat. The *fish conservation act* is generally implemented by the lessee. The three year *pile* fishing system is used and harvesting rotates among different *beels* in the *haor*. This plays an important role for maintaining production levels. The two-way water supply system, (hillside runoff and back flow) helps to maintain the natural environment.

ii) Hakaluki Haor Mother Fishery

Hakaluki Haor is an important mother fishery in the Northeast Region and has a natural

spawning ecology. It is the largest *haor* in Bangladesh with an area of 18,100 ha. It possesses a unique ecological support for fisheries. Hills in the western and the eastern sides have made the *haor* more favourable for spawning. Spawning suitability ecology of fish in this particular area has an important impact on overall fish production of the region. In 1993, carp spawn was collected downstream of *Hakaluki Haor* by FAP 17 (about 1.0-1.5 Km upstream of Fenchuganj Bridge) which confirmed the existence of the spawning ground.

More than 60 permanent *beels* with a total area of 3,835 ha are located in the *haor*. Among these, the *Dulla beel*, *Chatal beel*, *Sakua beel*, *Baghalkuri beel*, *Barajalla beel*, *Pinglarkona beel*, *Pioula beel*, *Niral beel*, *Lamba beel*, *Maiam beel*, *Balijhuri beel*, *Chinaura beel* are the most important ones and are large in size.

The *haor* is filled mostly by the backflow from the *Kushiyara* river. Water flows directly from the rivers *Juri*, the *Phanai* and more than 20 other hilly channels which create low velocity whirl pools in many places of the *haor*. There is silt deposition within the *haor* basin. The water becomes less turbid which facilitates better spawning of fish in the *haor*. These lomnological characteristics are good for producing more food (*phytoplakton* and *zooplakton*) for spawn, fry and fish. The brood fish that over-winter in different duars in the *Kushiyara* and its tributaries use these facilities in the *Hakaluki Haor*. At present, brood fish migration from far downstream in a upward direction find only the *Hakaluki Haor* to spawn in as they do not find any scope to spawn in the *Kawadighi Haor* (the nearest one) because of the FCDI project developed there.

Considering the present situation of fish abundance and breeding behavior, an estimated 6750 Kg of female brood fish of different species spawn over *Hakaluki Haor*. About 10% of the survived spawn are able to stay there while 90% are carried away out of the *haor* by the flow of water. The present level of fish production in the *Hakaluki Haor* is estimated to be 2,500 mt per year.

iii) Kawadighi Haor Mother Fishery

The main permanent *beels* in the *Kawadighi Haor* are *Patasingra beel*, *Shalkatua beel*, *Majerband beel*, *Rukya beel*, *Singua beel*, Hawa *beel*, *Goali beel*, *Peala beel*, *Kaliarkuri beel*, *Noamati Khora beel*, *Melaghar beel*, *Machhuakhali group fishery* and so on. The mother fishery in the *haor* has already been damaged by the *Manu River Irrigation Project*. The annual loss in fisheries production caused by this project is estimated at about Tk 120 million.

Most of the large brood fish from the greater depressions of the region tend to migrate upstream for spawning. Many of these brood fish are caught near Sherpur as they cannot find any breeding grounds. Previously the effluent from Fenchuganj Fertilizer Factory created further problems for fish moving to the *Hakaluki Haor*. The factory has now been closed down.

It has been indicated by the NERP field monitoring study that in 1993/1994, fish production in the *haor* may be 6-7 times more than the previous year (1992/1993) because of severe breaches in the embankment.

iv) Khaliajuri Mother Fishery Area

Khaliajuri mother fishery is in the main Sylhet depression and covers both sides of the main *Dhanu* river which flows through the depression. The fisheries areas can be defined as follows:

North: *Mora Surma* to the *Piyain* river through Gachhia, Kajaura, Madhupur, Dalua and Bhatpara.

East: *Kalni* river (from Nagarpur to Ajmiriganj), *Darain Gang*, *Mora Gang*, *Surma* river up to Gachhia.

South: *Kalni* river (Nagarpur) to west *Dhanu* river (near Simulbak) through *Chera Nadi*, *Baulai* river, *Phulbaria Khal* (near Dhaki), Phenohla, *Ghora Bhanga Nadi*, *Gokhra Nadi*.

West: West *Dhanu* river (near Simulbak) to main *Dhanu* river near Mandorbari through Paikartala, *Chinal Gang*, *Jhinal Nadi*, *Mora Gang*, *Balai Nadi*, *Dalai Gang*.

As it is the main depression of the region, it retains water for eight months of the year. A large number of *beels* and canals/rivers have over-wintering grounds for a long period where large fish take shelter during the dry season. The most important *beels* are *Chhaina beel*, *Dhailong beel*, *Bhanda beel*, *Menda beel*, *Barakuni beel*, *Bheramohana beel*, *Hogli beel*, *Makhnai beel*, *Kaurala beel*, *Telai beel*, *Ranatator beel*, *Garchair beel*, *Khura beel*, *Mathabhanga beel*, *Patbhanga beel*, *Chatal beel*, *Goldwar beel*, *Dhala beel*, *Shalkalama beel*, *Chhota Angan beel*, *Maitahata beel*, *Sundukhaia beel*, *Bhatia beel*, *Daia beel*, *Nili beel and so on*. The important channels and rivers are *Menda khal*, *Gazaria Nadi*, *Chinal Gang*, *Jhinal Gang*, *Putia Khal*, *Mailatur Khal*, *Chair dair Nadi*, *Darain Nadi*, *Darain Gang*, *Chela Gang*, *Srota Nadi*, *Piyani Nadi*, *Lamak-ora Nadi*, *Gachiduar Nadi*, *Ghungiardhir Nadi*, *Fira Gang*, *Chefer Gang* and so on.

v) Companiganj Mother Fishery area:

This mother fishery is located in Companiganj *thana* of Sylhet district. This is a unique area having natural reedlands on the north-western side. Relatively clear water flows from the *Piyain* river, *Dhalai Gang* and 25 small channels from the Indian hills creating a favourable environment for spawning. A number of channels are inter-connected with each other forming a channel network both in the reedland area and in other areas. This environment facilitates the production of more *Zooplakton* and *Phytoplankton*, as well as shelter for brood fishes, during the spawning period. The spawning success of this area is assumed to be higher than any other area of the region as the natural habitat has been maintained for a long period. The brood stock that over-winters in different duars of the *Piyain* and the *Surma* favour spawning migration toward this area. The grazing area surrounding this zone is filled with less turbid water flowing from the Indian hills. There is less HYV agriculture in this area and water quality is good.

The area is bordered by the *Cheal Gang* and the *Surma* river in the west, the *Singar khal* and the *kutcha* road from Salutikar ferry *ghat* to Goainghat in the south-east and Indian hills in the north.

About one hundred *beels* of varying sizes and more than forty channels are in this fishing zone. The main *beels* are *Rauti beel, Burohingai beel, Laukuri beel, Nogar beel, Pakhihaori beel, Dulainhaori beel, Baradungai beel, Dulain beel, Barabadal beel, Lobha Haor, Lali Haor, Sona haor, Sheiker haor, Baldai haor, Baoa haor, Khotajori haor, Pokohaoor haor, Singra beel, Patharchhulu haor, Pukharia beel, Digbali beel, Chakal beel, Bakara beel, Bugil beel, Korali beel, Kalenga beel, Pekua beel and Helua beel.*

d. Proposed FRI Station, Dabor, Sunamganj

Bangladesh Fisheries Development Corporation (BFDC) established a modern fish landing-cum-processing plant in Dabor, adjacent to the Sunamganj-Sylhet highway, on the bank of the *Mohasing* river. It was intended that a large quantity of fish would be supplied through this centre. But local fish marketing strategies were not evaluated properly. As a result, it could not compete with private traders. It has remained unused for last three years.

There is no floodplain research station of FRI in the Northeast Region, though it is necessary. In the meantime, the Director of FRI visited the Dabor campus and decided to propose to the Government to hand over all assets to FRI.

The BFDC in Dabor has the following assets:

a.	Building	7	(2 staff quarters (12 Units), 1 office building (8 rooms), 1 Auction hall, 1 security house, 1 rest house-cum-officers' quarter (3 Units), 1 sub-power station)
b.	Ice plant	1	13 mt/day (15 mt storing capacity)
c.	Freezing plant	1	50 mt (only for chilling, 5^0-7^0C)
d.	Floating deck	1	15 x 60 ft
e.	Tube well		
	Deep	1	
	Shallow	2	7.5 H.P.
f.	E. Generator	1	440 Volt
g.	Compressor Ma	3	
h.	Transformer	1	

At present, monthly electricity cost is around Tk 12,000 while around Tk 70,000 is needed for the operation of different plants.

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Proposed River Duar Fish Sanctuaries

Name of duar & location	Dry Sea. Depth(m)	Bara machh occurred	Chhoto machh occurred
River: **SURMA**			
Thanar duar, Chhatak.	17	LC,C,MC	B,Ch,Ca,R
Dwarabazar duar, Dwarabazar.	26	As above.	As above.
Brahmangaor duar, Sunamganj.	12-13	As above.	As above.
Jamlabazar duar, Jamalganj.	15-16	As above.	As above.
River: **SARIGOYAIN**			
Telanjir duar, Jaintapur	25-26	LC,MC,C	B,Ch,Ca,R
Jalmarar duar, Jaintapur	23-24	As above.	As above.
Bhuktar duar, Jaintiapur.	15-16	As above.	As above.
River: **LUBHA**			
Kukubarir duar, Kanairghat	12-14	As above.	Ch,Ca,P,T
Baganar duar, "	12-14	As above.	As above.
Bagbarir duar, "	15-16	As above.	As above.
Barar duar, "	27-30	As above.	As above.
Mainrir duar: "	27-30	As above.	As above.
River: **RAKTI**			
Ahmakkhalir duar, Tahirpur	14-15	LC,C,MC	B,R,Ca,L
River: **GHASIA/PATNAI**			
Alam duar, Tahirpur	16-17	C,LC,MC	B,L,Ca,Ch
Rupa Bhui duar, Tahirpur	12-13	LC,MC,C	As above.
River: **KUSHIYARA**			
Kakairdir duar, Beanibazar	10-11	LC,MC,C	B,Ch,Ca,L
Poradair, Rajnagar	17	LC,MC	B,Ch,Ca
Digholbagar duar, Jaganathpur	14-32	LC,MC	As above.
Ranigangar duar, "	22	LC,MC,C	As above.
Roailar duar, "	31	As above.	As above.
River: **BAULAI/DHANU**			
Chandpurar duar, Kaliajuri	10-11	LC,C,MC	B,Ch,Ca,L
Saldighar duar, "	15	As above.	As above.
Nawtanar duar, "	14 & 12	As above.	As above.
Bagadiar duar, Itna	10-11	As above.	As above.

Name of duar & location	Dry Sea. Depth(m)	Bara machh occurred	Chhoto machh occurred
River: **KAWNAI**			
Daulatpurar duar, Dharmapasa	12-13	C,P,LC,MC	As above.
Mukshedpur duar, "	20-22	As above.	As above.
River: **PIYAIN**			
Phada duar, Kaliajuri	14	MC,LC,C	B,Ca,L,S,G
Shisur duar, "	12	As above.	As above.
Shaintar duar, "	19	As above.	As above.
River: **KALI**			
Kunnamuk, Kuliarchar	16	LC,MC,C	Ch,Ca,B,Ba
Kadirpur, "	17	As above.	As above.
River: **UPPER MEGHNA**			
Mendipurar duar, Kuliarchar	19	LC,C,P,MC	As above.
Rajapurar duar, "	35	As above.	As above.
Chatalparar duar, Astagram.	24	LC,C,MC	As above.
River: **KANGSA**			
Banduk khali, Purbadhala	8-9	LC,MC	B,L,R,Ch,P
Kalam duar, "	8-9	LC,C,MC	As above.
River: **MOGRA/BISHNAI**			
Kalibarir duar, Atpara	10-11	As above.	As above.
Gulduba, "	5-6	As above.	As above.

B: Bacha; Ba: Bailla; C: Chital; Ca: Chapila; Ch: Chela;
G: Golda chingri; L:Laso; LC: Large catfish; MC: Major carp;
P: Pangas; Pa: Pabda; Pu: Puti; R: Rani; T: Tengra.

ANNEX B

COST ESTIMATE

1. Cost Estimate for NFMP Fishermen Support Programme for one fishery

Item	Description of the Item	Unit	Quantity	Rate (Tk/Unit)	Total (MTK)
Biological Management Training	Training to fishermen pertaining to biological management (conservation, harvesting, management and processing).	Person-day	3000	200	0.60
Literacy Programme	Mass education programme for each member of the society's families. It is assumed that there are about fifty families in fishermen's societies having 5.5 members in each family. There will be one class in each month and continue for five years.	L.S	16,500 person-days	-	1.15
Fishermen Community Centre		L.S	one	-	0.50
Management Support Cost	Cost involves to support the programme which will continue for five years	Year	5	50,000	0.25
TOTAL					2.50
GRAND TOTAL	**There will be no 120 units. Total cost : 120 x MTK 2.50**				**300.00**

Note : Provision for a special loan of TK 1.4 million for each unit for engine boat (TK. 0.30 m), net and gear (TK 1.0 million) and revenue (TK 0.10 million) will be required to be kept in the budget.
Total budget provision : 120 x MTK 1.40 = Tk 168.0 million.

2. Cost Estimate for Community Jalmahal Management

Item	Description of the Item	Unit	Quantity	Rate (Tk/Unit)	Total (MTK)
Beel Re-excavation	Earthwork in re-excavation of beels belonged to community jalmahal	m^3	2000000	30.0	60.00
Plantation	Plantation and nursing of hizal koroch and deep water trees on beel embankment to enhance the fish production in the beel areas	ha	200	500	0.10
Structure	Small regulating structure to prevent the early postmonsoon drainage from the beel areas belonging to the community jalmahal	no	200	50,000	10.00
Training	Practical biologocal management training to those fishermen managing the beels of the community jalmahal	Person-day	30,000	150	4.50
Training Management	Cost involves to support the programme for ten years	Year	10	100,000	1.00
O & M	Maintenance of 28 DOF and 20 BWDB local offices	L.S	48	-	9.40
TOTAL					**85.00**

3. Cost Estimate for one Mother Fishery Management

Item	Description of the Item	Unit	Quantity	Rate (Tk/Unit)	Total (MTK)
Infrastructure	Re-excavation of key area of beels and plantation of hizal koroch and deep water trees to enhance broodstock fisheries	L.S	-	-	3.00
Com. Fishery Welfare Centre	Construction of a commercial fishery welfare centre	L.S	one	2.50	2.50
Logistics	Purchase engine boat a. 10.0 m long with insulated box b. 7.5 m long without insulated Supporting equipment	 no no Yearly L.S	 one one ten	 400,000 200,000 200,00	 0.40 0.20 2.00
Training	Allowance to trainees attending the practical training course of 'mother fishery' management	Person-day	27000	150	4.06
Supporting Staff	Ten number of supporting staff to guard, operate and manage the 'mother fishery' for ten years	L.S	-	-	5.84
Management	Cost involving the training to fishermen, management of 'mother fishery' etc.	Yearly L.S	10	200,000	2.00
Miscellaneous	Cost involving payment of revenues, stationeries, nets, harvesting etc.	Yearly L.S	10	600,00	6.00
TOTAL					**26.00**
GRAND TOTAL	**There will be five such mother fisheries. The grand total is : 5 x MTK 26.00 = MTK 130.00**				**130.00**

4. Cost Estimate for River Patrol Project (Fish Sanctuary)

Item	Description of the Item	Unit	Quantity	Rate (Tk/Unit)	Total (MTK)
Patrol Boat	Purchase of Patrol boat	no	1	300,000	0.30
O & M	O & M of Patrol boats	Yearly L.S	10	120,000	1.20
Temporary shed	Construction of tin shed for the patrol party	no	2	50,000	0.10
Training	Allowance to patrol party attending the biological management training	Yearly L.S	10	50,000	0.50
Rehabilitation	Seasonal FM Rehabilitation	Yearly L.S	10	50,000	0.50
Training Cost	Remuneration to trainers	Yearly L.S	10	62,500	0.625
Support Staff	Salaries and allowances for six support staff for ten years	Man-month	720	2,500	1.80
Support Cost	Support to DOF local office for ten years	Yearly L.S	10	20,000	0.20
Logistics	Purchase of life jackets etc.	Yearly L.S	10	102,500	1.025
TOTAL					**6.25**
GRAND TOTAL	**Cost for eight such units. Total cost : 8 x MTK 6.25 = MTK 50.0**				**50.00**

5. Cost Estimate for Retail Fish Market
6 Units

Item	Description of the Item	Unit	Quantity	Rate (Tk/Unit)	Total (MTK)
Building (rooms)	Construction of three rooms (4 mx5 m) for 'Aratdhar' and office for each retail fish market. Total area, say 400 m^2 for 6 units	L.S	400	-	6.00
Fish Stall Sheds	Construction of stall sheds for retail fish sellers covering 3333 m^2 in each fish market.	m^2	20,000	4500	90.00
Insulated Room	Construction of 5.0mx6.0m insulated room to preserve fish in good conditions. Total floor area ≈ 200 m^2	m^2	200	20,000	4.00
TOTAL					**100.00**

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6. Cost Estimate for Fish Landing Centres
8 Units

Item	Description of the Item	Unit	Quantity	Rate (Tk/Unit)	Total (MTK)
Floating Dock	Purchase of a floating dock including installation at each site.	no	8	1,000,000	8.00
Insulated Room	Construction of insulated room covering 50.0 m^2 at each site to preserve fish in good conditions	m^2	400	20,000	8.00
Building	Construction of aratdar office rooms (10-70 no) covering needful floor area for different market	m^2	4000	6,500	26.00
Shed	Construction of Pucca shed for 'Arat' covering needful floor area for different market	L.S	5000	-	17.00
Ice Plant	Purchase and installation of one ice plant at each site	no	8	5,000,000	40.00
Land Acquisition	Land acquisition for development of fish landing centre	ha	1.0	25,000,000	25.00
Training Cost	Training to fish traders for efficient fish handling and landing centre management	man-day	5000	200	1.00
TOTAL					**125.00**

7. Cost Estimate for FRI Station at Dabor

Item	Description of the Item	Unit	Quantity	Rate (Tk/Unit)	Total (MTK)
Manpower	1. Scientist - 3 persons for 10 years	Man-month	360	10,000	3.60
	2. Technical staff - 12 persons for 10 years	Man-month	1440	5,000	7.20
	3. Supporting staff - 13 persons for 10 years	Man-month	1560	5,000	7.80
Training	Arrangement of seminars, workshops and training course for fisheries community	Yearly L.S	10	500,000	5.00
Equipment	1. Spectro Photometer	no	2	50,000	0.10
	2. Microscope (Inverted, Disecting, Stereoscopic binocular)	no	4	50,000	0.20
	3. Salter Spring Balance (1,5,10 and 20 kg)	no	4	25,000	0.10
	4. Fish Scale Reader	no	1	50,000	0.05
	5. Limnobiological equipment	L.S	-	-	0.20
	6. Portable Computer	no	1	100,000	0.10
	7. Computer Printer	no	1	75,000	0.075
	8. Plain Paper Copier	no	1	150,000	0.15
	9. Desk Top Printing Calculator	no	1	25,000	0.025
	10.Air Cooler	no	1	75,000	0.075
Logistics	1. Pickup Truck	no	1	700,000	0.70
	2. Motor Cycle	no	3	75,000	0.225
	3. Speed Boat	no	1	250,000	0.250
O & M	Operation and maintenance cost including payment of electricity bills etc.	Yearly L.S	10	415,000	4.15
TOTAL					**30.00**

8. Cost Estimate for Central Co-ordination Cell

Item	Description of the Item	Unit	Quantity	Rate (Tk/Unit)	Total (MTK)
Manpower	1. One NFMP + RP	Man-month	120	60,000	7.20
	2. One MF	Man-month	120	60,000	7.20
	3. One CB + RM + LC	Man-month	120	60,000	7.20
	4. Ten Field Biologist	Man-momth	1200	15,000	18.00
	5. Ten Field Assistant	Man-month	1200	5,000	6.00
	6. Fifteen support staff	Man-month	1800	5,000	9.00
Logistics and Equipment	1. Jeep	no	4	750,000	**3.00**
	2. Moto Cycle	no	10	75,000	**0.75**
	3. Speed Boat	no	4	250,000	**1.00**
	4. Computer	no	4	100,000	**0.40**
	5. Printer	no	4	100,000	**0.40**
	6. Photo-Copier	no	2	200,000	**0.40**
	7. Air Cooler	no	6	75,000	**0.45**
	8. Office Rant -Two Bldgs	Month	240	100,000	**2.40**
O & M	1. Operation and maintenance of vehicles, offices and equipments for two office building	Month	240	100,000	**24.00**
	2. Daily allowances, payment of electric and other bills and stationeries	Yearly L.S	10	-	**7.60**
TOTAL					**95.00**

ANNEX C

INITIAL ENVIRONMENTAL EXAMINATION

ANNEX C: INITIAL ENVIRONMENTAL EXAMINATION

C.1 Introduction

This Initial Environmental Examination (IEE) (pre-feasibility level Environmental Impact Assessment or EIA) follows the steps specified in the *Bangladesh Flood Action Plan Guidelines for Environmental Impact Assessment* (ISPAN, 1992). These steps are illustrated in Figure 2 of ISPAN (1992).

Much of the information required for the IEE/EIA appears in the main body of the study. The section and chapter references given below cite this information.

C.2 Alternative 1:

C.2.1 Project Design and Description (Step 1)

As in Section 6.3, Project Description.

C.2.2 Environmental Baseline Description (Step 2)

As in Chapter 2, Biophysical Description, and Chapter 3, Settlement, Development, and Resource Management.

C.2.3 Scoping (Step 3)

Technical:

Literature review: Presented in Chapter 4, Previous Studies.

Local community: As described in Section 3.1.6, People's Perception.

C.2.4 Bounding (Step 4)

Physical:

Gross area: 21,710 km^2.
Impacted (net) area: 21,710 km^2.
Impacted area outside project: impacts of fisheries programme are described in Section 6.7. Impacts outside the programme area are expected to be positive. During feasibility studies, impacts need to be assessed.

Temporal:

Preconstruction: years zero through year three .
Construction: year three through year six.
Operation: year four through year twenty.
Abandonment: N/A

Cumulative impacts:

e.g.: With other floodplain infrastructure: This will be looked at in the context of the Regional Plan.
With pre-existing no-project trends. Described in Chapter 5.

C.2.5 Field Investigations (Step 5)

Field investigations were limited to seven to ten days of informal reconnaissance by a multi-disciplinary team.

C.2.6 Impact Assessment (Step 6)

At this level of detail, a screening matrix (Table C.1) was filled out by the project team. Impacts are designated by:

+	positive impact
-	negative impact
•	neutral impact (such as conversion from one productive land use to another)
?	insufficient information to designate

Impacts are discussed in Section 6.7.

C.2.7 Quantify and Value Impacts (Step 7)

Quantification and evaluation of impacts is documented in Section 6.7.

C.2.8 Environmental Management Plan (Step 8)

At a pre-feasibility level, this section focuses on "identification of broad management options and major constraints" (p. 28, ISPAN, 1992).

Mitigation and enhancement. No mitigation measures are required

Compensation. Mandated requirements for land acquisition must be adhered to.

Monitoring. There is a need to define monitoring needs and methodologies at regional, institutional (DOF, NGO and BWDB), and projects levels. This exercise should reflect (i) the need for greater people's participation in all project activities, which would include monitoring project function and opportunities for discussion with DOF and (ii) the need for greater emphasis on operation and maintenance, of which monitoring can play an important role.

People's participation. There is a need at regional, institutional, and project levels to maintain enthusiasm for people's participation, and to develop effective and efficient public participation modalities.

Disaster management (contingency planning). Once the fisheries management measures are operational, investment in fisheries will likely rise. This increases the total amount of fishermens' assets that would increase their income and as well as the per capita consumption of fish of people of the region.

EMP institutionalization. Arrangements for sharing EMP responsibility between DOF, NGO, and local people would need to be worked out.

Residual impact description. This should be generated as part of the feasibility-level EIA.

Reporting and accountability framework. At a national or regional scale, there is a need to develop satisfactory reporting/accountability arrangements involving DOF, NGO and DOE, probably through an Environmental Cell within DOF linked to DOE. At the project level, the

client committee and local DOF staff should develop reporting/accountability arrangements satisfactory to themselves. Project implementation should be contingent upon development of satisfactory arrangements at the local level, at a minimum.

Budget estimates. These should be generated as part of the feasibility study.

Environmental Screening Matrix

Screening matrix PHASE	Normal/ Abnormal	Important Environmental Component Activity	Land Use	Agri-culture	Fisheries	Water Quality	Water Quantity	Human Health	Social Issues	Wild Plants & Animals	Hazards	Other
Preconstruction	Normal	Surveys & instrumentation: landmark, topographic, benchmark, hydrologic, climatic, socio-economic, land use, natural resource										
		Land acquisition										
		People's participation activities	+		+			+	+			
	Abnormal											
Construction	Normal	Site preparation: vegetation removal, infrastructure removal/relocation, resettlement, levelling, temporary structure installation (access roads, godowns, accommodations, garages and parking sites, cooking and eating facilities, waste disposal sites, water supply, drainage, sanitary facilities)	–						+			
		Canal excavation: labor and materials mobilization, crossdam construction, spoil transport, spoil disposal										
		Embankment construction: labor and materials mobilization, topsoil removal, soil taking and transport, compaction, turfing, paving										
		Structure (sluice gate, culvert, pump house, and so on) construction: labor and material mobilization, de-watering, excavation, pile driving, foundation works, structure construction, earthwork filling, turfing, paving										
		Tube well installation: boring, distribution facilities, electrification N/A										
	Abnormal	Suspension of construction before completion, construction delays										
		Incorrect construction practices or techniques										

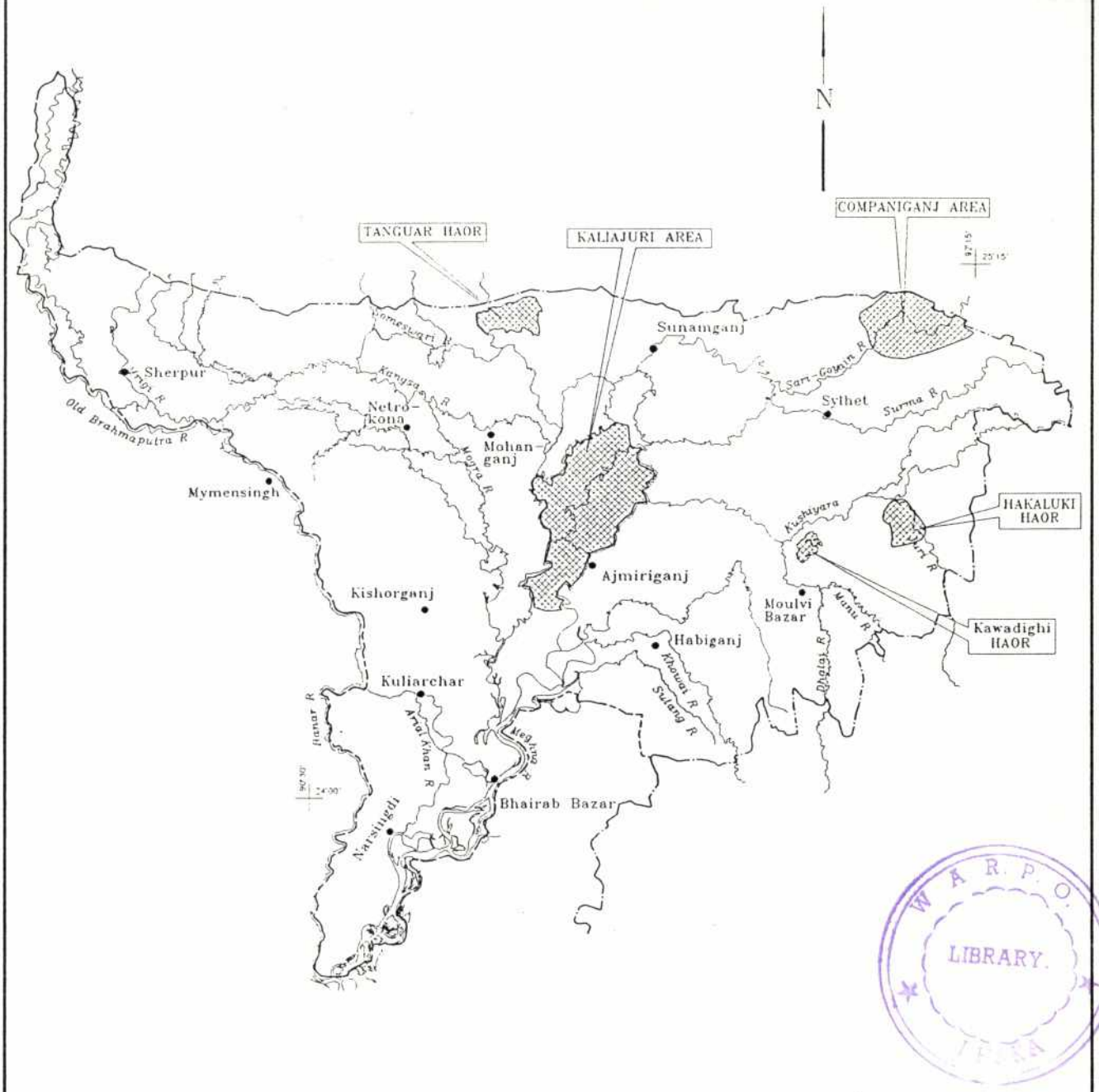
Environmental Screening Matrix

Screening matrix / PHASE	Normal/ Abnormal	Activity / Important Environmental Component	Land Use	Agri-culture	Fisheries	Water Quality	Water Quantity	Human Health	Social Issues	Wild Plants & Animals	Hazards	Other
Construction (continued)	Abnormal (cont'd)											
Operation	Normal	Pre-monsoon flood			+	+	+		+	+	+	
		Monsoon flood			+	+	+		+	+		
		Surface water irrigation N/A										
		Ground water irrigation N/A										
		Drainage										
		Agriculture: operation of institutions, extension, credit, seed distribution, fertilizer and pesticide storage and use, farmer groups										
		Water management: activities of BWDB, subproject implementation committee, local water user groups, structure committees and guards										
	Abnormal (relative to FWO, not FW normal)	Pre-monsoon flooding (due to extreme event, infrastructure failure)										
		Monsoon flooding (due to extreme event, infrastructure failure)										
		Embankment overtopping										
		Under- and over-drainage										
		Improper operation (public cuts, mistiming of scheduled O&M events etc)										
		Riverbed aggradation/degradation										
Abandonment	Normal	Re-occupation of infrastructure sites										
		Reclamation of materials										
	Abnormal											

ANNEX D

FIGURES

Figure 1



XREF:NERP-075.DWG
FILE: FISH-122.DWG

Northeast Regional Project

Location of Mother Fisheries

Prepared by: NCP/Jalal | January 1994

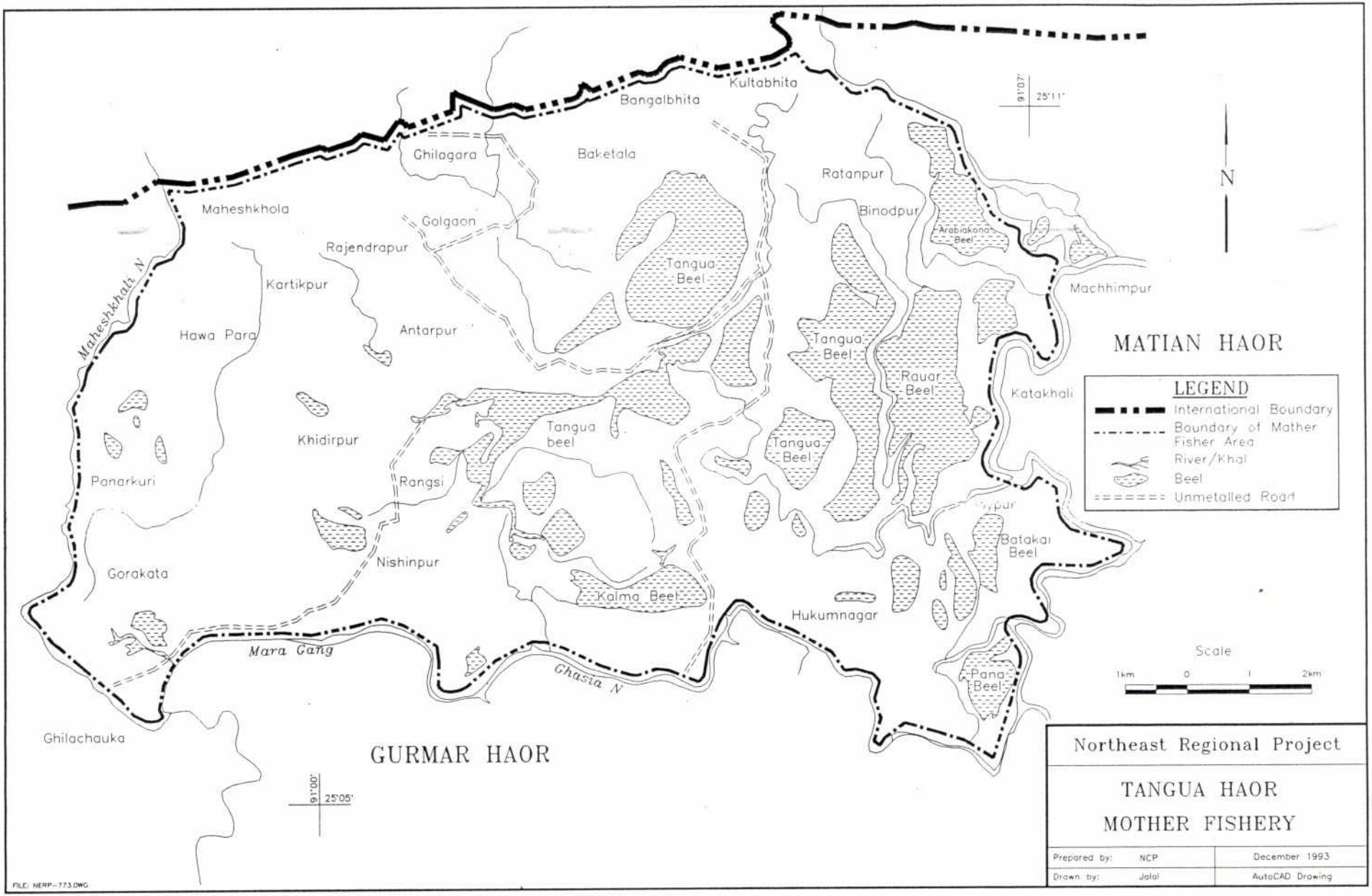
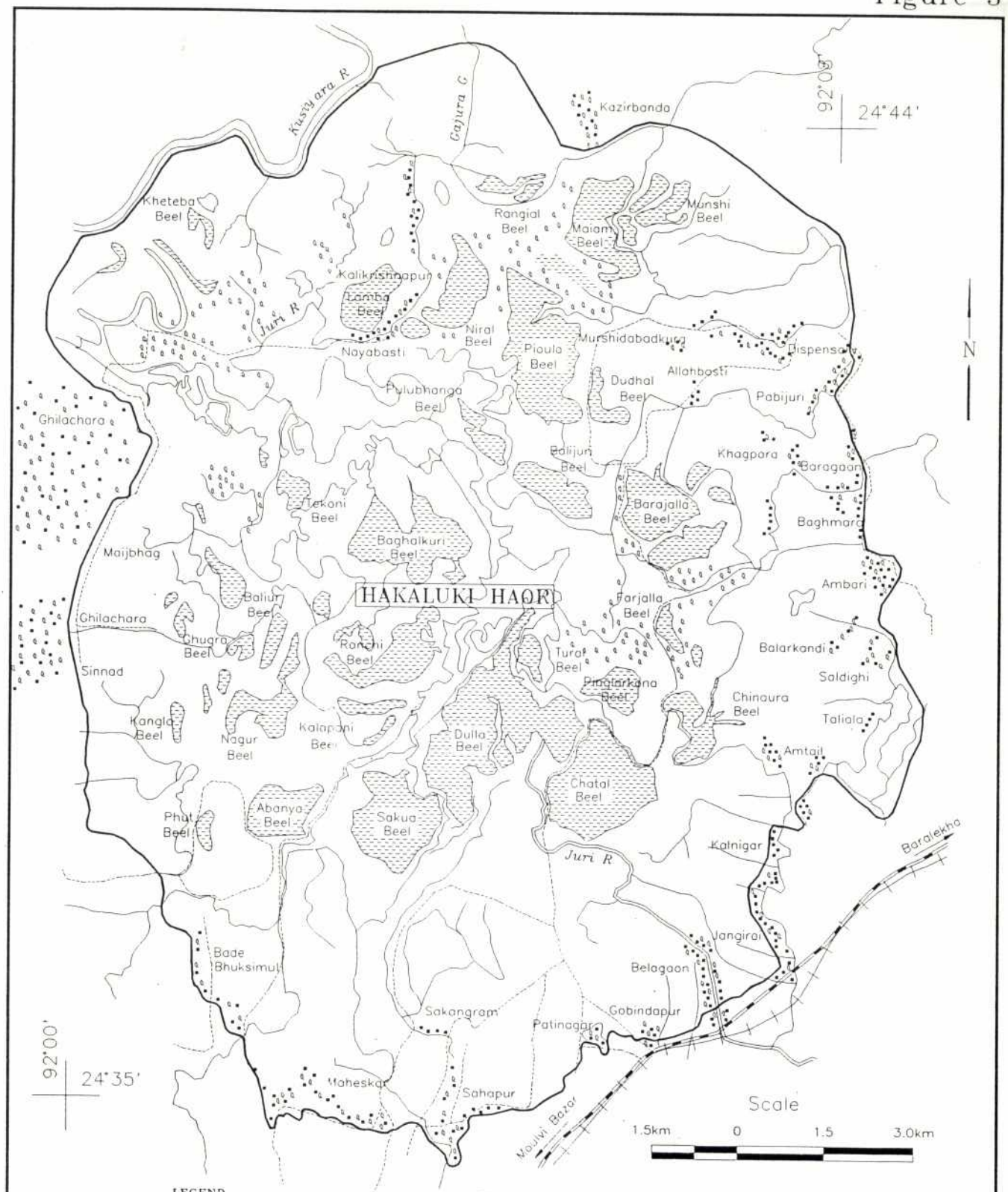

Kultabhita
Bangalbhita
Ghilagara
Baketala
Maheshkhola
Golgaon
Rajendrapur
Kartikpur
Hawa Para
Antarpur
Maheshkhali N
Khidirpur
Panarkuri
Rangsi
Tangua beel
Nishinpur
Gorakata
Kalma Beel
Mara Gang
Ghasia N
Ghilachauka
GURMAR HAOR
91°07'
25°11'
91°00'
25°05'
Ratanpur
Binodpur
Arabiakona Beel
Tangua Beel
Machhimpur
MATIAN HAOR
Tangua Beel
Rauar Beel
Katakhali
Tangua Beel
Batakai Beel
Hukumnagar
Pana Beel
N
LEGEND
International Boundary
Boundary of Mather Fisher Area
River/Khal
Beel
Unmetalled Road
Scale
1km 0 1 2km
Northeast Regional Project
TANGUA HAOR
MOTHER FISHERY
Prepared by: NCP
December 1993
Drawn by: Jalal
AutoCAD Drawing
FILE: NERP-773.DWG

Figure 2

Figure 3



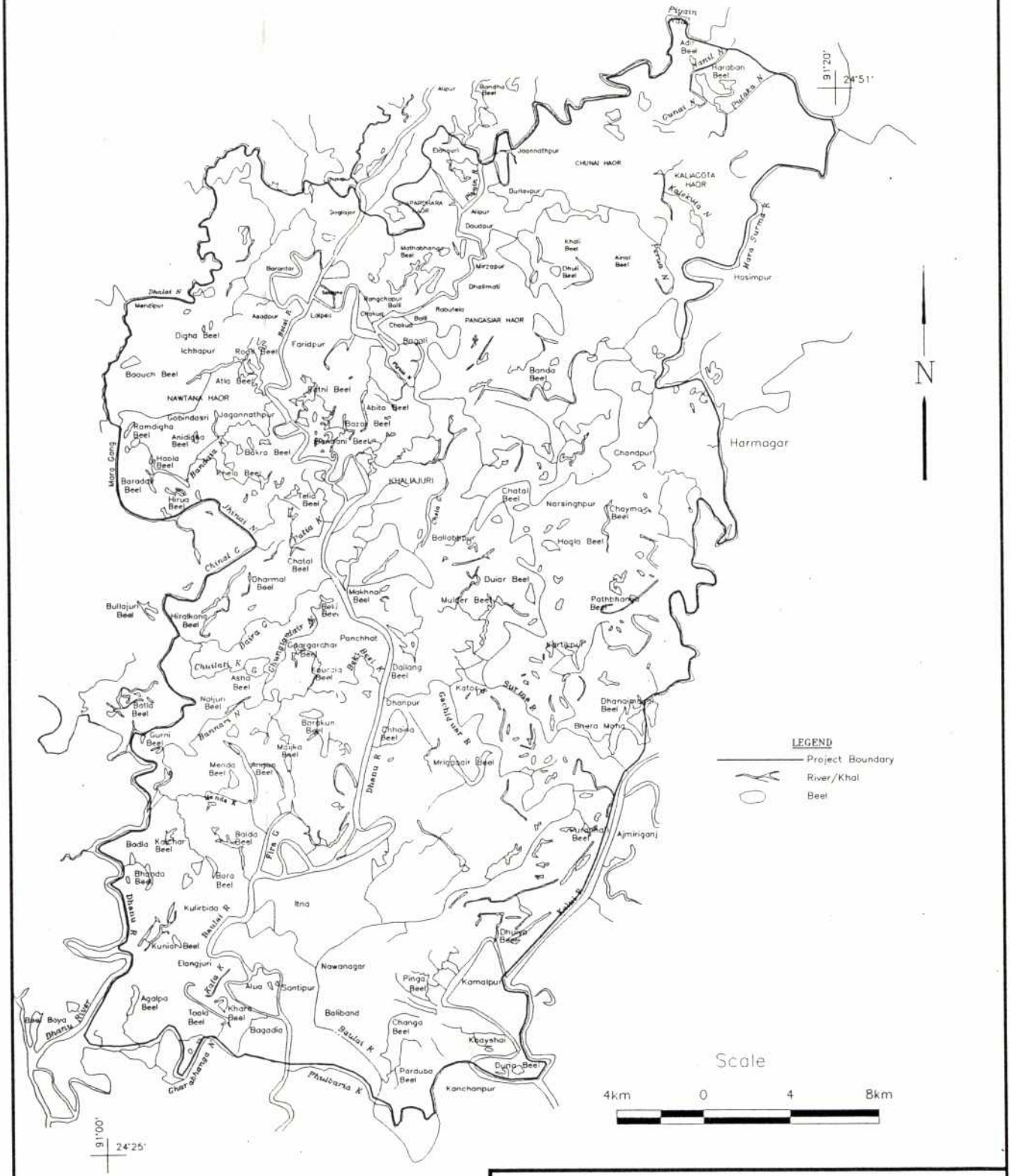
Northeast Regional Project

HAKALUKI HAOR MOTHER FISHERY

Prepared by:	NCP	December 1993
Drawn By:	Mamun	AutoCAD Drawing

FILE: NERP-765.DWG

Figure 4



Northeast Regional Project

Khaliajuri Area Mother Fishery

Prepared by:	NCP	January 1994
Drawn By:	Mamun	AutoCAD Drawing

FILE: NERP-762.DWG

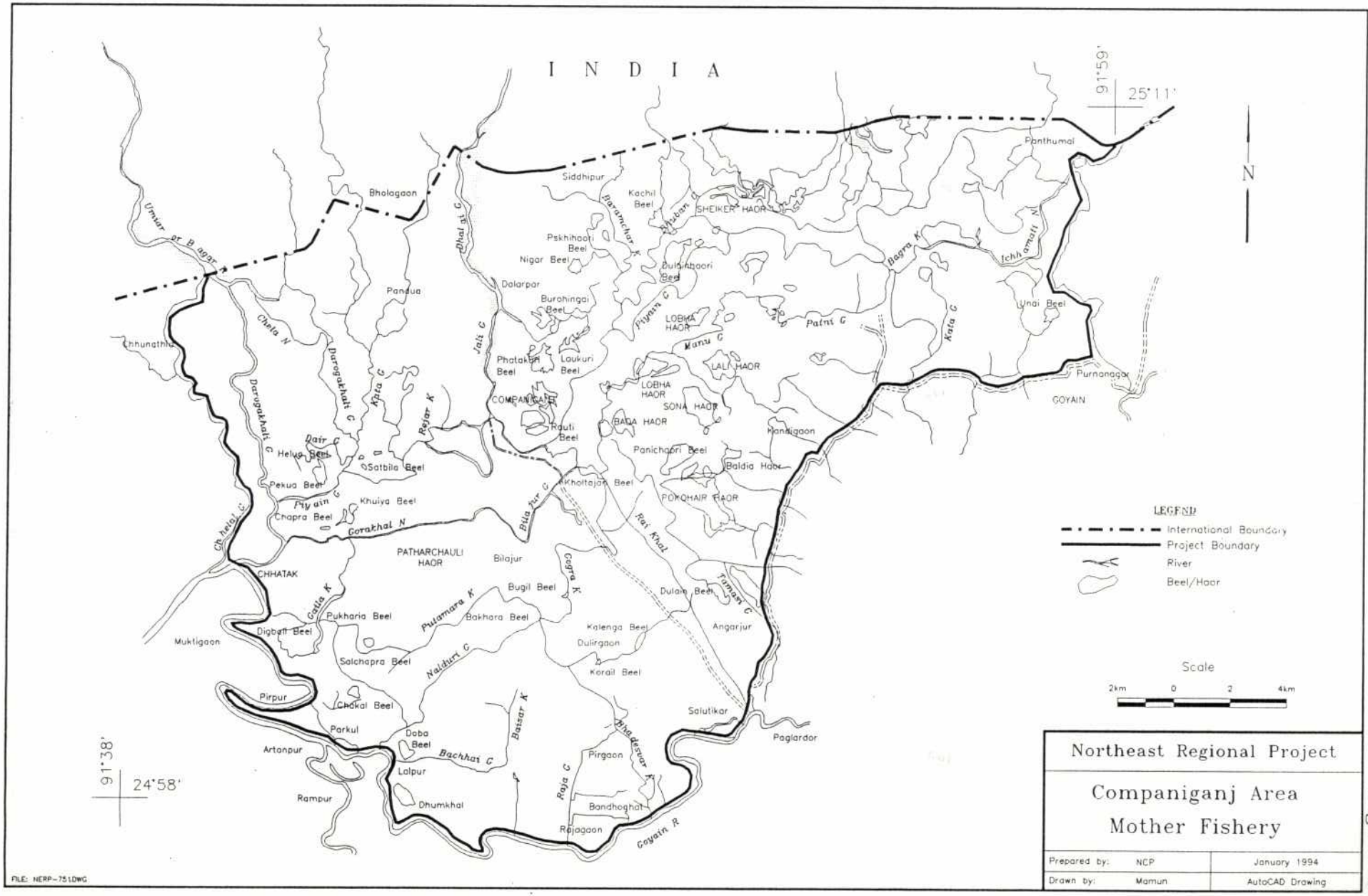
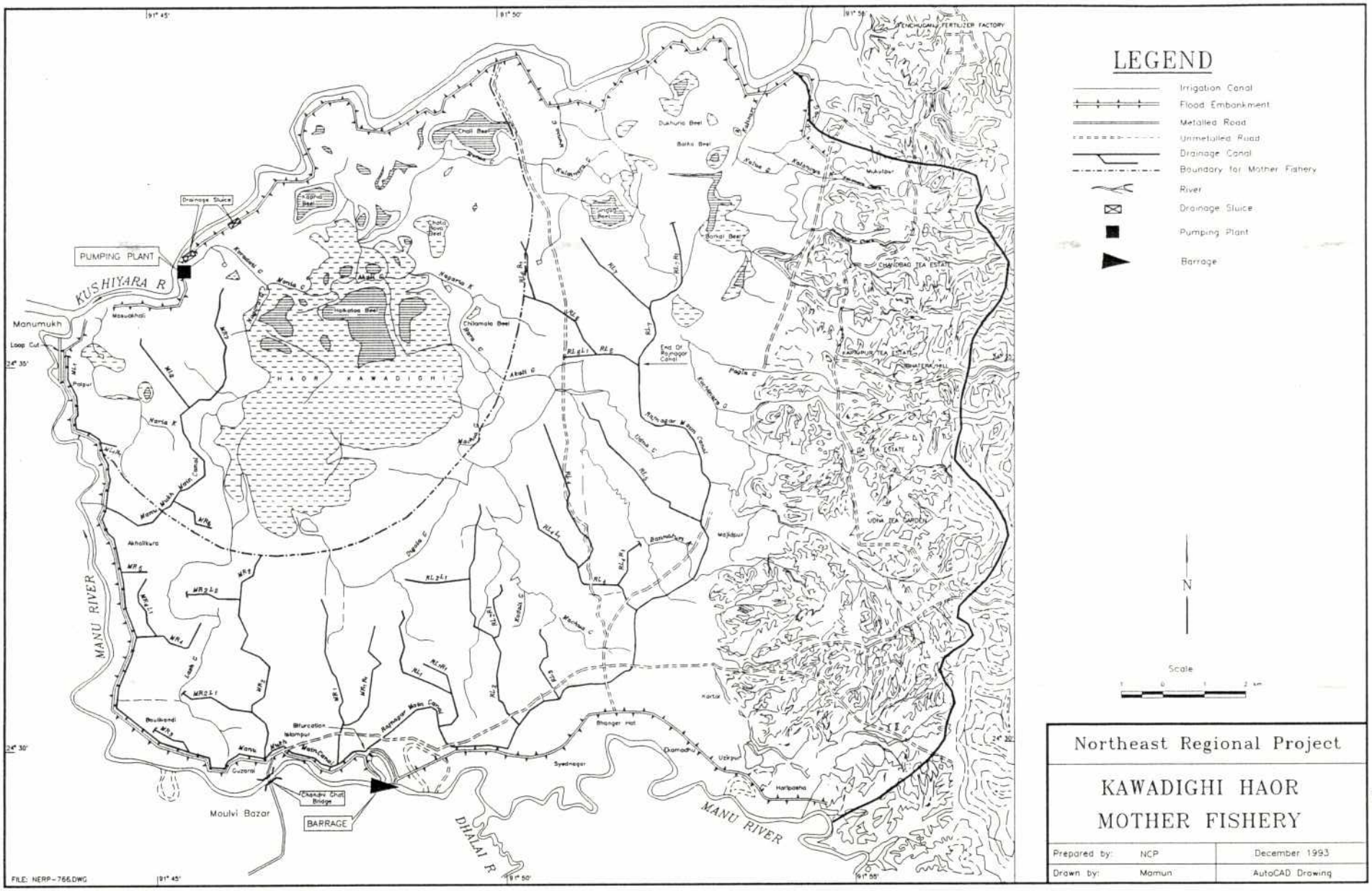

INDIA
91°59'
25°11'
91°38'
24°58'
N
Bholagaon
Umiur or B agar R
Chhunathia
Chela N
Panaua
Durogakhati C
Kata G
Rejar K
Jati G
Dhal gi G
Siddhipur
Kachil Beel
Baramchar K
Khoban G
SHEIKER HAOR
Pskhihaori Beel
Nigar Beel
Dulahaori Beel
Dolarpar
Burohingai Beel
Phatakari Beel
Laukuri Beel
COMPANIGANJ
Rauti Beel
Piyain G
LOBHA HAOR
Manu G
Patni G
LALA HAOR
LOBHA HAOR
SONA HAOR
BADA HAOR
Panichaori Beel
Khoitajan Beel
POKOHAIR HAOR
Bula jur G
Rai Khal
Tamam G
Dulain Beel
Angarjur
Kalenga Beel
Dulirgaon
Korail Beel
Salutikar
Paglardor
Nhadeswar K
Pirgaon
Bandhoghat
Rajagaon
Goyain R
Raja G
Bachhai G
Bazar K
Doba Beel
Lalpur
Dhumkhal
Rampur
Artanpur
Parkul
Chakal Beel
Pirpur
Salchapra Beel
Digbari Beel
Muktigaon
Pukharia Beel
Gatia K
Pulamara K
Bakhara Beel
Bugil Beel
Cogra K
Bilajur
PATHARCHAULI HAOR
CHHATAK
Gorakhal N
Chapra Beel
Khuiya Beel
Fly ain G
Pekua Beel
Satbila Beel
Helua Beel
Dair G
Ch helai C
Darogakhati C
Nalduri G
Panthumai
Begra K
Ichhamati N
Unai Beel
Purnanagar
GOYAIN
Kata G
Kanaigaon
Baldia Haor
LEGEND
International Boundary
Project Boundary
River
Beel/Haor
Scale
2km 0 2 4km
Northeast Regional Project
Companiganj Area
Mother Fishery
Prepared by: NCP
January 1994
Drawn by: Mamun
AutoCAD Drawing
FILE: NERP-75.DWG

Figure 5



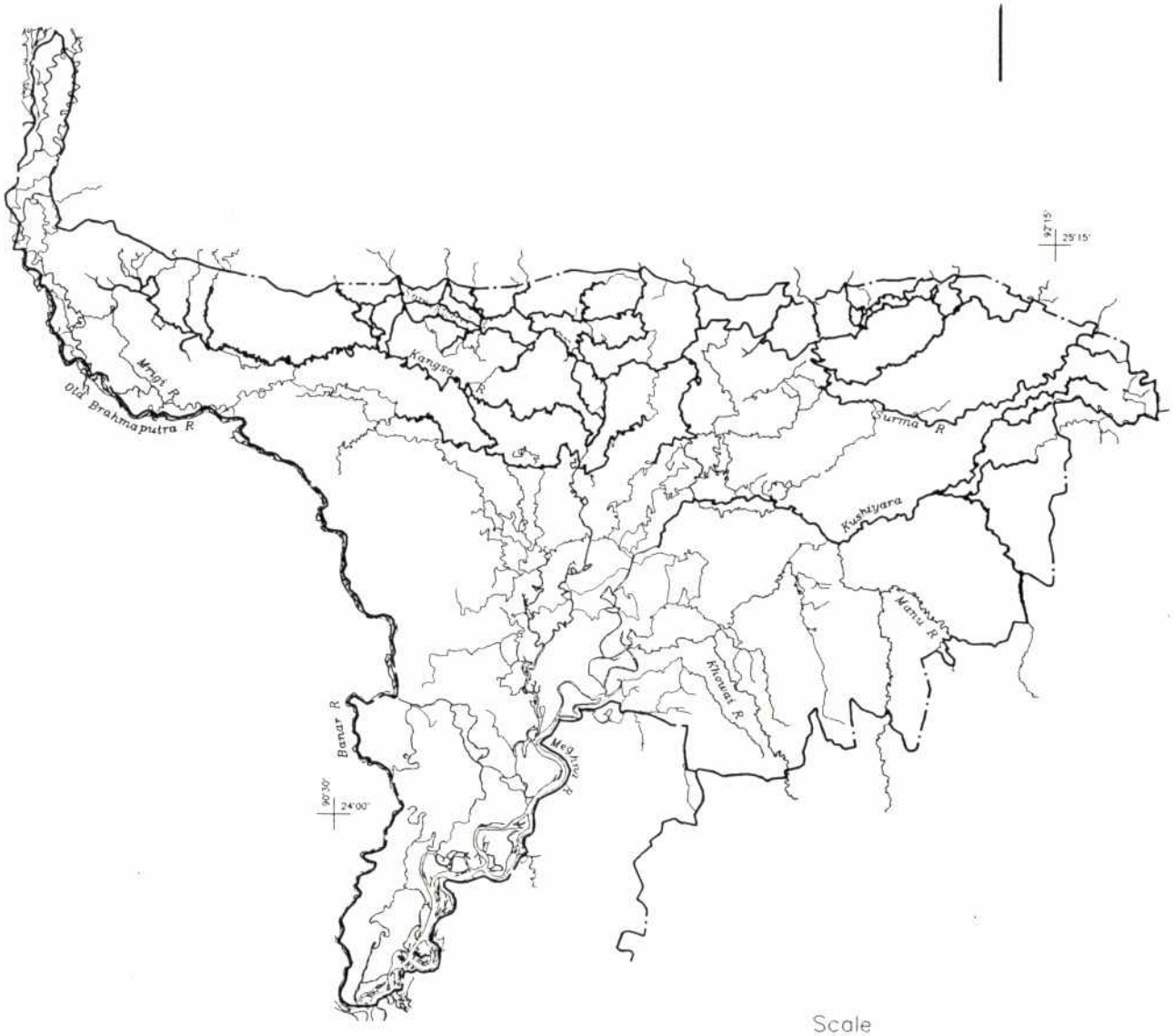
Northeast Regional Project

KAWADIGHI HAOR
MOTHER FISHERY

Prepared by:	NCP	December 1993
Drawn by:	Mamun	AutoCAD Drawing

Figure 6

Figure 7



Scale

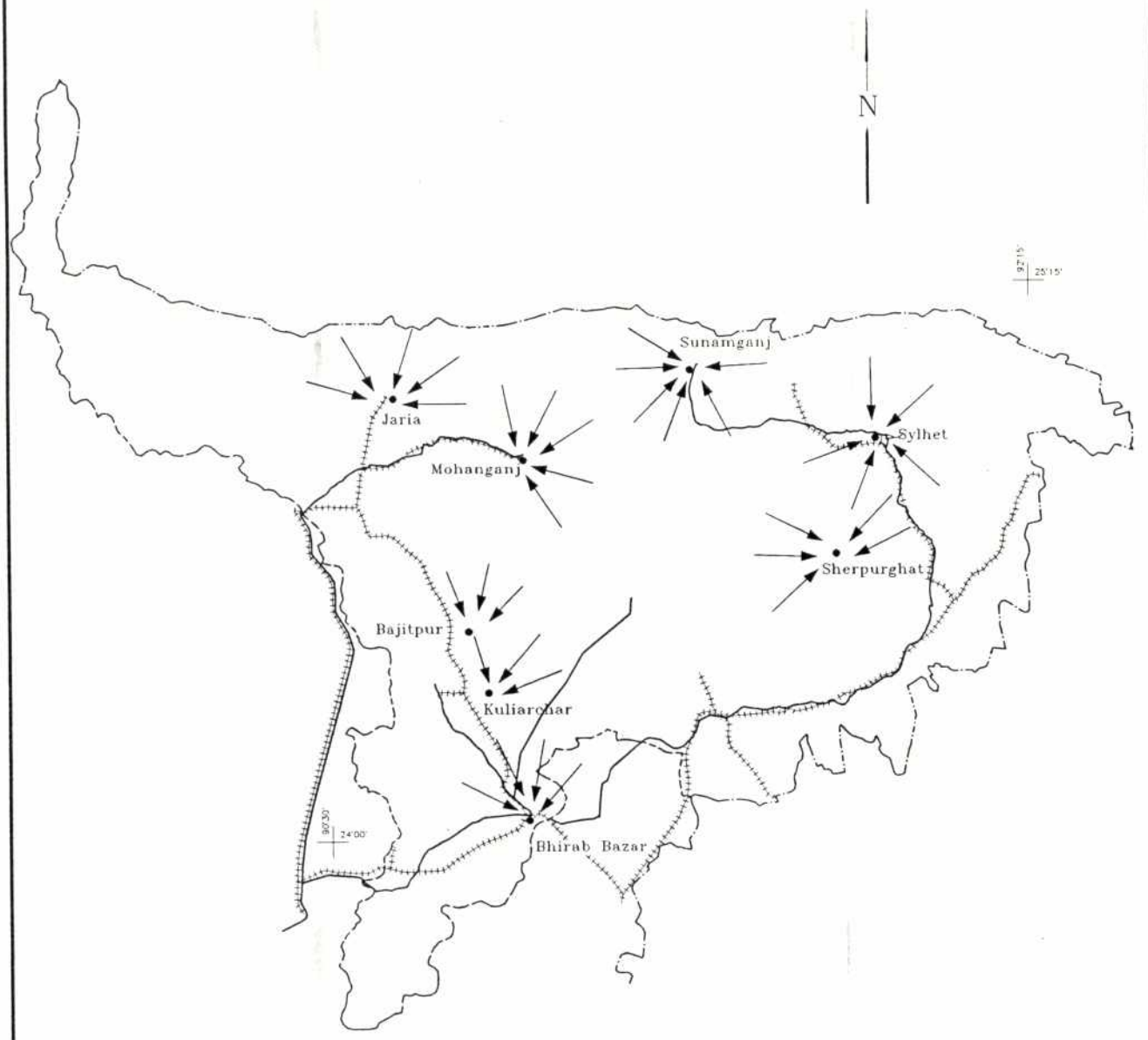
25km 0 25 50km

LEGEND

- International Boundary
- NERP Boundary
- River/Khal
- Patrol Route

Northeast Regional Project		
River Patrol Routes for Duar Sanctuaries		
Prepared by:	NCP	January 1994
Drawn By:	Mamun	AutoCAD Drawing

FILE: NERP-763.DWG



Scale

25km 0 25 50km

LEGEND

- Road
- International Boundary
- NERP Boundary
- Railway

Northeast Regional Project

FISH LANDINGS AND WHOLESALE FISH MARKETS

Prepared by:	NCP	January 1994
Drawn By:	Mamun	AutoCAD Drawing

FILE: NERP-764.DWG

Figure 9

Scale

25km 0 25 50km

LEGEND

- International Boundary
- NERP Boundary
- Railway
- Metalled Road

Northeast Regional Project

MUNICIPAL RETAIL FISH MARKETS

Prepared by:	NCP	January 1994
Drawn By:	Mamun	AutoCAD Drawing

FILE: NERP-772.DWG

ANNEX E

FISH SPECIES IN THE NORTHEAST REGION

ANNEX E: FISH SPECIES IN THE NORTHEAST REGION

Major carps
There are four cyprinid species which are commonly called 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 very rare at present in the region.

The major carps are important commercial species. *rui* is perhaps the most highly esteemed food fish in Bangladesh. *Kalibaus* and *Rui* are generally more abundant in catches than *Catla* and *Mrigel*. *Rui, Mrigel* and *Kalibaus* feed at the bottom 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.

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 suitable spawning localities. Ox-bow bends in particular appear to be favoured, probably because they possess unique hydrological features (deep pools in the outer bend, turbulence, upwelling and backwater currents at the inner bend [Tsai et al, 1981]). Eggs are non-adhesive and drift with the current. The embryo hatches out in 5 to 24 hours, depending on the 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 major carp spawning grounds nearby. Information on spawning localities in the 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 (ie Barak River basin). This suggests that some of the Upper Meghna basin broodstock present in Bangladesh swims upstream into India to spawn and is thus 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). A full account of information collected about carp spawning is presented in Section 2.3.3 below.

Large catfishes

Six species of large catfish occur in the region:

- *Boal* Wallago attu
- *Pangas* Pangasius pangasius
- *Air* Aorichthys aor
- *Guizza Air* Aorichthys seenghala
- *Baghair* Bagarius bagarius
- *Rita* Rita rita

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Boal is the most common species seen in markets followed by *Guizza Air, Air* and *Rita*. A few large *Baghair* are regularly seen. *Pangas* is rare, at least in the upper parts of the region. It is very occasionally caught in the Kushiyara around Sherpur. *Boal* inhabits all manner of lotic and lentic water bodies. It breed on floodplains during the pre-monsoon and monsoon. 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 the soft mud of river 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 region. Occasional individuals appear at markets, and originate from the Kushiyara. *Baghair* occurs in low abundance in the Surma, Kushiyara, Kangsha and Old Brahmaputra. It is a voracious predator. Large specimens have been landed from the Surma (150 kg from near the confluence with the Luba River) and the Kushiyara (120 kg from near the confluence of the Manu River). The latter specimen was sold in Moulvibazar market for Tk 15,000. *Rita* is found in muddy rivers and is carnivorous.

Minor carps

The most common of the minor carps is *Gonia* (Labeo gonius), followed by *Lasu* (Cirrhinus reba). *Nanid* (Labeo nandina) and *Angrot* (Labeo angra) were previously quite abundant but are now almost extinct in the region. *Lasu* feeds on plankton and detritus. *Gonia* breeds during the pre-monsoon on floodplains.

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 (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 place 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), 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 and are very abundant.

Ilish

Although of the greatest economic importance in Bangladesh fisheries as a whole, *Ilish* (Hilsa ilisha) is of only secondary importance in the region. The adults migrate from the sea far up

rivers to spawn. Some stock enters the Upper Meghna and penetrate far up the Kushiyara and Surma. 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 *Ilish* (*Jatka*) are the object of a special river fishery as they move downstream to the sea and are caught in the Surma and Kushiyara in Sunamganj District. Small *Ilish* occasionally appear in markets in the region. Most adult *Ilish* sold is iced product originating from Chittagong and Chandpur.

Snakeheads

Five species of Channa occur in the region:

- *Shol* (Channa striatus)
- *Gajar* (Channa marulius)
- *Tila Shol* (Channa barca)
- *Taki* (Channa punctatus)
- *Cheng* (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 pre-monsoon (March-April) in stagnant waters. A nest is constructed of aquatic weeds. The fry form shoals and are guarded by their parents.

Knifefishes

Chital (Notopterus chitala) is a *boromaach* of substantial commercial importance and is routinely seen at markets. It inhabits beels as well as rivers, but prefers clear water. During the rainy season it spawns in rivers. Breeding takes place in June and July. A nest is over hard structures. 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.

Stingray

Shakush, the large Gangetic Stingray (Himantura fluviatilis), occurs in the Kushiyara. Fishermen caught one specimen weighing 150 kg on 21 July 92 in the Kushiyara a few hundred meters downstream from the confluence of the Manu River.

Miscellaneous species

The remaining part of the indigenous ichthyofauna has been lumped together here as "miscellaneous" species. This includes both commercial and subsistence taxa. **Needlefishes**: *Kaikka* (Xenentodon cutcutia) is a very common predator in beels and flood lands. It is usually marketed in sun dried form. **Minnows, Rasboras and Barbs**: Various small cyprinids such as

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Punti, Chela, Mola 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 and is in demand for export. It occurs in the Surma and its tributaries around Sylhet, Chhatak, and Sunamganj. *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 is in 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 night during the dry season by constructing low bunds out from the shore. It is carnivorous and primarily of subsistence importance. **Mud Perches**: *Bheda* (Nandus nandus) is occasionally seen at markets. It is predatory and common in ditches and on flood lands. **Glassfishes**: *Chanda* (Chanda spp) is found in beels and is marketed in fresh and dry form.

Prawns

The giant freshwater prawn (*Golda Chingra*, 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 prawns species are also abundant and are collectively known as *Itcha*. (Note: The generic term "shrimp" is now applied only to species inhabiting the marine environment).

Exotic Introductions

Five carps, two cichlids and one barb have been introduced to Bangladesh. All are present within the 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.

Dolphin

The Gangetic dolphin, *sisu* (Platanista gangetica), is a mammal, not a fish. It is included in this report because its distribution and habits overlap many *boromaach* species. *Sisu* are especially abundant in the rivers during the rainy season and may also move on to floodplains. During the dry season they stay in deep duars in the larger rivers. Their food consists of most varieties of fish species. A high abundance of fresh water dolphins is one of the indicators of deeper places in a river, higher boromaach abundance and fish migratory routes within the river channel.

Sisu is common in the Surma and Kushiyara, as far upstream as their point of origin from the bifurcation of the Barak River at the Indian border at Amalshid. Dolphins are also seen in the

Babur *duar* near Sheola ferry ghat of the Kushiyara River. Further downstream, dolphins occur at the junction of the pumphouse khal of the Manu River Irrigation Project and the Kushiyara, and at the confluence of the Manu and Kushiyara. Dolphins are especially abundant in the Ajmiriganj area. Near Sullah bazar, a large number are present. This is an inundated shallow area and the presence of dolphins is an indicator of fish abundance. Bordair *duar* is located at the confluence of the Bheramona River and the Bordair khal. The duar is renowned for larger sized catfish (particularly *Air*), *Chitol* and *Guzi* and a number of dolphins inhabit the duar. Dolphins also occur in the Surma River at Sunamganj and near Jamalganj. Fresh water dolphins are most common in the Chamraghat area, particularly at the confluence of the Narasunda and the Dhanu River (near Noagaon village) where they occur in large numbers. There is no targeted fishery for dolphin. Some are occasionally caught by accident in fishermen's nets. The oil is extracted and thought to be beneficial when consumed by pregnant women.