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)

PRE-FEASIBILITY STUDY

POND AQUACULTURE

February 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

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)

PRE-FEASIBILITY STUDY

POND AQUACULTURE

February 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

ACRONYMS AND ABBREVIATIONS

BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advance Study
BFDC	Bangladesh Fisheries Development Corporation
BFRSS	Bangladesh Fisheries Resource System Survey
BKB	Bangladesh Krishi Bank
BRDB	Bangladesh Rural Development Board
BWDB	Bangladesh Water Development Board
CAS	Catch Assessment Survey
DAE	Department of Agricultural Extension
DOF	Department of Fisheries
DPHE	Department of Public Health Engineering
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ERR	Economic Rate of Return
FAP	Flood Action Plan
FCD/I	Flood Control, Drainage and Irrigation
FFW	Food for Work
FPCO	Flood Plan Coordination Organization
FRI	Fisheries Research Institute
FSMF	Fish Seed Multiplication Farm
FW	Future With project scenario
FWO	future without project scenario
GOB	Government of Bangladesh
HTW	Hand Tube Well
HYV	High Yielding Variety
IEE	Initial Environmental Evaluation
ISPAN	Irrigation Support Project Asia Near East
MPO	Master Planning Organization
MSY	Maximum sustainable yield
NERP	Northeast Regional Water Management Project
NFMP	New Fisheries Management Policy
NGO	Non-governmental Organization
NHC	Northwest Hydraulic Consultants
NPV	Net Present Value
PD	Person-day
PWD	Public Works Department
RCC	Reinforced Concrete
RD	Result Demonstrator
RD-12	Rural Development - 12
RHD	Roads and Highways Department
SLI	SNC-Lavalin International
TMA	Technical Management Assistance
UNDP	United Nation Development Programme

US $1 = Tk 38

EXECUTIVE SUMMARY

The project objective is to increase fish production through concentrated and supervised demonstration ponds, and to improve the socio-economic situation of small and landless farmers by providing opportunities for non-agricultural employment.

There are about 0.2 million ponds in the region with a total area of about 18,700 ha . The ponds are classified as cultured (49% by area), culturable (23% by area) and derelict (28% by area). Ponds contribute less than 16% of the overall fish production in the region and the average production from cultured ponds is about 800 kg/ha/year - considerably less than the national average of 1100 kg/ha/year. Little support is extended to aquaculture in the region; the exception being the DANIDA-financed Aquaculture Extension Project, but even this operates only in parts of Kishoreganj and Mymensingh districts.

This initiative proposes direct intervention on 500 ha of culturable ponds and indirect intervention on a further 2,000 ha of culturable ponds. This will involve providing extension support to farmers through training, supervision, and credit in two stages:

- Assist 20% of culturable pond owners (who will become Result Demonstrators) in semi-intensive fish cultivation methods by providing training, follow-up and credit support leading to improved yields on their ponds; and

- Assist the Result Demonstrators in extending these technologies through method demonstrations in their localities.

The project would be implemented by the Department of Fisheries. The project is estimated at about US$1.5 million plus a revolving loan fund of US$1.3 million.

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 prefeasibility 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 Dredging
Mrigi River Drainage Improvement Project
Kushiyara Dredging
Fisheries Management Programme
Fisheries Engineering Measures
Environmental Management, Research, and Education Project (EMREP)
Habiganj-Khowai Area Development
Development of Rural Settlements
Pond Aquaculture
Applied Research for Improved Farming Systems
Manu River Improvement Project
Narayanganj-Narsingdi Project
Narsingdi District Development Project
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
Sarigoyain-Piyain Basin Development

TABLE OF CONTENTS

LIST OF TABLES

1. INTRODUCTION

1.1 General Information

Number of ponds	200828
Total area of ponds	18,744 ha
Number of beels	6,149
Total area of beels	635 sq km
Haor basin (Sylhet Depression)	6000 sq km
Lowland floodplain	13,260 sq km
Piedmont floodplain	960 sq km
Alluvial fans	1,490 sq km
Total (Upper Meghna floodplain)	21,710 sq km
Catchment in India	45,574 sq km
Total river channel lengths	2,150 km
River channel surface area	832 sq km
- Upper Meghna River	336 sq km
- other rivers	496 sq km

1.2 Scope and Methodology

This is a pre-feasibility study that was undertaken intermittently over a period of two months in 1993. The study team consisted of three fisheries specialists. Additional analytical support was provided by 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 pond management. Chapter 4 briefly reviews previous studies and ongoing fisheries development projects, and Chapter 5 provides details of the proposed project. The annexes consist of detailed information to support the main body of the report.

2. BIOPHYSICAL DESCRIPTION

2.1 Location

The proposed 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.

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 Bhairabazar 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 12,000 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 floodplain, then gently sloping piedmont floodplain, 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 elevation and 50% lies below 8 m 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 Floodplain are the deposition and erosion arenas of the major rivers of the region. Land elevations range between 9 and 16 m PWD on the Surma/Kushiyara floodplain, 9 and 22 m PWD on the Old Brahmaputra floodplain, and less than 7 m PWD on the Meghna floodplain. The Piedmont Floodplain are found along tributary streams in the southeastern part of the region. Land elevations range between 9 and 24 m PWD. 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 PWD in the east.

2.4 Hydrology

2.4.1 Runoff Patterns

Most of the region is a self-contained drainage basin (with catchment extending into India) separate and distinct from the other large river systems of Bangladesh (Jamuna, Padma). The region is drained by a single major river channel in the southwest: the Upper Meghna River. This river receives inflow from two large tributaries, the Baulai River coming from the north, and the Kushiyara River from the northeast. The Baulai itself is formed by the confluence of the Kangsha River (which flows from west to east) and the Surma river (which flows east to west). The Surma and Kushiyara share a common origin at the bifurcation of the Barak River which flow into Bangladesh from India at the extreme eastern part of the region at Amalshid. The Kangsha, Surma and Kushiyara receive lower order tributary inflows from numerous small rivers and streams draining the Meghalaya and Tripura Hills, such as the Luba, Jhalukhali, Manu and Khowai Rivers. The western boundary of the region is defined by the Old Brahmaputra channel, which no longer conducts major discharge volumes due to siltation at its origin. The current meagre bank overspill of the Old Brahmaputra has reduced the water supply of rivers to the east (such as the Mogra) which discharge into the Sylhet Depression. The region is crossed by numerous khals and silted up old river beds which conduct drainage flows rather than mainstream discharges.

2.4.2 Flooding

There is extensive pre-monsoon and monsoon flooding in the project area and this constrains the development of pond aquaculture. 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. Un-embanked 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. During the dry season the Upper Meghna River, the Baulai, the Surma as far as Chhatak, and portions of the Kushiyara River have large water depths (although discharge is minimal) and deep scour holes (*duars*). Because of this these rivers are 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 Rivers have shallow water depths (below one metre in depth) and have little flow. It appears that approximately one-third of the project area is inundated annually due partly to the tidal backing-up of the Upper Meghna into the Sylhet Depression.

2.4.4 Water Bodies

Closed water bodies

There are about 201,000 ponds in the region with a total area of 18,700 ha. Many of these are borrow pits which were formed during homestead site preparation. The DOF classifies ponds as cultured (49.1% by area), culturable (22.8%) and derelict (28.1%). The cultured ponds are generally larger and deeper than other ponds and are used for wild fish stock and fingerlings of cultured species. They are mostly located in flood-free areas. Culturable ponds are shallow and are often located in areas subject to flooding. The derelict ponds are in poor condition.

The homestead ponds are used for domestic purposes including bathing, washing, and rearing fish. The ponds are more intensively used during the dry season when water levels are low. Generally about 90 persons may use one pond.

There are many borrow pits adjacent to road embankments.

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 floodplain, piedmont floodplain, alluvial fans). Together these form the larger floodplain of the Upper Meghna River.

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. Essentially, a haor is a small internal drainage basin located on low-lying land between two or more rivers. Haors form as a result of sediment-laden water spilling over the river banks and building up natural levees which eventually enclose the land. Characteristically, there is one or more small lakes (*beels),* at the centre of the haor. The beels are usually connected to the rivers surrounding the haor by one or more drainage channels (*khals)*. Haors are particularly prevalent in the region.

The total number of beels in the region is 6,149. They cover 635 sq km 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.

2.5 Ecology and Swamp Forest

2.5.1 Floodplain Limnology and Water Quality

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). No re-excavation work or cleaning out of ponds has been undertaken for most ponds and a muddy silty layer has formed which lowers water quality. Leaves which fall in the pond can also lower water quality. Water lettuce (Pistia stratoides) also occurs in the region but is not particularly abundant, and therefore not a major problem.

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.

Some water quality problems exist in the region and are described in the Fisheries Specialist Report.

3. SETTLEMENT, DEVELOPMENT, AND RESOURCE MANAGEMENT

3.1 Human Resources

3.1.1 Settlement Patterns

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 and Quality of Life Indicators

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. The average household size in the area is estimated to be 5.34 persons.

3.1.3 Employment and Wage Rates

There are four general occupational categories for fishermen within the production sector as follows:

- Fish farmers, who own ponds and operate at various levels of production intensity. A few fish farmers, mostly in the Kishoreganj and Moulvibazar areas, have developed their ponds and are earning high incomes. Most pond owners however are generating little income from pond aquaculture although there is a good opportunity for increased employment and income.
- 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.

3.1.4 Situation of Women

Women often participate in each step of pond aquaculture from pond preparation, to fish feeding, and maintenance. Women and girls work in fish harvesting in ponds, rice fields, and borrow pits. For the ongoing RD-12 program many women groups have been formed and are operating successful aquaculture ponds.

3.1.5 People's Perception

Numerous interviews were conducted with fish farmers, fish traders, leaseholders, and DOF officials at the District and Thana levels. In the early 1980's local people were mostly interested in open water fisheries. But now due partly to the decline in openwater fisheries local people have shown more interest in pond aquaculture.

3.2 Fisheries Resources

3.2.1 General

Of the 260 species of freshwater fish known to inhabit Bangladesh, over 143 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.

Major carps including some exotic species are the main species used in aquaculture.

The four most common local species used for pond aquaculture (commonly called the major carps) are:

- *Rui* Labeo rohita
- *Catla* Catla catla
- *Mrigel* Cirrhinus mrigala
- *Kalibaus* Labeo calbasu

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 floodplain and small numbers of adults are seen regularly at markets. Silver carp are raised in ponds and have a high growth rate; often they are

marketed after one year. Bighead, grass and black carp are as yet not often seen at markets. The Thai Barb is not yet widely cultured.

There are five exotic species which were introduced to Bangladesh and are now quite commonly used for culture purposes:

- *Common carp* Cyprinous carpio
- *Grass carp* Ctenopharyngodon idellus
- *Tilapia* Oreocromis mossambicus
- *Tilapia* Oreocromis niloticus
- *Silver carp* Hypophthalmichthys molitrics

3.2.2 Ponds and borrowpits

There are about 201,000 ponds in the region with a total area of about 18,700 ha (Table 3.1). Many of these are borrow pits which were formed when homestead sites were prepared. Many ponds are inundated by floods in some years and this threat of flooding often discourages pond owners from investing in fish culture.

Another important microfishery real estate are the borrow pits running along road embankments. These are owned by the RHD and are leased out for fishery purposes. Their water supply is dependent on river overspill flooding and rainfall, while their fish resources 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 part of the dry season katha is installed to harvest 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 embankment construction work are owned by the BWDB and are often leased out for fish production through auctions.

Table 3.1: Fish Ponds

District	Pond (number)	Area (ha)
Sunamganj	32594	2524
Sylhet	32307	2504
Moulvibazar	29179	2260
Habiganj	23186	1796
Kishoreganj	20791	2333
Netrokona	25413	2852
Sherpur	3999	564
Mymensingh	17519	1966
Narsingdi	8110	1026
Narayanganj	3660	420
Gazipur	4070	502
Total	200828	18744

Source: BFRSS 1988/89

3.2.3 Fish Seed Multiplication Farms

There are 11 private and 11 government Fish Seed Multiplication Farms and hatcheries in the Northeast Region. Of the 11 private farms there is one renowned fish hatchery: Gochihata Aquaculture Farm Ltd. Each government farm is producing about 60 kg/yr of hatchlings and about 0.5 million fingerlings per year. Together the private and government hatcheries produce 930 kg of hatchlings and 17.2 million fingerlings per year. Most of the private hatcheries are in the western part of region, except one in Golapganj. Only four government hatcheries are located within the Greater Sylhet District while the other seven are located in the western part of the region (Figure 2).

3.3 Fish Production and Utilization

3.3.1 Specialized Fishing Methods

Katha and de-watering are used in pond and borrow pit fisheries.

Table 3.2: Fish Seed Multiplication Farms

Location	Ownership		Product & capacity		Fingerling production (million)
	DOF	Private	Type	Capacity (kg)	
Sylhet sadar	1	1	Carp,catfish	70	0.6
Golapganj	1	-	Carp	60	0.5
Moulvibazar	1	-	Carp,Catfish	60	0.6
Chunarughat	1	-	Carp	60	0.5
Narsindi	1	1	Carp,Catfish	100	1.0
Katiadi	-	1	Carp	120	1.0
Kishoreganj	1	2	Carp,Catfish	170	5.0
Nandail	1	-	Carp	30	0.5
Iswarganj	1	1	Carp	60	1.0
Gauripur	1	4	Carp,Prawn	120	5.0
Netrokona	1	-	Carp	30	0.5
Dubaura	-	1	Carp	20	0.5
Sherpur	1	-	Carp	30	0.5
	11	11		930	17.2

Katha

Some pond owners install katha in their ponds when flood waters are receding to attract wild fish stock. When water levels are low the pond embankment is closed and the fish trapped in the pond. The katha in its simplest form consists of a pile of tree branches and bushes (hence the quasi-synonymous term "pile fishery"). It is set in a corner of the pond, or borrow pits. Hijal are the preferred branches for *katha* because of their hardness and resistance to rot. *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. *Hijal* and *koroch* branches are not available everywhere in the region. In Hail Haor, Mango (Magnifera indica) *Am*, *Jam* (Syzygium cumini), *Bot* (Ficus benghalensis), *Shobri* and *Shawra* are used. In the Kangsha area mainly *Shawra*, Mango and *Jam* tree branches are used. In the Kaliajuri area *Barun, Mera, Jarul* and *Jam* are used, along with *Hizal* and *Koroch*.

De-watering

Borrow pit de-watering is practiced in 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) would probably yield greater returns over the long run.

3.3.2 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.

The CAS determine the mean yields for each of the three categories: cultured, culturable, and derelict. 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. Generally the samples are too small and there are too few sampling villages.

3.3.3 Production Trends

Pond culture production is growing whereas open water fisheries is declining. Nominal BFRSS statistics for the 6 year period 1983/84 to 1988/89 show the following apparent trends in the region:

Closed water (pond) culture production grew by 9.7% per annum, from 12,340 to 18,075 tons (5,735 tons or 46.5% increment). Ponds contribute 15.8% of overall production. Pond production in greater Mymensingh District is mainly major carps, while in Sylhet *Air, Punti* and other species are also important. Collection of natural carp spawn from the Old Brahmaputra River to supply ponds has declined steeply, but a small recovery took place in 1989. This is a

lucrative business as spawn can sell for up to Tk 5,000 per kg. Pond culture is further supported by 16 carp hatcheries (11 Government and five private) in and around the region. Many pond owners in the region release an uncounted number of fingerling into their ponds without undertaking other basic management activities such as predatory fish eradication and regular application of feed and fertilizer. Other pond owners rely on passive stocking of ponds by flood-borne seed. Monitoring the growth and health of the fish is also not done on a regular basis. The fish are usually harvested during the dry season. It should be noted that the many ponds that adjoin homestead land provide domestic water supply for a wide variety of activities (bathing, washing clothes and dishes, occasionally watering homestead vegetable plots, and so on).

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

3.3.4 Effects of Environmental Variables on Fish Production

Several environmental factors of anthropomorphic origin have some effect on pond and 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. This nutrient loading likely results 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, paralleling human population growth (1.8% per annum over the last 10 years).

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 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.

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.

3.3.5 Fish Marketing

Most of the fish produced by pond aquaculture in the Region is sold in local markets and is not consumed by the family.

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 fish farmers or fishermen. If the *Nikari* has purchased the fish with 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* market) 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 from all sources. Small consignments of cultured fish are generally transported directly to a retail market. Other fish which has to travel long distances is packed in baskets in ice and is sold by the *aratdar* at wholesale markets, where it is bought by *paikers*. The *paikers* transport the fish to retail markets for sale to consumers.

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 Kishoreganj

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 the 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.

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. Retailer trade margins vary between 6% and 33% which is not especially large compared to other developing countries.

3.3.6 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 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.

3.3.7 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 (FAO). 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% was 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 out flow of fish (to Dhaka, other larger Bangladesh urban areas, India and international markets), and an increasing population it is quite probable that regional per capita consumption will decline further.

3.4 Pond Tenure and Management

3.4.1 Pond Ownership

Most of the ponds adjoin homestead land and are owned by rural people. On average about 90 people use one pond. About 95% of the ponds in the Northeast Region are owned by more than one family. Some ponds have been developed be a group of people for their common use and others are owned by the GOB (mainly the revenue department). Multiple ownership of private ponds is a major constraint to the further development of pond aquaculture. Often the different owners of the pond can not agree on taking loans and on the management of the pond.

3.4.2 Pond Leasing

Ponds which are owned by the revenue department or other government department are leased out to the public for fish culture. The ponds are leased out through open auction for one to several years. When multiple owners can not agree on the use of a pond they sometimes will lease it out to a third party for fish culture. Ponds which are on Government land but are close to a public or private institution, may be leased out to that institution for pond aquaculture.

3.4.3 Pond Management

Ponds in the Region are often not properly managed either for domestic use or for fish farming. Because of leakage from some ponds and other factors the water level can go down below one metre in depth and excessive use makes the pond water muddy.

Some pond owners stock wild fish or fingerlings during the monsoon season. Most owners do not follow a culture system but instead do not eradicate predator fish and release an uncounted stock of fingerlings into the pond. The production rate from cultured ponds in the Northeast Region is low; about 800 kg/ha/year whereas the National average is 1,100 kg/ha/year. For culturable ponds in the Northeast Region the production rate is even lower at about 300 kg/ha/year.

There are a number of problems with pond culture in the area. These include the risk of flooding, drought, variable quality of fingerlings, lack of knowledge, and so on. Multi-ownership is a major pond management problem. Conflicts of interest between the needs of fish pond cultivation and other uses such as access for cattle, washing, and bathing make it difficult to reach agreements on pond management under conditions of multiple ownership. The lack of accessible credit has also been identified as one key constraint to aquaculture development. Usually differing opinions by shareholders leads to the pond being under utilized. To make ponds more productive the extension system needs to be strengthened.

4. PREVIOUS STUDIES/EXISTING GOVERNMENT PROJECTS

The Northeast Region is deeply flooded and as a result aquaculture is developing very slowly. There has been no significant effort to develop aquaculture in the region. The studies and government aquaculture projects which have been implemented in other parts of Bangladesh and are considered relavant are described below.

4.1 Integrated Fisheries Development Project

The project was completed in 1992-93. It was funded by the GOB and had the following objectives:

- To increase fish production for domestic consumption through an integrated aquaculture and fisheries development programme.
- to create employment opportunities for the rural people.
- To improve the socio-economic condition of fish farmers and fishermen through increased fish production and increased employment.
- To impart training on modern aquaculture and fisheries management techniques to the fish farmers and fishermen through demonstration/ extension service.
- To adopt the New Fisheries Management Policy and to organize fishermen so that they could have fishing rights in the open water bodies under the project.

4.2 Second Aquaculture Project (Revised 1993)

The project was started in 1987 and has the following objectives:

- to promote the continued growth of shrimp production from pond culture to generate added foreign exchange earnings;
- to increase the availability of fish for domestic consumption, through its carp and floodplain components;
- to expand employment opportunities and increase income in the rural areas;
- to optimize the use of the natural resources of the country; and
- to assist in the rehabilitation/ reconstruction of shrimp farms damaged by the April, 1991 cyclone.

The project included four districts for shrimp culture, 22 districts for carp culture, and the floodplain areas of the greater Meghna River basin districts.

The report states that though the carp sector has also undergone major changes in recent years, principally in hatchery technology and fry raising techniques, the growth in productivity of hatcheries and nurseries has not been matched by improvements in grow out operations. Grow out operations can be improved by adopting better management techniques. Accordingly, the project will address two major constraints to increased productivity. These are slow transfer of technology, and inadequate credit to meet capital and operation costs for fresh and salt water ponds.

4.3 Mymensingh Aquaculture Extension Project

Phase 1.
The Phase 1 program is now complete. The objective of the project was to develop a 'turn key' extension system under joint DOF/DANIDA management which would spread semi-intensive aquaculture techniques and provide access to supervised credit to landless or marginal fish farmers. The project aimed to increase the production of food fish, generate income, and create employment through semi - intensive aquaculture in 2640 ponds. Extension work was carried out through a 'crash' program employing young, local people on a contract basis and training them as extension workers. The main components of the program were: training and extension, credit, technical assistance, and a program for women.

Phase 2.
The Phase 2 program is now ongoing and is an extension of the phase-1 work. The program extends over 26 thanas of greater Mymensingh, Tangail and Gazipur districts and aims to increase fish production through aquaculture. The semi-intensive fish culture techniques developed during phase-1 are being used for a crash program on at least 25,000 ponds.

4.4 March 1990, Credit and the Development of Fish Culture in North West Bangladesh.

This report was a part of the program of socio- economic research for the Dinajpur Fish Culture Development Project. The study included the following issues:

- the significance of credit relations in the fish culture system of the project area arising out of the NGO and Rural Poor Program, and trading network.
- the credit needs for landless people engaging in :
    - nursery pond production;
    - food fish production;
    - borrow pit improvement;
    - marketing of food fish.
- the credit practices among NGOs with a commitment to fish culture, and assess the credit requirements for the different fish culture categories (including raising fingerlings, producing hatchlings, rearing, and producing table fish) .
- the possibilities for supporting the provision of credit to potential NGO 'partners' of the Parbatipur hatchery.

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

The Fourth Five Year Plan 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, coastal areas, and sweet and brackish water areas including khas lands are to be optimally used for culture of shrimp and suitable fish species.

A major target of the Plan is to improve extension capabilities so that pond fish culture systems can be developed throughout the country.

4.6 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 and suggests a gradual, phase-by-phase planning approach. The study also points out that at present planning in Bangladesh is carried out on a sector by sector basis. 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 study describes four culture-based fisheries: pond aquaculture, fish pen and cage systems, integrated fish farming systems, and fish seed multiplication farms. In Bangladesh the pond system on a unit area basis is more than ten times as productive as open water fisheries. Higher productivity rates for intensive pond management systems have been obtained locally under experimental and field conditions. For example, using the Chinese Integrated Fish Farming System adapted for local conditions the annual yields have been more than 10 tons/ha/yr. Thus, the technology is available in Bangladesh to greatly increase fish production. The study proposes that pond fish culture production can increased more than tenfold from 0.6 to 10 tons/ha/yr. Aquaculture is thus the sub-sector which has the potential and opportunity of greater growth in fish supply for the country. Of the total pond area in Bangladesh only about 43% is presently being used for fish culture.

The study also recommended that fisheries credit programmes should be modelled after the Grameen Bank model. The report assumed that no liberal credit policy or special concessions would need to be extended to ensure the success of a credit program. The main requirements are that: (1) those implementing the credit programme be fair and honest, (2) that the fishermen do not have the perception of being exploited by the programme, and (3) the Grameen credit program model be adapted and modified to suit the needs of the fishing community.

The study recommended that GOB's main fisheries development thrusts should be (1) to actively promote aquaculture, (2) improved management of open water fisheries, (3) more importance given to fishery laws, and (4) enforcement for stock conservation regulations.

4.7 BARC/ICLARM/USAID Workshop on Inland Aquaculture Development Strategies for Bangladesh, September, 1991.

The workshop concluded that the existing extension service of the DOF is undersized and presently not capable of undertaking the enormous task of providing extension services to a client group of about 22 million. For aquaculture development, a "trickle down" extension approach is presently being followed by the DOF in 11 districts under a FAO/UNDP assisted project. Initially farmers meeting certain criteria are selected. The fish farms are designed to meet the farmers' own resources, activities, and areas of interest. While designing the farming plan proper care is taken to honour the farmers' values and traditions. The initial fish farmers are designated as Result Demonstrators (RDs) and are assigned to demonstrate the results of their selected aquaculture practice in their ponds. The improved aquaculture practices are demonstrated to at least ten neighbouring fish farmers who are designated as Fellow Fish Farmers (FFs).

4.8 FAO/UNDP, Programming Mission Report on the Fishery Sector, 1992.

Pond fishery is an important component of the Bangladesh fishery. Total aquaculture production (mainly carp species) in 1989 was about 163,000 tons. Production increased by 27% during the period from 1983 to 1989. Annual growth rate was about seven percent.

There is considerable potential to increase pond production. There are about 1.3 million ponds in the country covering an area of 147,000 ha. At the national level , 46% of the ponds (covering 52% of pond area) are cultured. Present production is low partly because of high risks associated with flooding and drought, and because pond owners and operators lack technical knowledge about aquaculture. The risk of flooding and drought can not be eliminated, but knowledge on aquaculture can be improved through extension services. Proposed technology must be adapted to suit the financial and technical realities of farm and market conditions.

The World Bank (1991) projected that pond fishery production could double from 150,000 tons(1987-88) to about 296,000 tons in 2010 with an annual growth rate ranging between 3.2% and 3.7%.

Constraints are as follows:

- Ponds are not specifically designed for fish culture and require physical improvements.
- Multiple ownership of a pond makes decision-making difficult especially when investments are needed for physical improvement of ponds.
- Private pond owners are constrained by a lack of knowledge on aquaculture techniques, lack of quality seeds, lack of credit, and high risks.

- Multiple use of ponds including irrigation interferes with fish culture.

Needed action was recommended as follows:

- Physical improvements should be made to ponds including facilities to drain and fill the ponds, removal of predatory fish population, removal of weeds, and dredging deteriorated sediments.

- Development of infrastructure: access roads, marketing facilities, landing sites, transport and storage facilities, and easily accessible markets.

- Strengthening of management and extension activities on aquaculture techniques.

- Increased supply of quality fish seed and development of private hatcheries and nurseries for fry and fingerlings.

- Easier access to credit from institutional sources.

4.9 Rural Development Project -12.

Objectives of the project include increased rural production and employment. The ongoing program is funded by CIDA includes a credit system and a revolving loan fund which is providing credit to Bittaheen Society members in support of income generating activities. The credit facilities are operated partly at thana level through primary groups, solidarity groups, and individual members. Most first time loans are about Tk.1,500. Many of the loans have been for pond aquaculture development. RD-12 report that forming of agreements with multiple-owners of ponds has been a major problem. Many loans have been to women. Repayment of loans has been good; over 93%.

The project aims to establish a revolving fund which is self-sustaining. The credit society is expected to service some 14,500 primary societies having a membership of about 362,500. Loan recovery rates of 95% are expected.

5. PROPOSED POND AQUACULTURE

5.1 Rationale

The proposed pond aquaculture project would provide extension and management to support semi-intensive culture to about 18,700 ha of ponds in the Northeast Region. The project is expected to increase culture fish production by very roughly eight times present production. An improved pond culture system will benefit pond owners and labourers by increasing income and per capita availability of protein.

5.2 Objectives

Objectives of the project are:

- to provide direct extension support to 20% of the targeted culturable pond owners of 10 Districts in the Northeast Region.
- to demonstrate the benefits of pond fish culture to the owners of 200,828 ponds of the region.
- to provide a source of income to poor people having culturable ponds.
- to provide more employment to poor people of the region.
- to promote involvement of women in fish culture.
- to increase protein availability in the region.

5.3 Project Description

The project proposes to develop semi-intensive aquaculture techniques through demonstration ponds and extension work, and provide access to a supervised revolving loan fund to marginal fish farmers. The program would be jointly managed by DOF and NGOs. Initially semi-intensive aquaculture would be introduced to about 5,000 ponds (20% of the targeted pond) in the Northeast Region. Ponds would be selected from existing culturable ponds located in flood-free or in flood-protected areas. It is proposed that local people would be employed on a contract basis and be trained as extension workers. The main components of the program are: training and extension, credit facilities through a revolving loan fund, technical management assistance, and a program for women.

The following activities are included in the project:

- About 5,000 culturable ponds (20% of the targeted ponds) covering 500 ha will be brought under direct supervision of the project and used as Result Demonstration Ponds.

92

- Indirect intervention of a further 2,000 ha of culturable ponds.
- Training of 5000 Result Demonstrators (pond owners) on semi-intensive fish culture techniques.
- Training of 10,000 fellow farmers on improved fish culture.
- Provide a revolving loan/credit to the Result Demonstration Pond owner to follow-up the program.
- Strengthening of extension activities on aquaculture techniques and pond management.
- Regular follow-up activities.

5.4 Project Operation and Maintenance

The overall project would be controlled by the Technical Management Assistance (TMA) office in Sylhet. This office would also supervise the eastern part of the project area. The western part of the program would be supervised through a sub-office located in Kishoreganj. Each office would be managed by a senior fisheries consultant and two fisheries extension biologists. One senior level government DOF official would be needed at the sylhet office. Technical Management Assistance branches would be responsible for implementation. District Fishery Officers (DFOs) and Thana Fishery Officers (TFOs) would select the fish farms. They would also supervise the progress of the project. TFOs would be responsible for administrative and logistic support to the extension officers and farmers involved in the project.

5.5 Organization and Management

During the early part of the feasibility study process, at least one central client team and one sub-client team in each district would be needed to oversee project development. Each sub-client team would be composed of a District Fishery Officer, fishery survey officer, representative from fishermen, fish farmer, related NGOs, and BKB while the central client team would be composed of DFOs, consultants, and NGOs. Each sub-client group would select the suitable locations and prepare a list of farmers' priorities, the scope for extension work, and scope for demonstration of the project. Regular discussions would be held during the feasibility work and the suggestions from the sub-client group would be would be factored into the studies. During implementation these teams would monitor progress.

The DOF would be the implementation agency and would administer the project.

The Ministry of Lands would be encouraged when leasing out khas ponds to include a condition that they be used as demonstration ponds.

Bangladesh Bank/BKB would provide logistic support for credit to the fish farmers.

5.6 Project Cost Estimate

Total project costs are estimated at Tk 105.5 million. This preliminary estimate includes Tk. 50 million which would be used as a revolving fund. Administrative support costs for DOF officials is estimated at Tk. 12.55 million, extension support at Tk. 24 million and project management at Tk. 18.95 million (Table 5.1). Vehicles required for the project would include 63 motor cycles and two jeeps. A breakdown of the estimates is given in Annex B.

Table 5.1: Summary of Costs

Item of Cost	Taka (10^6)
Revolving fund	50.00
Admin. Support	12.55
Ext. Support	24.00
Project Manag.	18.95
TOTAL	**105.50**

Notes: Total number of targeted ponds - 5000
Total Area - 500 ha

5.7 Project Phasing and Disbursement period

Six years are required to implement the project. One year is required for completion of feasibility studies and conducting field surveys. Extension support would start in year one and continue throughout the project. The revolving fund would start in year two and continue through the end of the project.

5.8 Evaluation

5.8.1 Environmental

This project will improve the pond environment by:

- increased pond water volume throughout the year by improving pond embankments, and reducing leakage.
- improved ecological condition of culturable pond.

5.8.2 Social

Employment
There will be an overall increase in direct employment for about 26,260 culturable pond owners (about 50,000 families) of the region and by landless people. Other pond owners (cultured and derelict) would be motivated to improve culture techniques through the project's demonstration program.

Equity
The net equity impact would appear to be somewhat progressive. Who benefits?

- Pond owners benefit directly from investment in aquaculture development and its distribution is *regressive*.

- Landless people get a direct employment benefit. *Progressive.*

Gender Equity
The net equity impact is progressive. Many groups of women would be expected to participate in the program. Employment opportunities would increase.

5.8.3 Costs - Benefits

It is considered that the objectives of this project are necessary, desirable, and of high priority. To achieve these objectives, technical options were evaluated and chosen, based in part, on cost-effectiveness. The project components were partly modelled on successful ongoing aquaculture projects in Bangladesh. The possible benefits of the proposed project would appear to be large based on the success of similar projects in other areas of Bangladesh. However at this time it is not possible to accurately predict expected aquaculture benefits in the Northeast Region. Hence it was decided that computations of economic benefits and rates of return from the project would not be meaningful at this stage.

5.8.4 Qualitative Impact Analysis

The qualitative criteria shown in Table 5.2 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). The sign reflects whether the impact is positive or negative.

Table 5.2: Qualitative Impact Analysis

Qualitative Impacts (ranked from -5 ...0... +5)	
Impact	**Rank**
Ecological Character	+5
Regional Biodiversity	+3
Flood Levels Outside Project Area	+4
Conflicts	+3
Socioeconomic Equity	+2
Gender Equity	+3
Decentralized Organization and Management	0
Responds to Public Concerns	+3
Conformity to Regional Strategy	+5

5.8.5 Summary Analysis

From a multi criteria perspective, the project is attractive in the following respects:

The positive aspects of the project are:

- Utilization of productive culturable abundant ponds.
- Substantial increase in fish production.
- Increased economic return to pond owners.
- Rate of return is attractive.
- General equity impact is progressive.
- Gender equity impact is progressive.
- Project responds to public concerns.

ANNEX A

EXISTING PONDS

ANNEX A: EXISTING PONDS

Existing Ponds:

District	Thana	Culturable pond		
		Targeted %	Number	Area (ha)
Habiganj	Baniachanj	50	780	54
	Chunarughat	100	1330	92
	Bahubal	60	478	33
	Habiganj	60	463	32
	Madhabpur	60	567	39
	Nabigonj	50	706	49
Sub Total			**4324**	**299**
Moulvibazar	Baralekha	50	698	48
	Kulaura	50	1150	80
	Kamalgonj	60	1390	96
	Moulvibazar	100	1093	76
	Rajnagar	100	1388	96
	Srimongal	100	1544	107
Sub Total			**6263**	**503**
Sylhet	Balagonj	50	608	42
	Beanibazar	80	638	44
	Biswanath	40	269	19
	Companiganj	30	276	19
	Fenchuganj	50	172	12
	Golapgonj	100	862	60
	Goainghat	50	895	62
	Jointapur	50	320	22
	Kanairghat	50	636	44
	Kotwaly	100	1725	119
	Zakigonj	60	123	36
Sub Total			**6524**	**479**

District	Thana	Culturable pond		
Sunamganj	Biswamberpur	20	107	7
	Chhatak	80	1137	79
	Dharmapasha	10	71	5
	Dowarabazar	10	83	6
	Jaganathpur	10	115	8
	Jamalgonj	10	92	6
	Sunamganj	40	700	48
Sub Total			**2305**	**159**
Narayanganj	Sonargaon, Bandar, Rupganj, Arai hazar	**100**	**782**	**168**
Narsingdi	All Thana	**100**	**2149**	**416**
Sherpur	All Thana	**100**	**824**	**166**
Kishoreganj	Astagram	**30**	**194**	**12**
	Bhairab	30	70	5
	Katiadi	100	439	30
	Kuliarchar	20	41	5
	Pakundia	5	357	24
	Tarail	40	112	7
Sub Total			**1213**	**83**
Mymensingh	Haluaghat	100	605	40
	Nandail	100	646	43
	Phulpur	100	1205	80
Sub Total			**1456**	**163**
Netrokona	Purbadhala	20	136	10
	Mohangonj	20	97	6
	Durgapur	20	108	7
	Atpara	20	78	5
			419	**28**
T O T A L			**26259**	**2464**

ANNEX B

COST ANALYSIS

ANNEX B : COST ANALYSIS

Table B.1 : Bill of Quantities

Item	Description of Item	Unit	Quantity	Cost (TK/Unit)	Amount (MTK)
Extension Support Programme	1. Per diem to 2500 RD (Result Demonstrator) for six days in a year for four years	day	60,000	50	3.00
	2. Supply of training materials to 2500 RD trainees in every year for four years	person-year	10,000	200	2.00
	3. Per diem to additional 10,000 trainees for three days in a year for four years	day	120,000	50	6.00
	4. Supply of training materials to additional 10,000 trainees in every year for four years	person-year	40,000	200	8.00
	5. Establishment cost for training centres for four years	L.S			5.00
Sub-Total					24.00
Project Management Cost	1. Two Senior Consultants to conduct the programme for five years	mm	120	60,000	7.20
	2. Four Extension officer for five years	mm	240	15,000	3.60
	3. Seven Support staff for five years	mm	420	6,000	2.50
	4. Purchase of vehicle (2 Jeep, 5 motor cycles)	L.S			1.90
	5. Office contingencies including office rent, maintenance of vehicles and fuel etc	month	60	62,500	3.75
Sub-Total					18.95
Co-ordination and Supervision from Fisheries Directorate	1. Per diem to 58 Thana Fisheries officer for co-ordination and supervision of the programme	Month	3500	2000	7.00
	2. Per diem to 10 District Fisheries officer	month	600	2000	1.20
	3. Purchase of 58 motor cycles including maintenance and fuel cost	nos.	58	75,000	4.35
Sub-Total					12.55
Total Cost					**55.50**

Note: 1) A revolving fund of TK 50.00 million will be required to provide credit to the pond owners for re-excavation of derelict ponds, treatment of the ponds, weed eradication and purchase of fingerlings etc.

2) A contingency of 15% is included for each item.

Table B.2 : Expenses Schedule

Item of Work	Base Cost (MTK)	Expenses(MTK)				
		1st Year	2nd Year	3rd Year	4th Year	5th Year
1. Extension Support Programme	24.00	6.00	6.00	6.00	6.00	-
2. Project Management Programme						
- Purchase of vehicles	1.90	1.90	-	-	-	-
- Others	17.05	3.41	3.41	3.41	3.41	3.41
3. Co-ordination and Supervision from Fisheries Directorate						
- Purchase of vehicles	4.35	4.35	-	-	-	-
- Others	8.20	1.64	1.64	1.64	1.64	1.64
Total	55.50	**17.30**	**11.05**	**11.05**	**11.05**	**5.05**

Note: Revolving fund of TK 50.00 million not shown.

ANNEX C

INITIAL ENVIRONMENTAL EVALUATION

ANNEX C: INITIAL ENVIRONMENTAL EVALUATION

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: Proposed FCD Project

C.2.1 Project Design and Description (Step 1)

As in Section 5.3, 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 Related Studies.

C.2.4 Bounding (Step 4)

Physical:

Gross area: 4300 ha. (total culturable ponds in region).
Impacted (net) area: 500 ha. (ponds)
Impacted area outside project: Pond Aquaculture program will have a positive impact on cultured ponds (about 9200 ha) and derelict ponds (about 5200 ha) in the region. No negative impacts are expected outside the pond area.

Temporal:

Preconstruction: years zero through year one
Construction: Year one through year four.
Operation: year three through year 20.
Abandonment: after year 20.

C.2.5 Field Investigations (Step 5)

Field investigations were limited by several weeks of field work by the Fisheries Specialist 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

Impacts are discussed in Section 5.8.1

C.2.7 Quantify and Value Impacts (Step 7)

Quantification and evaluation of impacts is documented in Section 5.8 .

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.

Monitoring. There is a need to define monitoring needs and methodologies at regional, institutional (DOF), 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 Pond Aquaculture program is operational, investment in aquaculture will likely rise. This increases the total amount of farmers' assets that are at risk should an extreme flood event occur or the pond embankment fail for any reason.

EMP institutionalization. Arrangements for sharing EMP responsibility between DOF and local people would need to be worked out. Project implementation should be contingent upon agreement on this matter between DOF and local people.

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 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.

Table C2: 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
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										
	Abnormal	Suspension of construction before completion, construction delays										
		Incorrect construction practices or techniques										
Construction (continued)	Abnormal (cont'd)											

Table C2: 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
Operation	Normal	Pre-monsoon flood protection	+		+	+	+	+	+			
		Monsoon flood protection	+		+	+	+	+	+			
		Surface water irrigation										
		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

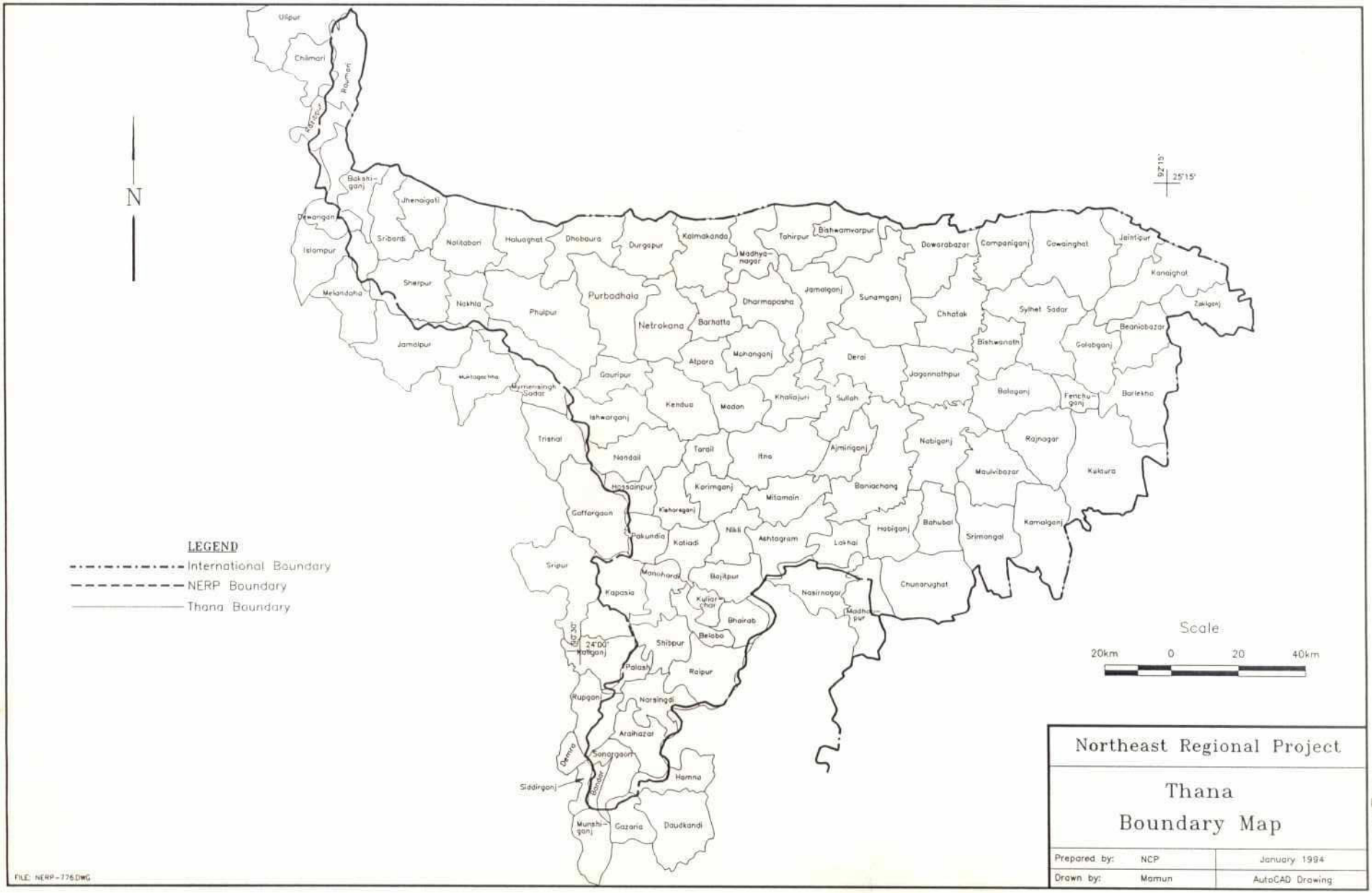
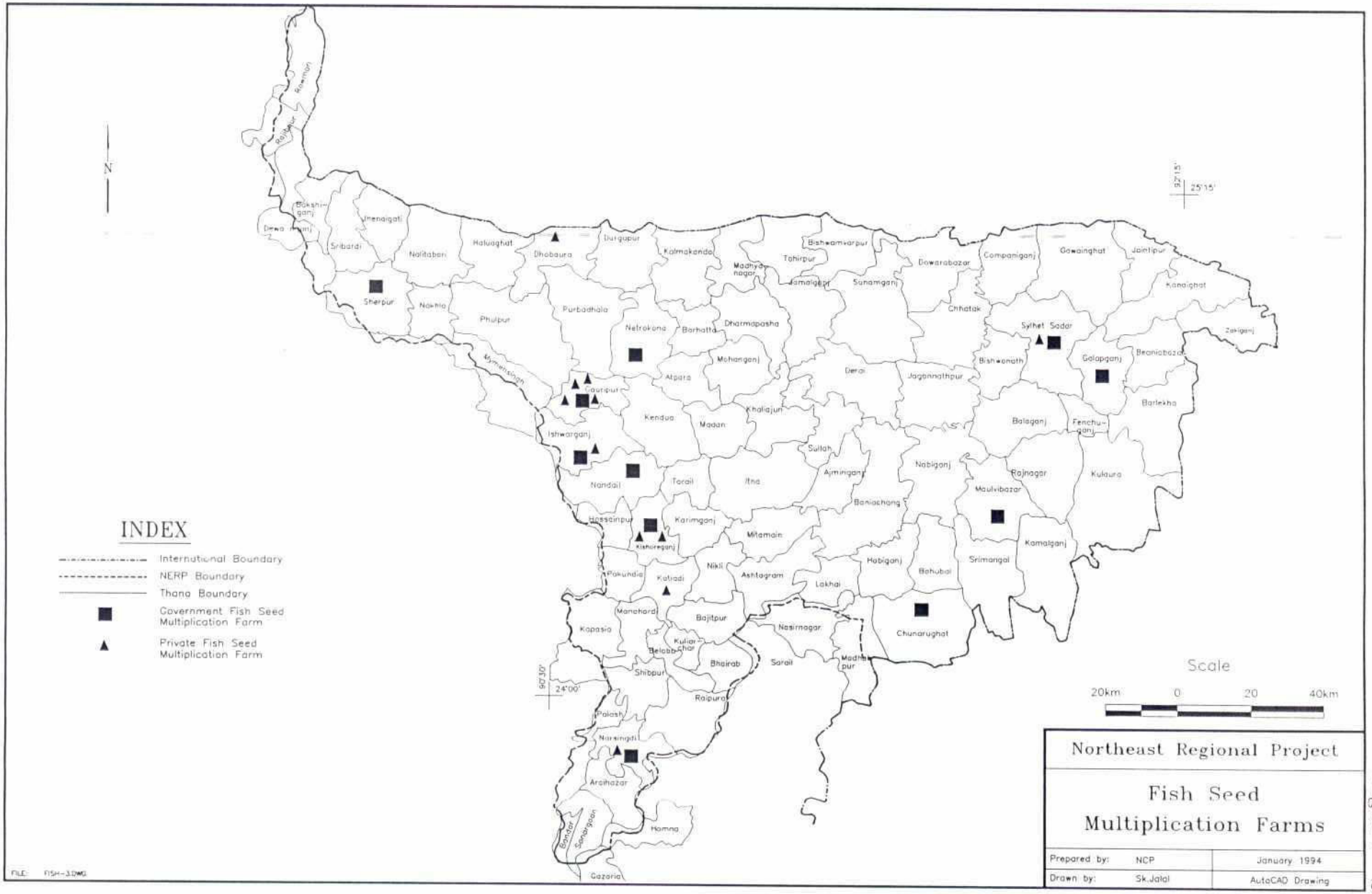

N
LEGEND
International Boundary
NERP Boundary
Thana Boundary
Scale
20km 0 20 40km
Northeast Regional Project
Thana
Boundary Map
Prepared by: NCP
January 1994
Drawn by: Mamun
AutoCAD Drawing
FILE: NERP-776.DWG
Ulipur
Chilmari
Rajibpur
Dewanganj
Islampur
Melandaha
Sharpur
Jamalpur
Sribardi
Nalitabari
Jhenaigati
Bakshiganj
Nakhla
Phulpur
Haluaghat
Dhobaura
Durgapur
Kalmakanda
Madhyanagar
Tahirpur
Bishwamvarpur
Purbadhala
Netrokana
Barhatta
Dharmapasha
Jamalganj
Sunamganj
Dowarabazar
Companiganj
Gowainghat
Jaintiapur
Kanaighat
Zakiganj
Sylhet Sadar
Chhatak
Beanibazar
Golabganj
Bishwanath
Derai
Jagannathpur
Balaganj
Fenchuganj
Barlekha
Mymensingh Sadar
Muktagacha
Gauripur
Atpara
Mohanganj
Kendua
Madan
Khaliajuri
Sullah
Ishwarganj
Trishal
Nandail
Tarail
Itna
Ajmiriganj
Nabiganj
Rajnagar
Kulaura
Moulvibazar
Hossainpur
Karimganj
Mitamain
Baniachang
Kishoreganj
Gaffargaon
Pakundia
Katiadi
Nikli
Ashtagram
Lakhai
Habiganj
Bahubal
Srimangal
Kamalganj
Sripur
Manohardi
Bajitpur
Kapasia
Kuliar Char
Nasirnagar
Madhabpur
Chunarughat
Bhairab
Belabo
Shibpur
Palash
Raipur
Rupganj
Narsingdi
Araihazar
Sonargaon
Demra
Buriganga
Siddirganj
Hamna
Munshiganj
Gazaria
Daudkandi

Figure 1



Northeast Regional Project

Fish Seed Multiplication Farms

Prepared by:	NCP	January 1994
Drawn by:	Sk.Jalal	AutoCAD Drawing

Figure 2