BANGLADESH FLOOD ACTION PLAN

Ministry of Water Resources
Flood Plan Coordination Organization (FPCO)

5

Potential Impacts of Flood Control on the Biological Diversity and Nutritional Value of Subsistence Fisheries in Bangladesh

April 1995

Prepared by

Environmental Study

FAP 16

ISPAN

IRRIGATION SUPPORT PROJECT FOR ASIA AND THE NEAR EAST

Sponsored by the U.S. Agency for International Development

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ACRONYMS

ADB	Asian Development Bank
BWDB	Bangladesh Water Development Board
CPP	Compartmentalization Pilot Project
DOF	Department of Fisheries
EIA	Environmental Impact Assessment
FCD/I	Flood Control, Drainage, and Irrigation
FCD	Flood Control and Drainage
FEZ	Fisheries Ecological Zone
FPCO	Flood Plan Coordination Organization
ISPAN	Irrigation Support Project for Asia and the Near East
MPO	Master Plan Organization

EXECUTIVE SUMMARY

1. Introduction

1.1 Objectives

This study of fisheries biodiversity examines four areas of Bangladesh where flood mitigation projects have been planned or executed. Its purpose is to assess the direct impact of flood mitigation on fish populations and the indirect nutritional consequences of fisheries losses. The study has six specific objectives:

- Establish baseline data on fish consumption by people within the floodplain.
- Measure the extent of community participation and use of fisheries.
- Develop methods for assessing household fish consumption.
- Evaluate the potential effects of flood control projects on fish biodiversity and related household nutrition.
- Assess the migration patterns of floodplain species.
- Ascertain seasonal variation of fish species and their market price.

The areas studied were:

- The Tangail Compartmentalization Pilot Project (CPP) in the Brahmaputra floodplain (Tangail and Delduar).
- The Surma-Kushiyara Project in the Surma-Kushiyara floodplain (Zakiganj, Kanaighat, and Bianibazar).
- The Chalan Beel Project in the Ganges-Atrai floodplain (Singra).
- The Meghna-Dhonagoda Flood Control and Irrigation Project in the Meghna floodplain (Matlab).

1.2 Background

In Bangladesh, fish is second only to rice as a source of food, and it is the primary source of protein for the poor. The 1980-81 Nutritional Survey of Bangladesh found that of 28 grams of animal protein consumed per capita, 80 percent, or 22 grams, came from fish. Although nutrition is seldom linked to the diversity of available fish species, the Bangladeshi people eat a wide variety of fish on a regular basis. The Household Survey conducted for this study found that people consumed anywhere from 56 to 73 different species of fish. Despite its apparent importance, the dietary contributions of the fish species of Bangladesh have received little scientific study.

Fish also play an important role in the economy of Bangladesh. More than 1.1 million people are involved in the country's commercial fisheries, and an estimated 73 percent of rural families engage in part-time fish capture from floodplains, rivers, and *beels*. Large numbers, perhaps millions of otherwise "unemployed" people work in this wageless labor system and produce food for their families by catching fish.

Bangladesh has one of the richest inland fisheries in the world. The country's aquatic fauna reportedly comprises more than 260 fish species (Rahman 1989)—more than all the states of Europe combined (Rainboth 1990). According to the Bangladesh Bureau of Statistics (BBS 1992), this resource has been declining rapidly over the past two decades. Should this trend continue, declines both in number of species and in production seem inevitable.

1.3 Flood Control and Fisheries

The complex community of fish species in Bangladesh is highly dependent on seasonal inundation and on floodplain access, both of which can be negatively affected by flood control projects. The negative impact of flood control projects on fisheries has been well documented and analyzed. Many fisheries losses can be directly attributed to habitat destruction related to changes in the water regime such as the building of embankments and raised roads that block water flow, the use of regulators to change the flow of water through canals, and delaying flooding through the use of submersible embankments. These activities are expected to continue into the foreseeable future, with consequent declines in the quantity and diversity of fish species.

According to the MPO, 3.14 million hectares of the country will be brought under FCD and FCD/I projects by the year 2005. A full 2 million hectares will become flood-free, and the aquatic environment of 1.4 million hectares will be greatly changed by delayed flooding or reduced water surface area. If these projections come true, one third of Bangladesh's floodplain area will have vanished over only two decades (MPO 1985).

The effect the Flood Action Plan will have on these projections depends on what actions are taken. Mitigation projects must concentrate on improving drainage and reopening access routes between the floodplain and river for fish and fishing boats. If this is done, flood damage to crops and property caused by drainage congestion will decrease, and fish production will be maintained. Alternatively, if those projects further restrict the size of the floodplain and impede access to it, dramatic reductions in fish populations and harvest will invariably follow at incalculable costs to the country.

1.4 Evaluating Project Impact

The Interim Report of the Tangail Compartmentalization Pilot Project (FAP 20), estimated present annual fish production in the project area is 420 tons annually, of which 40 tons is from aquaculture (FPCO, Compartmentalization, 1992). Losses of capture fisheries were estimated under 12 potential scenarios to range from a minimum of 47 tons per year to 138 tons per year. The estimated value of lost capture fishery under Scenario 4, which results in the highest predicted loss of 138 tons, is Tk. 6.85 million. Such an estimate of lost fisheries value would normally be considered sufficient for the cost-benefit analysis in a project feasibility study. The fisheries analysis in the proposed Tangail project feasibility study is an improvement over previous analyses.

In the past, estimates of the impact of flood control, drainage, and irrigation projects on subsistence fisheries suffered from an absence of data. Most findings were based on large, aggregated estimates of production and consumption. Fishery losses attributable to FCD/I were assessed independent of basic information on the structure of fish communities and their relationship to human consumption patterns. As a result, planners, even with the best of intentions, lacked the tools for understanding the economic importance of Bangladesh's capture fisheries. This resulted in underestimations of environmental impacts and failure to consider the nutritional implications of species diversity for the rural poor.

Capture fisheries are a depletable resource, and when assessing a project, some form of scarcity premium is required to reflect the dimension of fish population (Shahabuddin & Rahman 1992). Moreover, those fisheries are a source of protein for poor households, which may not purchase fish from the market. In calculating the impact of a flood control project, therefore, it is necessary to include measure of cost to account for "income" lost when capture fisheries are destroyed. A weighting based on income loss multiplied by the marginal utility of income may be useful in this regard. The loss of food could be reflected in the income value of fish based on the cost of providing equivalent food value and nutrition.

2. Household Survey

Each of the selected households was surveyed for one year in three cycles, each of which covered a period of 17.33 weeks. The households were visited three times daily (morning, afternoon, and evening) for seven consecutive days per cycle. At each visit detailed information was gathered about family composition, food intake and meal composition, and the source of fish.

2.1 Consumption

The overall average per capita food consumption rate in the survey area was 25 gm/day; the national average in 1991 was 22 gm/day. After rice and vegetables, fish was the food most commonly consumed: 85 percent of households ate fish at least once a week, and the average household ate fish 3.5 days per week, compared to 2.1 days for pulses, and 0.5 for meat.

Fish was also found to be the most important protein source for pregnant and nursing women and for children over two years old. During Cycles 1 and 3, almost half of the school children surveyed had eaten fish for breakfast, and nearly two thirds had eaten it at dinner the previous evening. Even during the period of least availability in Cycle 2, one third of the children had fish for breakfast, and almost half had it for dinner. During Cycle 3, school children reported consuming 50 species of fresh fish during these meals.

Capture fisheries account for 90 percent of the fish consumed by rural people. As would be expected, small and medium farmers consumed more fish than landless and marginal farmers, although the amounts varied between the surveyed regions.

The survey results indicate that large numbers of species were consumed in every area, ranging from 56 in Tangail to 73 in Singra. Ranking the species consumed offers a perspective on the relative importance of each to the overall diet of rural people. Capture fish, particularly small species, are important sources of protein. The Household Survey found that 43 percent of all fish consumption consists of small species, while only 13 percent is carp. Of the top 10 species consumed, only two, silver carp and telapia, are culture fish, and six, *pooti, koi, foli, koi, kachki, chanda,* and *kholisha*, are small capture species. Variations between cycles represent species seasonality, for example, *ilish* ranked highest during monsoon season, which started in Cycle 2 and ended in Cycle 3.

2.2 Source of Catch

Sixty-one percent of the reported subsistence fishery catch comes from *beels*, floodplains, and canals—the sources most adversely affected by FCD projects. Another 29 percent of the catch comes from ponds, which also may be severely depleted by FCD projects. More than 81 percent of the pond catch is capture fish that are dependent on annual inundation.

2.3 Income and Employment

The average value of fish consumed by households was Tk. 610, and the average value sold was Tk. 618, making the total value of subsistence fishing Tk. 1,228. For landless households, the cash income from selling fish averaged Tk. 484, and the value of fish consumed or sold was Tk. 966 per household, bringing the total value to Tk. 1,450.

In all four survey areas most people reported that they worked in agriculture—3.6 days out of every 8.4 days. Fishing accounted for 1.2 days and other activities made up the remaining 3.9 days of work. The average number of people engaged in fishing per household for all areas is 0.40 compared to 0.73 in agriculture.

2.4 Value of Fisheries

There is considerable regional variation in market prices. Lower prices reflect distance from, and limited access to, urban markets. The average market price for small fish was 47 Tk./kg; shrimp, 35; catfish, 63; snakeheads, 46; and carp, 53.

Assuming a 1.25 scarcity premium and standard conversion factor of 0.87, the average economic prices for species groups in Tk./kg are: small fish, 51; shrimp, 38; catfish, 68; snakeheads, 49; and carp, 58.

Although preliminary figures indicate that fish stocking may be an economically promising method of boosting fish production, the benefits of the increased productivity may go to relatively wealthy landowners, leaseholders, and middlemen. These people profit as the culture fish are sold in large markets, while the poor, who do not have ponds or land on which to dig tanks, do not benefit.

3. Fish Migration

Almost every inland freshwater fish species in the Ganges-Brahmaputra floodplain migrates to fulfil some biological need, whether spawning, feeding, larval development, or early growth. Each of these activities requires a specific habitat, and the fish migrate accordingly. In general, fish migrate in two ways: upstream and downstream in river channels and back and forth between rivers and their floodplains.

Most fish in the Ganges-Brahmaputra river system leave their dry season refuge before or during early monsoon season and move toward their spawning grounds. The spawning destination depends on the species; some prefer river channels (carp), some newly inundated floodplain (catfish), and some stagnant pools (snakeheads). Spawning is timed with temperature rises, rainfall, and water flow.

The early monsoon season peak, coinciding with the coming of the rains, consists of gravid catfish, particularly *aair* and *boal*, as well as *tengras* and *boro baim*, all of which are assumed to spawn in the floodplain. In addition, the eggs, larvae, juveniles, and adults of many other species use the floodplain for spawning, nursing, and feeding. Many species of small fish and shrimp, for example, which can breed in *beels* and stagnant pools, were observed migrating against the heavy current of early monsoon season to reach the floodplain.

The highest level of spawning migration from river to floodplain occurs during the first few days of the influx of early monsoon waters. Even species that spawn elsewhere take advantage of the floodplains during monsoon season. After spawning in upstream rivers, adult major carp migrate downstream and then laterally onto floodplains to feed. Their spawn and fry are gradually swept downstream to small rivers and are then dispersed through distributary channels onto the floodplains for early growth and feeding.

After spending three to six months in the floodplain, all fish species (young, subadults, and adults) migrate back to the rivers along with the receding floodwater. At this time, some of the fish also migrate to, or are trapped in, local, relatively deep *beels*, borrow pits, ponds, and other perennial water bodies in the flood-plain basin. Fish shelter in rivers and perennial water bodies for the entire dry season, at which time they become vulnerable to over-fishing, disease, and harsh environmental conditions.

Fish migration can be obstructed in three ways: by structures that block flow, through siltation, and by flooding extremes.

The study found that the adults of 24 to 36 species of fish migrate either during early monsoon or late monsoon. This migration is time-specific and closely synchronized with the annual flooding cycle. Presumably, therefore, late flooding or reduced flooding under the controlled flooding management concept of FCD projects would hamper the biological activities of fish by delaying migration, limiting the time for migration, and by shortening the time and area for dispersal, feeding, and growth.

4. Subsistence Fishing

The economic and nutritional benefits of fishing are not limited to professional fishermen and their families. Many other people fish on a subsistence level, either consuming their catch or selling it for cash income. For those people, as well as for the professional fishermen, the open water capture fisheries of Bangladesh's floodplains are a vital natural resource.

The subsistence fishing survey found that 85 percent of the households fished during the course of the year. Of those, 63 percent fished for consumption and 22 percent were professionals who depended on fishing for their livelihood at least part of the year. Subsistence fishing also was not limited to a single family member. In Tangail, 48 percent of the household members fished. Overall, 35 percent of all surveyed household members participated in fishing, including women and children.

The most intense fishing generally occurs during the monsoon (June through September) and post-monsoon (October through January) seasons, and it reaches a peak between October and November. Fishing is usually least intense just prior to the onset of the rains, and the lowest level of fishing occurs during the pre-monsoon months, varying from March through June, depending on location.

Only 7 percent of the subsistence fishing catch was carp. Of the remaining 93 percent, the majority were species of small fish. Eighty-six percent of the catch came from open water sources: 75 percent from floodplains, *beels*, *khals*, and borrow pits or ditches, all of which are dependent on flood for replenishing and sustaining fish stocks. They are therefore also the most vulnerable to the adverse affects of FCD/I projects.

The annual catch per household ranged from 20 kg to 120 kg and averaged 56.75 kg. The number of fishing days per year ranged from 46.4 to 86.2 and averaged 67.85 per household.

Most fishing was done in the floodplains and *beels*, but this is not consistent; the study found that people fished in all sorts of open water—rivers, *khals*, *beels*, floodplain, ditches, and borrow pits. They also fished in ponds, including both culture ponds and derelict ponds that had been restocked by flood inundation.

The results of data gathered about fishing rights found that little subsistence fishing took place on water bodies leased from the government. Forty-eight percent of subsistence fishing occurred primarily on unleased private land, and 22 percent occurred on leased lands that allowed local access for consumption fishing. The next most important source was public water bodies for which there was no lease.

5. Catch Assessment

The Catch Assessment Survey was designed to determine the current levels of fish yield and species diversity in the floodplains and *beels*. The floodplain fishing season is usually four to six months long, starting with the onset of monsoon season in June and continuing until November or December. The *beel* season in all the areas studied was largely concentrated in the post-monsoon period, starting in November and continuing until March, although in some *beels* fishing went on almost all year long, depending on leasing agreements.

Although the estimated national catch from floodplains is 66 kg/ha (the figure usually used to calculate floodplain fisheries losses), this survey found the catch to be 75 kg/ha. Moreover, had Bangladesh not experienced abnormally low flooding in 1992, the yield likely would have been even higher.

The floodplain catch was dominated by small fish species (38 percent), while the so-called economic species, atfish and carp, comprised less of the catch (24 percent and 9 percent, respectively).

The average yield from completely harvested *beels* in Sylhet was 778 kg/ha, and in Tangail it was 477 kg/ha. The figures are higher than the estimated national figure of 412 kg/ha.

It is impossible to compare the fish yield of the Singra *beels* with those of the other areas because its *kuas*, scattered depressions that capture and retain fish, yield a much higher number of kilograms per hectare. The average annual yield of the *kuas* was 252 kg/kua, or, using the mean size of the *kuas*, .09 hectares, about 2,800 kg/ha of *kua*.

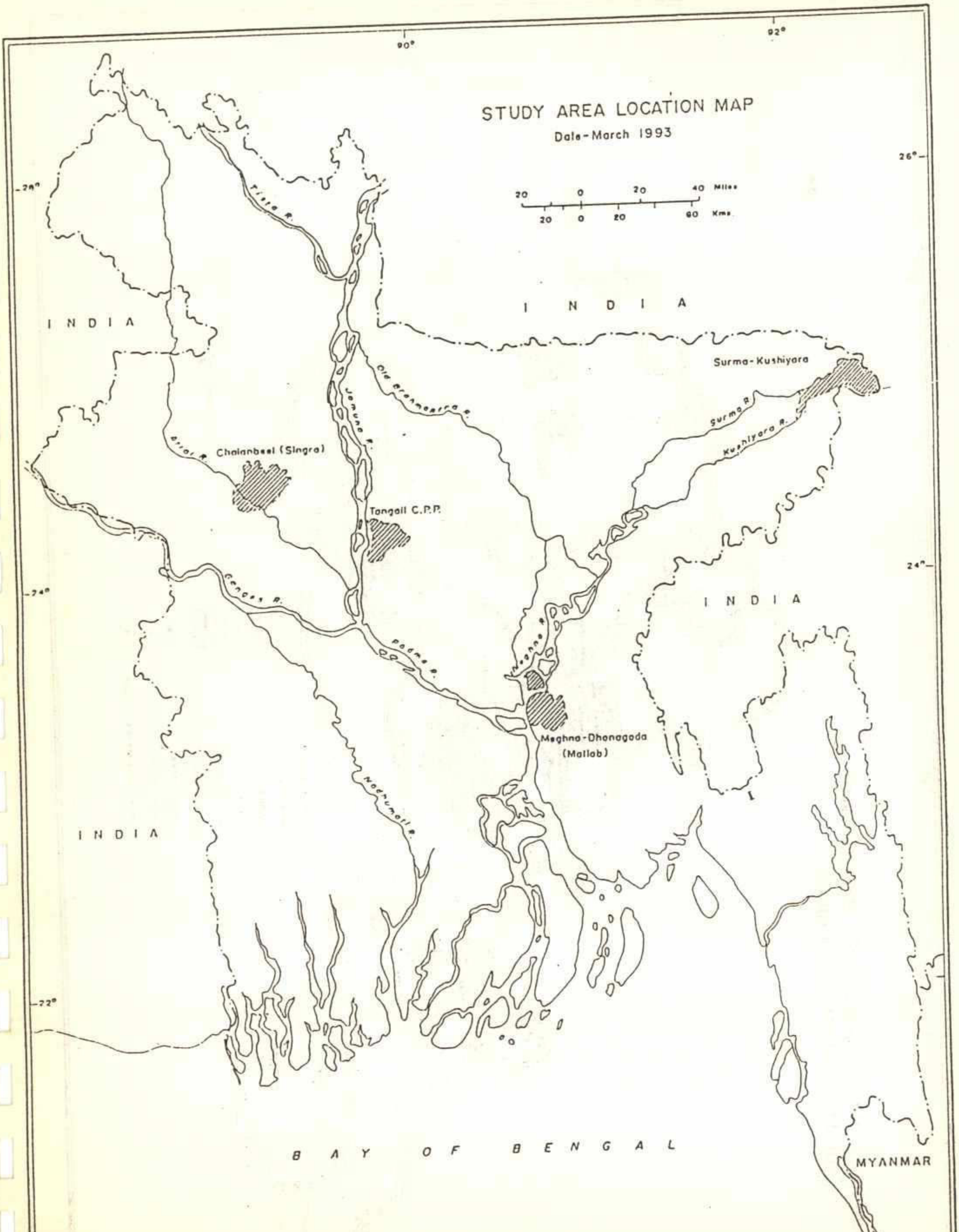
Unlike the floodplain catch, the *beel* catch was dominated by catfish, which made up 47 percent of the total. Still, small fish species were the second largest group in the catch, comprising 24 percent of the total, and carp made up 13 percent.

6. Recommendations

Based on the findings of this study, the following measures are recommended:

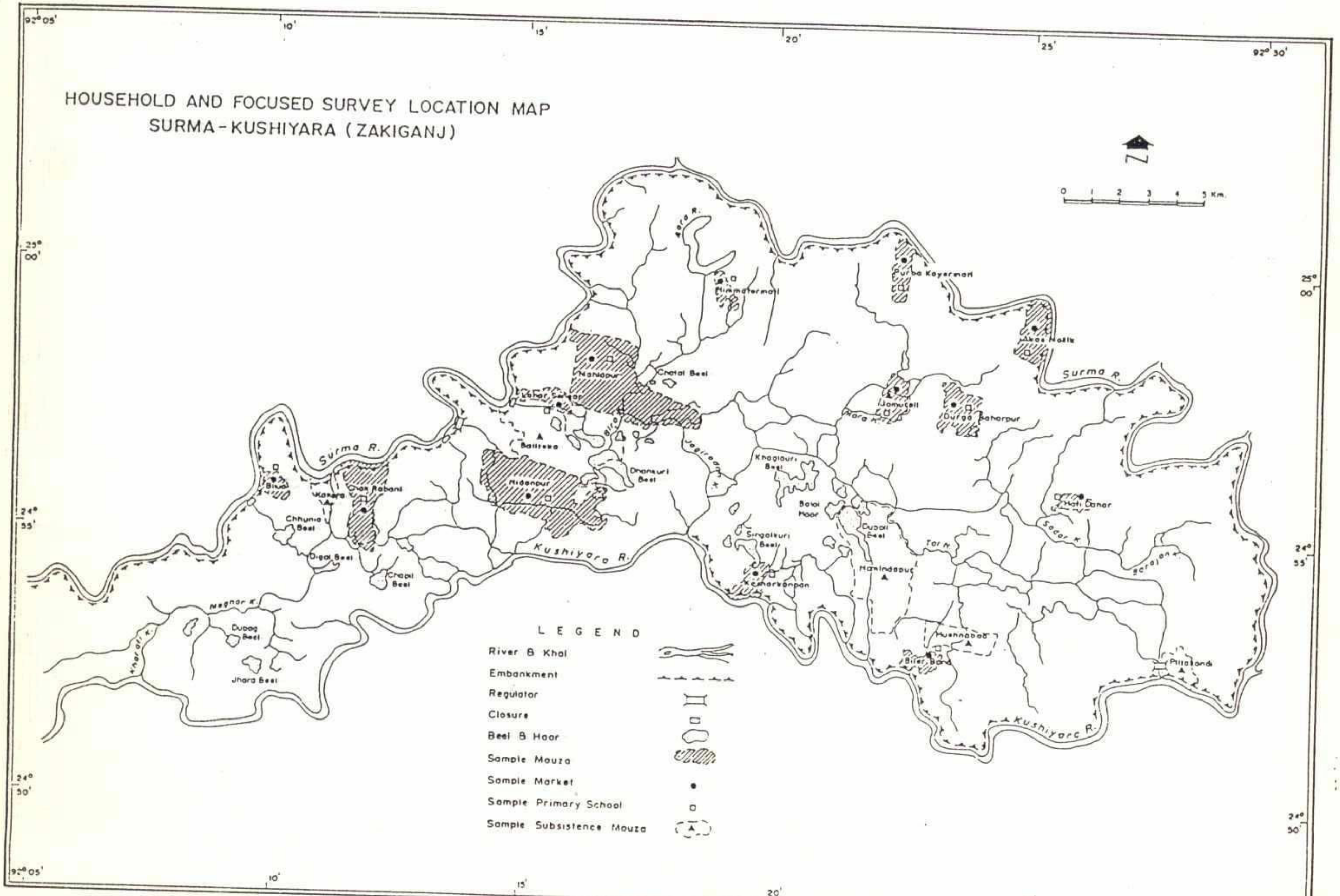
- The preservation of capture fishery resources should be the highest priority of water resource allocation and planning.
- In some situations, improved drainage and flood proofing can both reduce crop damage and improve floodplain access for migrating fish.
- Incremental benefit/cost analysis of separable components of FCD/I projects should be required as part of project formulation and justification.
- Investments in fish culture and fish stocking projects should not be considered a substitute for the natural capture fishery.

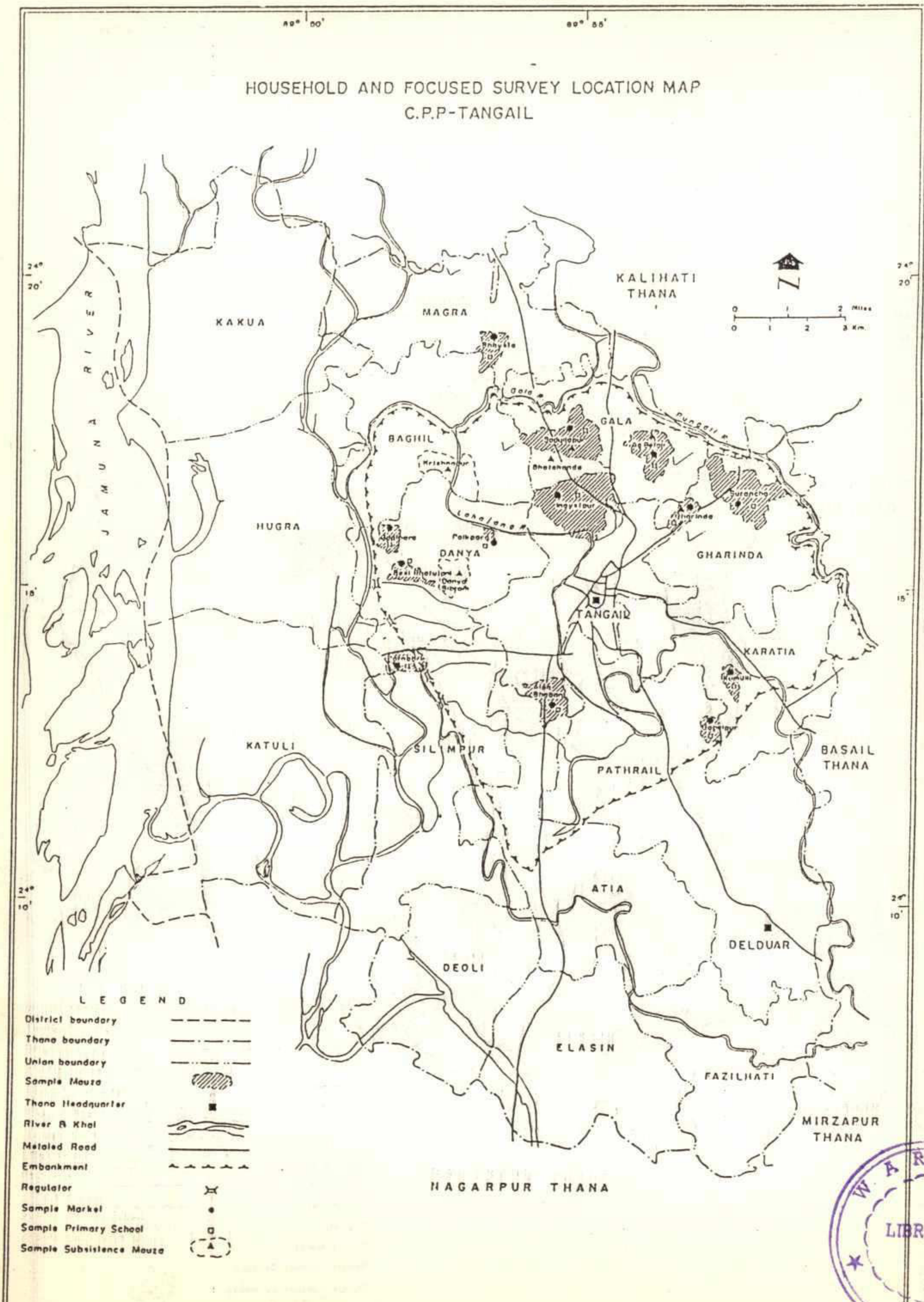
In addition, too little is known about the biology or population dynamics of most of the floodplain species of Bangladesh. Consequently, impact assessments of FCD/I projects inadequately quantify fisheries losses and incompletely estimate the affects of mitigation measures. To correct this problem, more detailed study of the country's fisheries is required.



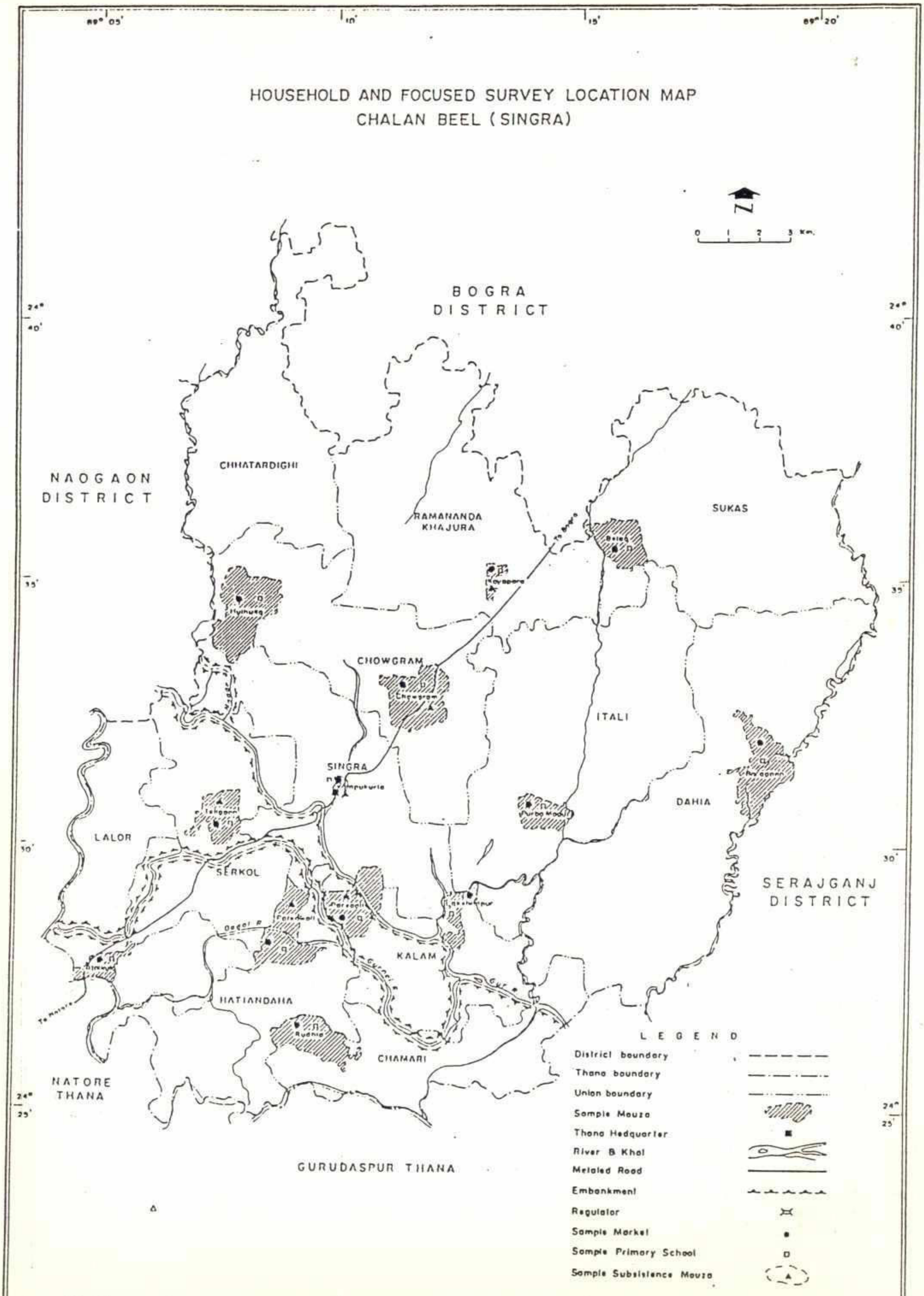
STUDY AREA LOCATION MAP
Date-March 1993
20 0 20 40 Miles
20 0 20 60 Kms
90°
92°
26°
24°
22°
I N D I A
I N D I A
I N D I A
I N D I A
Tista R.
Old Brahmaputra R.
Jamuna R.
Atrai R.
Chalanbeel (Singra)
Tangail C.P.P.
Ganges R.
Padma R.
Meghna R.
Meghna-Dhonagoda (Matlab)
Surma-Kushiyara
Surma R.
Kushiyara R.
Madhumati R.
B A Y O F B E N G A L
MYANMAR

HOUSEHOLD AND FOCUSED SURVEY LOCATION MAP
SURMA-KUSHIYARA (ZAKIGANJ)

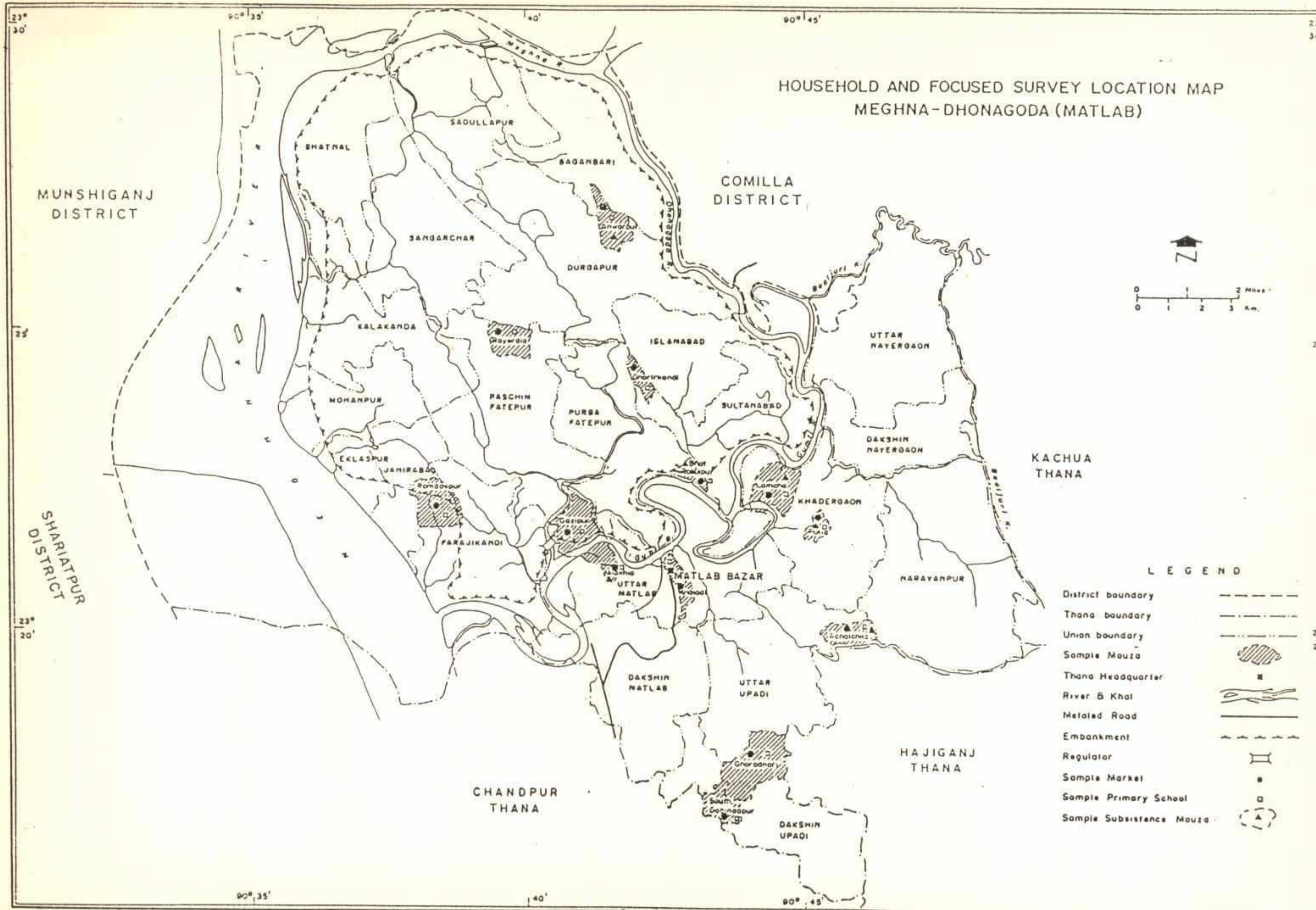




HOUSEHOLD AND FOCUSED SURVEY LOCATION MAP
C.P.P-TANGAIL
89° 50'
89° 55'
24° 20'
15'
24° 10'
0 1 2 Miles
0 1 2 3 Km.
KALIHATI THANA
KAKUA
MAGRA
JAMUNA RIVER
GALA
BAGHIL
HUGRA
DANYA
GHARINDA
TANGAIL
KARATIA
KATULI
SILIMPUR
PATHRAIL
BASAIL THANA
ATIA
DELDUAR
DEOLI
ELASIN
FAZILHATI
MIRZAPUR THANA
NAGARPUR THANA
LEGEND
District boundary
Thana boundary
Union boundary
Sample Mouza
Thana Headquarter
River & Khal
Metaled Road
Embankment
Regulator
Sample Market
Sample Primary School
Sample Subsistence Mouza



HOUSEHOLD AND FOCUSED SURVEY LOCATION MAP
CHALAN BEEL (SINGRA)
89° 05'
10'
15'
89° 20'
24° 40'
35'
30'
24° 25'
0 1 2 3 Km.
N
BOGRA DISTRICT
NAOGAON DISTRICT
SERAJGANJ DISTRICT
NATORE THANA
GURUDASPUR THANA
CHHATARDIGHI
RAMANANDA KHAJURA
SUKAS
CHOWGRAM
ITALI
SINGRA
DAHIA
LALOR
SERKOL
KALAM
HATIANDAHA
CHAMARI
To Bogra
LEGEND
District boundary
Thana boundary
Union boundary
Sample Mouza
Thana Hedquarter
River & Khal
Metaled Road
Embankment
Regulator
Sample Market
Sample Primary School
Sample Subsistence Mouza


HOUSEHOLD AND FOCUSED SURVEY LOCATION MAP
MEGHNA-DHONAGODA (MATLAB)
MUNSHIGANJ DISTRICT
COMILLA DISTRICT
SHARIATPUR DISTRICT
CHANDPUR THANA
HAJIGANJ THANA
KACHUA THANA
SADULLAPUR
SHATNAL
BAGANBARI
SANGARCHAR
DURGAPUR
KALAKANDA
ISLAMABAD
PASCHIN FATEPUR
PURBA FATEPUR
MOHANPUR
SULTANABAD
UTTAR NAYERGAON
DAKSHIN NAYERGAON
EKLASPUR
JAHIRABAD
FARAJIKANDI
KHADERGAON
MATLAB BAZAR
UTTAR MATLAB
NARAYANPUR
DAKSHIN NATLAB
UTTAR UPADI
DAKSHIN UPADI
Meghna R.
Dhonagoda R.
Boaljuri K.
23° 30'
23° 20'
25'
90° 35'
40'
90° 45'
0 1 2 Miles
0 1 2 3 Km.
LEGEND
District boundary
Thana boundary
Union boundary
Sample Mouza
Thana Headquarter
River & Khal
Metaled Road
Embankment
Regulator
Sample Market
Sample Primary School
Sample Subsistence Mouza

Chapter 1

INTRODUCTION

1.1 Study Context

Bangladesh, the eighth signatory to the 1992 International Treaty for the Protection of Biodiversity of Flora and Fauna, has one of the richest inland fisheries in the world. The country has aquatic fauna reportedly consisting of more than 260 fish species (Rahman 1989, World Bank 1991, and Rainboth 1990). Species diversity is an important component of the nutritional profile of the Bangladeshi people. As this study will show, poor people rely on a wide variety of species to meet their nutritional needs. The 1980-81 Nutritional Survey of Bangladesh, for instance, found that of 28 grams of animal protein consumed per capita, 80 percent, or 22 grams, came from fish. Subsistence fishing, in particular, provides agricultural laborers and their families with their principal source of animal protein.

1.2 Nutrition, Biod'versity, and Economics

In Bangladesh, fish is second only to rice as food and a source of wealth, yet in official economic studies and documents, hundreds of edible species are lumped together under the misleading headings "miscellaneous" or "other" (DOF 1987-88). Even guidelines produced by the Flood Plan Coordination Organization refer only to a handful of "economic species," (FPCO 1992) leaving most of the fish produced and consumed in Bangladesh with no implicit value. Fish is the daily food of tens of millions, and it plays an major role in the nation's economy.

Substantial numbers of people in Bangladesh engage in subsistence fishing. Their numbers in fact constitute a hidden economy. During this study, interviewed families often said that members engaged in subsistence fishing were unemployed *(bekar)*. Large numbers, perhaps millions, of so-called unemployed individuals enter a wageless labor system and produce food for their families by catching fish. Inexpensive or even free fish effectively subsidize grain production by allowing landless families to obtain essential nutrients.

Much of the fish consumed in Bangladesh requires no intermediate market mechanisms and costs families nothing but their labor. The presence of free or seasonally low-cost fish in rural areas has important implications for population stability. The loss of subsistence fisheries could compel the many landless, marginal, and small farmers that rely on them to migrate to the cities. The most commonly consumed species are less regulated by leasing systems, easier to catch with inexpensive gear, and independent of the culture fisheries markets and government stocking programs.

Despite its apparent importance, the dietary contribution of the many fish species eaten in Bangladesh has received little scientific study. Likewise, the nutritional and economic consequences of declining biodiversity and fisheries yields largely have been overlooked.

Historically, government and donor agency support for fisheries has concentrated attention on a handful of species. Carp stocking and production, for example, which can lead to lowered species and genetic diversity, not only can reduce fish consumption directly, by reducing the variety and overall population of fish through competition, but also indirectly, by increasing production of more costly varieties. Such measures can affect leasing practices and may introduce hatchery diseases into the natural environment, bringing about the destruction of other species (Minkin 1989).

One Asian Development Bank (ADB)-funded scheme, the Second Aquaculture Project, for example, poisoned wild species in more than 400 hectares of *beel* in order to facilitate carp culture. In some areas of the country, leasing systems have been strictly enforced to the advantage of carp stocking, but to the detriment of the local poor. As a result of these practices, poor people often lose traditional fishing rights that enable them to provide affordable fish for household consumption.

1.3 Fish Production

Open-water capture fisheries contribute hundreds of thousands of metric tons of fish to the annual fish production of Bangladesh. According to BBS data, however, inland fish catches, which once accounted for nearly 90 percent of all fish production (BBS 1987), have declined in both absolute and relative terms.

Figure 1.1, adapted from the Master Plan Organization (MPO), shows projected relationships between demand and production. The demand lines are based on constant and increasing per capita availability and a five percent growth in gross national product (GNP).[1] In 1986, the MPO forecast a 35 percent drop in per capita fish consumption by the year 2005 (MPO 1986). Most of the reduction, the MPO said, will be due to partial loss of the areas available to floodplain fisheries.

1.4 The Economic Value of Fisheries

The people of Bangladesh depend heavily on natural wild aquatic resources for their livelihood. Fish constitutes nearly 6 percent of the gross domestic product and more than 12 percent of the country's export earnings (Fourth Five Year Plan 1970). More than 1.1 million people are involved in commercial fisheries. An estimated 73 percent of rural families are engaged in part-time fish capture from floodplains, rivers, and *beels* (DOF 1990). This means that even the poorest families depend on this resource.

Perhaps because the resource has been so abundant in the past, it has been taken for granted and sacrificed in the pursuit of food grain self-sufficiency. A Technical Report of the First National Water Plan warned clearly that:

> *Open water fisheries production potential has been reduced and is being reduced every year as more and more fish production areas are removed and/or altered for food grain production....The removal of the water or production areas of these very important fisheries is going to reduce total fisheries production irreversibly.* (MPO 1985)

Nonetheless, the loss of capture fisheries was not included as a cost in the economic analysis of potential flood control and drainage (FCD) projects in developing the National Water Plan because there was no basis for estimating the magnitude of loss at the time the plan was prepared.

More recently, the FCD/I Agricultural Study (FAP 12), found that:

> *FCD/I projects have usually had a major negative impact on capture fisheries, resulting from substantial reductions in the areas of regularly inundated floodplains, in the areas of permanent beels and in the blockages to past fish migration routes. Many fishermen have lost their livelihoods, or been diverted to river fisheries, leading to over fishing in these areas which are also adversely*

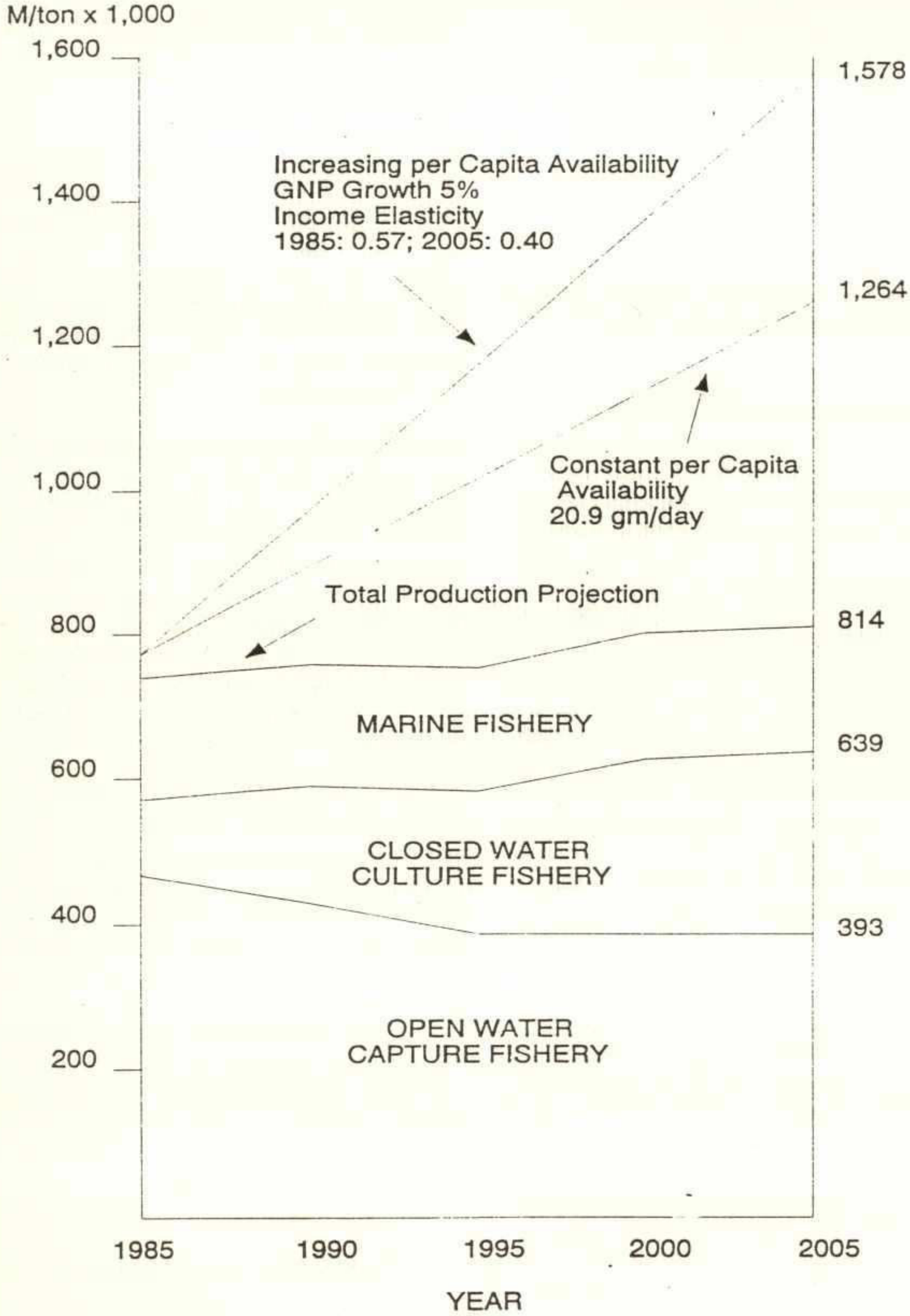


Figure 1.1 Fish Demand and Production (1985-2005)

affected by the changes in fish migration potential. The magnitude of these losses is generally substantially greater than has been previously estimated, and in some cases is similar in economic value to the agricultural benefits. (FPCO 1991)

Since the National Water Plan was completed in 1986, the effect of FCD projects on capture fisheries has been recognized, and resources have been devoted to quantifying their impact.

1.5 Flood Control and Fish Losses

Successful FCD projects usually create an environment that is hostile to the recruitment and replacement of fish lost to human and animal predation. This is because recruitment tends to be directly dependent on the abundance of parent stock and the survival of young fish (Wootton 1990). In most areas, recruitment takes place from the rivers with the onset of the rains. During monsoon season, fish movement increases throughout the floodplain and from rivers into distributary channels. The start of the rains mandates migration for reproduction by adults and for food by newly hatched or maturing fish. When migration routes are cut off by the closing of distributary channels or the walling in of the floodplain, it has an adverse impact on fish demography.

It is also important that the parent stock have a relatively safe area to live during the dry season. Unfortunately, fishing practices in Bangladesh greatly reduce the survival chances of parent stock at that time of year. As soon as the floodwaters recede, fishing intensity increases dramatically. Water in leased areas often is pumped out, and intense effort is put into catching each and every remaining fish. Water routes and channels between fields are seined with a variety of traps and nets. Children may be employed to search for burrowing fish in mud bottoms, and even after the organized catch ends, custom allows people to continue their search for fish while farmers plow the land. Eventually, catch per unit of effort drastically decreases and the only remaining fish are in a limited number of *beels* (water-filled floodplain depressions) and river pools.

Beels continue to yield fish during the dry season in some areas, but discussions with fishermen and field observations suggest that many *beels* either completely dry up or become unproductive. Other *beels* do support populations of adult fish. Evidence from this study's evaluation of fish migration, however, suggest that even these water bodies are partly dependent on recruitment from rivers in order to maintain their reproductive potential.

Reproduction by adults is only part of the productive equation. Survival of young in larval and immature stages is also necessary. During these life stages fish are particularly vulnerable to delays in access to the floodplain. These delays can be caused by closed regulators or submersible structures. The full impact of delays on recruitment have yet to be studied. An unusual drought that occurred during the study period interfered with FAP 16's attempt to provide cross-sectional data on the timing of movements into many areas.

Under natural circumstances the intrinsic reproductive capacity of fish is very high. Environmental improvements that favor the growth of fish populations may increase eco mic returns and improve social equity. Further research efforts should assess the potential for increasing fish yields through eliminating obstructions, and by improving drainage that can open migration routes. Without such measurements, project cost-benefit estimations are unrealistic. It would be imprudent to sacrifice future productive potential because resources have not yet gone into making accurate measurements and because of the haste of the project implementation process.

1.6 Flood Control Project Appraisal

The negative impact of flood control projects on fisheries has been well documented and analyzed.

While demand for fish is increasing, habitats are being systematically destroyed, and migration routes are being blocked by embankments and roads. The MPO has summarized the long-term impact of flood control, drainage, and irrigation (FCD/I) projects:

> *The major constraint to the maintenance or increase in the open water capture fishery is flood control, drainage, and irrigation activities. Open water fisheries production potential has been reduced and is being reduced every year as more and more fish production areas are removed and/or altered for food grain production. Removal of the water or production areas in one location will not only reduce local fish production but also will harm fish production in all the components of the system from rivers and beels to the estuaries and the sea* (MPO 1985, 17)

Many fisheries losses can be attributed to habitat destruction that is related to changes in the water regime, which is expected to continue into the foreseeable future. According to the MPO, 3.14 million hectares will be brought under FCD and FCD/I projects by the year 2005. A full 2 million hectares will become flood-free, and the aquatic environment of 1.4 million hectares will be greatly changed by delayed flooding or reduced water surface area. If these projections come true, one third of Bangladesh's floodplains will have vanished over only two decades (MPO 1985).

The effect that the Flood Action Plan will have on these projections depends on what actions are taken. If mitigation projects concentrate on improving drainage and reopening access routes between the floodplain and river for fish and fishing boats, significant benefit will follow. Flood damage to crops and property caused by drainage congestion would decrease, and quantum increases in fish production could occur. Alternatively, if those projects further restrict the size of the floodplain and impede access to it, dramatic reductions in fish populations and harvest will invariably follow at an incalculable cost to the country.

In the absence of detailed information on the entire spectrum of edible fish, there is a real possibility that the benefits of flood control projects may be inflated in relation to their social and economic costs. As this report will show, the complex community of fish species in Bangladesh is highly dependent on seasonal inundations and on floodplain access, both of which can be negatively affected by flood control projects.[2]

The Flood Action Plan as originally outlined proposed to consider effective resource management in the prefeasibility and feasibility stages of project formulation. Whether the plan can achieve these objectives depends on the will of planners and a commitment to ensuring that social, environmental, and nutritional issues are considered.

1.6.1 Multi-criteria Analysis

Project assessment guidelines seek to ensure that flood control projects are evaluated according to their environmental, economic, and social impacts (FPCO, Guidelines, 1992). Adherence to such an approach, called multi-criteria analysis, would be a positive departure from the time-worn practice of concentrating on a limited number of economic parameters. Unfortunately, the assessment process remains biased in favor of structural solutions, and the contributions of environmentalists and social scientists have been constrained by resource shortages and lack of clear priorities.

To assist progress toward true multi-criteria analysis, conceptual differences between the standard economic evaluation used by the World Bank and evaluation based on environmental economics need to be resolved. This is particularly true with respect to fisheries.[3]

Multi-criteria analysis, as described for the FAP, requires that costs and benefits of proposed interventions be estimated using taka values along with other quantitative indices. This approach is not sensitive enough for evaluating the contribution of the diverse species comprising subsistence fisheries (or such environmental assets as waterways available for transport and the relative absence of mosquitoes). Data on the species diversity, seasonal abundance of fish, and consumption and market information are needed to understand the effects of water management schemes, both individually and in aggregate, in order to construct meaningful impact assessment criteria.

Multi-criteria analysis also is vulnerable to shortcomings related to data requirements and data interpretation. Data collection requires considerable resources and effort. Even where the resources exist, conceptual misunderstandings or insensitivity to the food intake requirements of large segments of the population would undermine the credibility of the exercise.

1.6.2 Assessing FCD/I Projects

In the past, estimates of the impact of flood control, drainage, and irrigation projects on subsistence fisheries suffered from an absence of data. Most findings were based on large, aggregated estimates of production and consumption. Fishery losses attributable to FCD/I were assessed independent of basic information on the structure of fish communities and their relationship to human consumption patterns. As a result, planners, even with the best of intentions, lacked the tools for understanding the economic importance of Bangladesh's capture fisheries. This resulted in underestimations of environmental impacts and failure to consider the nutritional implications of species diversity for the rural poor.

Capture fisheries are a depletable resource that, when assessing a project, require a scarcity premium to reflect the dimension of fish population (Shahabuddin & Rahman 1992). Moreover, those fisheries are a source of nutrients for poor households, which may not otherwise purchase fish from the market. In calculating the impact of a flood control project, then, it is necessary to include measure of cost to account for "income" lost when capture fisheries are destroyed. A weighting based on income loss multiplied by the marginal utility of income may be useful for this purpose. The loss of food could be reflected in the income value of fish based on the cost of providing equivalent food value and nutrition.

To estimate a project's distribution of benefits and harm it is necessary to understand species consumption patterns, as well as the recruitment and reproductive patterns of the diverse species consumed. Such an assessment not only should consider actual losses to production but also lost opportunities to enhance production. The elasticity of fish populations, especially their potential for rapid growth or decline relative to habitat availability, makes the comparison of this biological resource different from calculations based on rice cultivation or the protection of durable goods.

The impact of flood control projects on future fish production should moreover be assessed in the context of rising demand, declining yields, habitat destruction, and the obstruction of migration routes. The falling production trends cited earlier suggest that it will become increasingly difficult for natural replenishment to occur. Therefore, facilitating fish production by improving migration into and out of the floodplain should be viewed as a planning priority. Eliminating drainage congestion, by reopening canals, also is generally beneficial to fish populations.

Any realistic assessment of project impact also should determine which members of society would be most adversely affected by a project. First, any fishing opportunity loss for poor people must be calculated on the cost side of the equation. The participation rate of families in subsistence fisheries also should be known before costs and benefits can be estimated. Bias against valuing the economic contribution of women and children, for instance, pervade the current guidelines for project economic analysis. In terms of food production, such labor makes a significant contribution to the national economy.

Recently prepared guidelines on economic evaluation for the FPCO suggest that while detailed assessment of negative impacts on fisheries is valuable, it should be optional for project assessment because of the amount of work required (FPCO, Guidelines, 1992).

Indeed, it does require a lot of work. A proper evaluation of the environmental impact of a project requires detailed knowledge of who is fishing, what they are catching, and what people are eating. A minimum of one year of in-depth household survey data—to assess seasonal variations in this information—is required to make an adequate impact assessment. Furthermore, projections of the long-term impact on fisheries require detailed baseline information on productivity of the various fish species that are caught and consumed in Bangladesh. But sacrificing environmental impact assessment to expediency can have severe implications for the future economic development of the country.

This study seeks to improve future project preparation by showing that it is possible to quantify the contribution of diverse fish species to various social classes and the household economy. The analysis of collected data will contribute to understanding population dynamics, life cycles, and migration requirements of commonly consumed fish species. The study attempts to identify minimal criteria for assessing the environmental, economic, and social impacts of flood control projects on fisheries. In addition, it raises questions about open water fisheries development, which increasingly focuses on a few hatchery-dependent carp species rather than on unleashing the reproductive and growth potential of hundreds of natural species whose habitats are continuously being eroded.

1.7 Mitigation

The alternative to improving drainage and access of fish to the floodplain has been costly carp stocking programs. While in theory such efforts are profitable from the prospective of increasing production for a narrow band of species, their overall impact on fish production, and the distribution of benefits, has yet to be analyzed. The results of this study as well as national data indicate that only a small portion of the population will benefit from the capture, marketing, and consumption of carp. In general, the rural poor will be net losers. In addition, these projects result in more strict policing of aquatic resources, leading to the erosion of a long heritage of common property rights to subsistence fisheries.

The richness of fish species in Bangladesh has been neglected both by government planners and by donor agencies. While more than 150 million dollars has been invested in the fisheries sector in the last decade, no attention has been given to the contribution of diverse species in creating employment and as sources of food, nor have the consequences of such massive investments, in terms of the distribution of costs and benefits, been carefully weighed. This is the first study that attempts to clarify the contribution made to the diet and employment of rural people by the 85 percent of inland fish capture that is not linked to common carp species.

The World Bank Fisheries Sector Review emphasizes that, "There are good prospects for reversing the decline in fish production in floodplains in Bangladesh by adopting a culture-based fisheries model." The approach calls for "technology and management, which involves continually stocking floodplains with appropriate carp species (primarily polyculture) at optimum stocking ratios and densities." This model calls for the manipulation of Asiatic carp through artificial breeding, proper stocking, and timely harvesting in order "to compensate for the decline in floodlands fishery resulting from flood control, drainage and irrigation development projects." (World Bank 1991).

NOTES

1. The current annual GNP growth is about four percent.

2. Appendix 1 is a partial list of reports attributing fish losses to flood control and irrigation projects.

3. The utility of project assessment guidelines in the evaluation of negative impacts on fisheries has been expressed by Chisholm & Smith (1992).

Chapter 2

METHODOLOGY

This study examines four areas of Bangladesh where flood mitigation projects have been planned or executed. Its purpose is to assess the direct impact of flood mitigation on fish populations and the indirect nutritional consequences of fisheries losses. The study has five objectives:

- Review the relationship between species diversity and consumption.
- Highlight the vulnerability of diverse fisheries resources to human intervention.
- Show the migration patterns of floodplain species.
- Ascertain seasonal variation of fish species and their market price.
- Measure the extent of community participation in open-water fisheries.

2.1 Study Areas

The areas used for this study were:

- The Tangail Compartmentalization Pilot Project (CPP) in the Brahmaputra floodplain (Tangail and Delduar).
- The Surma-Kushiyara Project in the Surma-Kushiyara floodplain (Zakiganj, Bianibazar, and Kanaighat).
- The Chalan Beel Project in the Ganges-Atrai floodplain (Singra).
- The Meghna-Dhonagoda Flood Control and Irrigation Project in the Meghna floodplain (Matlab).

They were selected to represent a variety of ecological zones. In Tangail and the Surma-Kushiyara area they also coincided with environmental impact assessment (EIA) case studies being carried out by FAP 16. This enabled the researchers of this study to exchange information about fisheries, social conditions, and resources with the other studies.

2.2 Household Survey

The Household Survey used a three-stage, stratified random sampling technique. In the first stage, all mouzas[1] within the study area were stratified according to their Fisheries Ecological Zone (FEZ). These zones were:

- FEZ 1—*Beel* or depression linked with a canal or river where water is available most of the year.[2]
- FEZ 2—Area within one and a half miles of a river.
- FEZ 3—Highland or flood-free area.

The mouzas in each FEZ were then grouped into three size categories: small, those with fewer than 150 households (at this stage of sample selection, only those with more than 40 households were considered); medium, with 151 to 300 households; and large, with more than 300 households.

In the second stage of stratification, 10 percent of the mouzas were randomly selected from each size category. During the selection, a minor adjustment was made for fractional numbers without replacement. This part of the process was designed to ensure that the size of the sample mouzas was representative of the mouzas in each FEZ.[3]

In the third stage of stratification, all the households within the sampled mouzas first were inventoried and stratified on the basis of land ownership. To do this, a simple household census asked for household identification (the name of the household head), the main and secondary occupations of the household head, the number of people in the household, the amount and type of land owned, and the amount of operational land.

Based on this census, the households were then grouped into seven socioeconomic categories:

- Landless—no cultivable land
- Functionally landless—up to 0.5 acres of cultivable land
- Marginal farmer—0.51 to 1.5 acres of cultivable land
- Small farmer—1.51 to 2.5 acres of cultivable land
- Medium farmer—2.51 to 5 acres of cultivable land
- Large farmer—more than 5 acres of cultivable land

The large farmer category was then discarded, and the landless and functionally landless were combined in a single group. Finally, for each mouza selected during stage two, a proportionate random sample of households was chosen from each of the four remaining strata (Figure 2.1).

Each of the selected households was surveyed for one year in three cycles. Each cycle covered a period of about 17 weeks. Cycle 1 ran from December 15 through April 15 *(Push-Chaitra)*, Cycle 2 from April 16 to August 15 *(Baishak-Sraban)*, and Cycle 3 from August 16 to December 14 *(Bhadra-Agrahayan)*. The households were visited three times daily (morning, afternoon, and evening)[4] for seven consecutive days per cycle.

At each household visit, the following detailed information was collected:

- Family composition—sex, age, occupation, and employment of household members.
- Daily food intake—number of meals, fish eaten (by species), and other food consumed.
- Source of fish—capture (including catch amount, source, and time; place of sale, and sale value by species),[5] or market purchase (including source, distance to market, quantity and value by species).
- Nutrition and hunger—data on pregnant or nursing women and young children; data on staples, pulses, meat, vegetables, fruits, and other foods eaten at three consecutive meals.
- Fish preparation—cooking methods by species for children and for pregnant or nursing women.

Each cluster of 10 surveyed households represents a population defined by mouza size, FEZ, and study area. The data from each record of a surveyed household is expanded to the population it represents based on the ratio of the surveyed households to the total number of households in the represented population. For example, in Tangail Compartmentalization Pilot Project (CPP), FEZ 1, there are 35 small mouzas. Eight of them have fewer than 40 households, so they were discarded from the list of those to be surveyed. One of the remaining mouzas, Beel Bathuajani, was randomly selected from the list of 27 mouzas in the size range of 40 to 150 households. Ten households in Beel Bathuajani were surveyed. In the full group of 35 small mouzas, there are 2,844 households. Therefore, the expansion factor for each of the 10 surveyed households is 284.4 (2,844/10). The expansion factors for the medium and large mouzas in FEZ 1 are 174.35 and 278.10, respectively. The data from each survey cluster is multiplied by its expansion factor for the FEZ level. The sum of the expanded data for a particular entry, therefore, represents the total population of the FEZ. Similarly, the sum of data from all three of the FEZs represents the results for the entire study area.

The same process was applied to all four study areas, except in Meghna-Dhonagoda, where the mouzas were initially stratified by whether they were inside or outside of the embankment, rather than according to their FEZ.

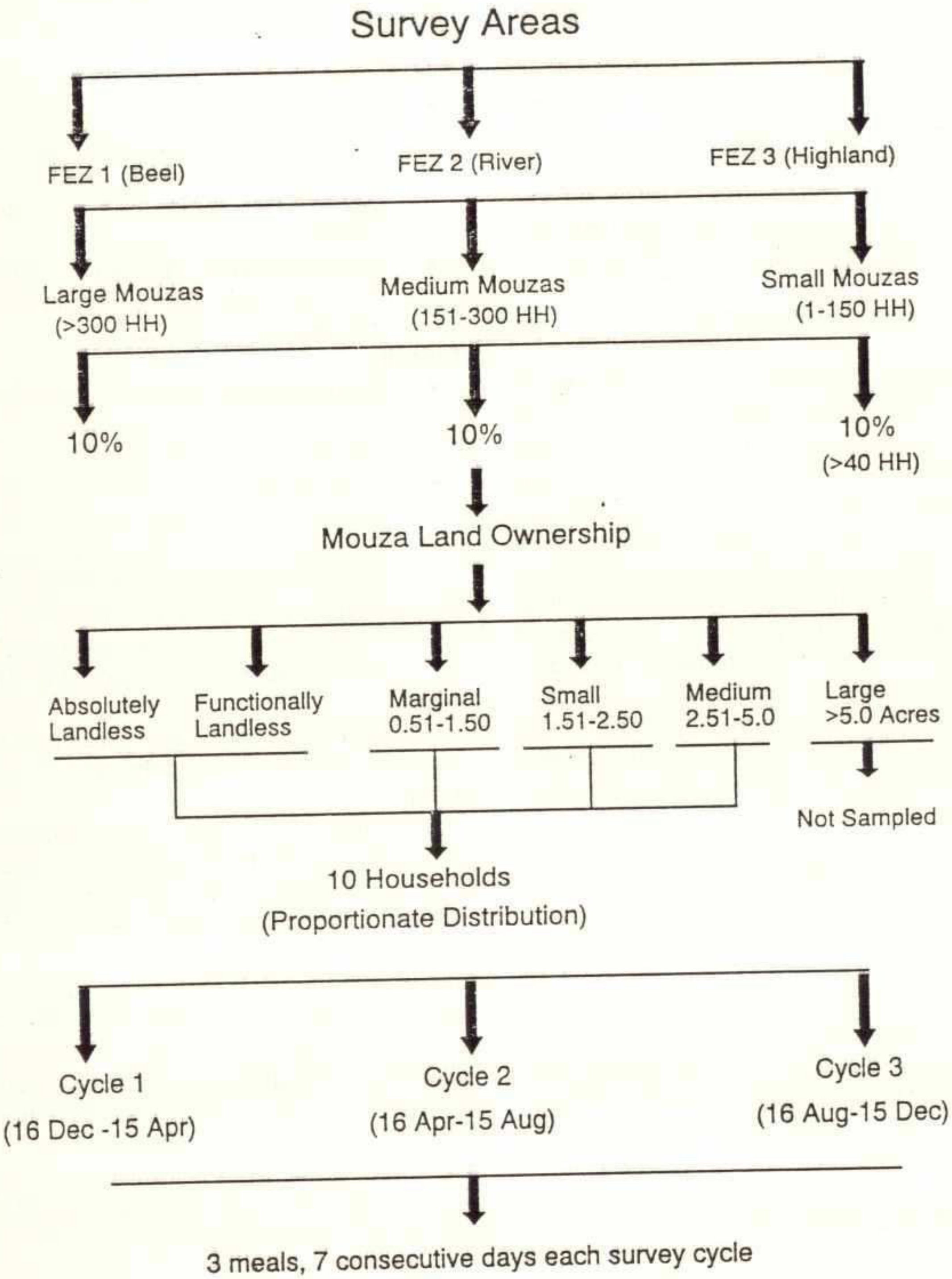


Figure 2.1 **Household Survey Data Sampling Method**

2.3 Focused Surveys

To better understand the dynamics of fisheries and nutrition, additional surveys were conducted. These were: Fish Market Survey, Fish Migration Survey, Subsistence Fisheries Survey, Fish Catch Assessment Survey, Professional Fishermen Survey, and Socioeconomic Survey. To cross check and supplement the data gathered by the Household Survey and the fish resources surveys, field workers also conducted interviews with focus groups of school children in the study areas.

2.3.1 School Children Survey

For the School Children Focus Group Survey, 13 primary schools were selected in and around the sample mouzas of each study area. The students were asked about their diet, household fishing activity, and species consumption during the same three seasons as in the Household Survey. These interviews also elicited information on fish consumption, the children's participation in fishing, fish capture, and fish purchase. Interviews of Class III children were used to assess the importance of local fisheries resources on child nutrition. In one school in each mouza, students were interviewed once per survey cycle about their diet on the morning of the interview and at the previous evening meal.

2.3.2 Fish Market Survey

Thirteen fish markets in and around the sample mouzas of each study area comprised the Fish Market Survey. The survey was conducted in each market once during each of the three seasons used for the Household Survey. The information gathered was: type of market; type of sellers; quantity, source and price of each species; price of rice, pulses, and vegetables; and price of dried fish.

2.3.3 Fish Migration Survey

The purpose of the Fish Migration Survey was to monitor the migration of fish between rivers and the floodplain. To do so, *khals* (canals) originating in rivers adjacent to the project area[6] were used as sampling sites. *Khals* were selected for study based on observation and interviews with local fishermen. The following were selected for study:

Surma-Kushiyara

- Kakura Khal: The major *khal* draining the *haor* inside the project into the Surma River.
- Sunam Khal: This *khal*, originating at the Surma River, is blocked by regulator at its offtake.
- Rahimpuri Khal: This *khal*, originating at the Kushiyara River, is blocked by a regulator at its offtake.

Tangail

- Gaijabari Khal: An open *khal* originating at the Lohajong River and feeding the floodplain inside the project area.
- Shadullahpur Khal: An open *khal* that originates at the Gala Khal and feeds the floodplain inside the project area with water from Lohajong and Pungli rivers.
- Darjipara Khal: The water flow in this *khal*, originating at the Dhaleswari River, is regulated by a sluice gate at its offtake.

Singra

Of three public cuts in Chalan Beel Polder C, the Jormollika public cut was used.

Matlab

Baispur Khal: This *khal* originates at the Dhonagoda River opposite the Meghna-Dhonagoda project and feeds the Baispur floodplain and a dead river.

After the *khals* were selected, several fishing points along each canal were targeted for survey. The monitoring procedures used traps and mesh nets of various sizes. Nets and traps also were set with their entrances facing both upstream and downstream, as well as at several water depths from bottom to surface. The variety of net sizes and placements enabled the gathering of all possible fish species migrating in either direction and in all life stages from egg to adult.

The sampling methods used differed depending on the conditions at the study area. The following were the methods used:

Kakura Khal, Sylhet: The migration of large fish from river to floodplain during early monsoon season was monitored by almost blocking the *khal* at six points with bamboo fence and traps, locally called *gors*. Each *gor* was equipped with two to three bamboo traps called *gui*. The entrances of the *guies* were facing river in order to trap fish ascending from the Surma River to the *haor* inside the project. The late monsoon return migration of fish was monitored by setting one *gor*. In addition to the *gors*, small mesh bamboo traps were set to trap migrating small fish, and catches made by hooks and drag nets were also monitored.

Sunam and Rahimpuri ***khals*****, Sylhet:** In these *khals*, people fished on the river side of the regulators during early monsoon season. Fish ascending from river could enter the project area and were aggregated on the river side of the regulators. In addition to the catch taken by small mesh traps, fish catches taken by other gear (hooks, push nets, cast nets, etc.) were monitored.

Jormollika public cut, Singra: Since the floodplain inside the project area was dry until monsoon season, fish movement during monsoon was one way: from the Gur River to the floodplain inside. Bamboo traps and lift nets were used to sample the migrating fish.

Baispur Khal, Matlab: In Matlab, which is influenced by tides, at high tide river water enters through the *khal* and at low tide it recedes. Sampling here was done by setting a bag net covering the entire width of the *khal*. With this device, fish migrating in during high tide or out during low tide were caught.

Monitoring was done once a week for 24 hours at four to six-hour intervals throughout monsoon. Testing started in April-May, when the floodplain and river were reconnected through the sample canal, and ended in October-November, when the link was once again disrupted.

Fish larvae migration in Tangail was monitored in three *khals* and at one point on the Lohajong River. Monitoring was done by setting two fine-mesh bag nets (one at the water surface and one at the bottom) for two hours each during the day and night. The daytime monitoring was done between 0900 and 1400 hours, and the nighttime monitoring was done between 1630 and 2300 hours. The number of larvae caught was expanded based on the width of the canal and the total daytime or nighttime hours. The data was gathered by fishery biologists, who physically observed the catch taken from the canals as well as the type of gear used.

2.3.4 Fish Catch Assessment Survey

The Fish Catch Assessment Survey monitored the quantity and species of fish taken from selected floodplains and *beels*.

Catch assessment in the *beels* was complicated by the fact that Meghna-Dhonagoda has no *beel* at all and Singra has no perennial *beel*. Moreover, the fishing methods used in each area were radically different. Meghna-Dhonagoda was eliminated from this part of the study and for the remaining areas, slightly differing methods were used.

In Surma-Kushiyara, where *beels* are fished once a year by leaseholders who drain them and use seines to capture the fish, fishing was monitored regularly at four-day intervals during the fishing period (November through February). On observation day, data was collected on that day's catch as well as the catch of the previous three days.

In Singra, landowners excavate ditches in low-lying areas. As the flood waters recede, fish accumulate in these *kuas*, as they are called. The captured fish are harvested between December and April. This catch was monitored by selecting sample *kuas* in each of four *beel* areas in Singra, Teligram, Balubhara, Noorpur, and Chakly. The catch was observed and recorded at intervals of seven to 10 days, depending on fishing activity. The catch data from each sample *kua* was expanded by multiplying the sample data by the total number of *kuas* in the *beel*.

In Tangail fishing occurs almost year-round. In this area, catches were monitored at 10-day intervals. On observation day all the fishing units (a unit being one or more people operating a particular kind of fishing gear) were counted and categorized according to fishing gear. A sample group from each category was then selected for observation and their catch was observed, counted according to species, and recorded. To estimate the total catch (both by species and overall) the observed sample was averaged and multiplied by the total number of units employing that type of fishing gear. On each observation day, data was also collected for the previous three days' catches.

For the floodplain catch assessment, two sections of floodplain were selected in each of the four study areas. To determine the area of each section, global positioning system (GPS) measurements were taken in the field and the area was calculated from that data. The assessment method described above for the Tangail *beels* was used for floodplain catch assessment in all study areas.

2.3.5 Subsistence Fisheries Survey

The Subsistence Fisheries Survey examined subsistence fishing in six sample villages of each study area. The selected villages were near rivers, *khals*, ditches, swamps, *beels*, or inundated paddy fields where fishing could occur. Other factors considered for selection of sample villages included accessibility, easy communication, and concentration of habitats.

In each mouza, researchers interviewed 100 households, which were then divided into three categories: subsistence fishing households, commercial fishing households, and non-fishing households. If a sample mouza had fewer than 100 households, additional households were randomly selected from adjacent areas. From the subsistence fishing category, 10 households were randomly selected for catch monitoring. The heads of these households were interviewed once every 15 days. Each was asked about his fishing activities during the previous 15 days and the data was recorded. During their field trips, the researchers collected data on who had caught and sold fish from rivers, canals, creeks, ditches, swamp, paddy fields, and flooded lands during the previous 15-day period. Field observations of subsistence fishermen were also conducted during these visits. Data gathered about captured fish species, quantities captured, and the fishing gear employed was used to verify the accuracy of the data obtained from the sample households. Information also was collected on fishing rights and heritage, categories of common property rights, and leasing arrangements.

2.3.6 Socioeconomic Survey

The Socioeconomic Survey collected data from the selected households once during the survey period. It asked questions about family size, occupational pattern, annual income, expenditures, and major source of income. The results of this survey are reported in Appendix 2.

2.4 Statistical Analysis

Statistical analyses (t-test, ANOA, and regression analysis) were done for the following key indicators (the inferences and results are in Appendix 3):

- Per capita fish consumption of socioeconomic groups;
- Per capita fish consumption by study area;
- Per capita fish consumption by Fishery Ecological Zone;
- Per capita fish consumption inside and outside the Meghna-Dhonagoda project;
- Regression analysis for species diversity and per-household fish consumption.

NOTES

1. The smallest revenue unit in Bangladesh; it comprises one or more villages.

2. Beels and depressions were identified using available maps and cross-checked with the records of Thana Fishery Offices and the Bangladesh Water Development Board (BWDB).

3. In Matlab Thana, mouzas were selected in proportion to the number of households inside and outside of the Meghna-Dhonagoda embankment.

4. The requirement for three daily visits was determined by the pilot survey analysis of daily variations in household consumption.

5. Fish species were identified by their local names, and identifications were verified by collecting samples and taking photographs. The species were weighed, and local beliefs about qualities attributable to their consumption were gathered.

6. Such canals are assumed to be the main route of migration.

Chapter 3

FISH CONSUMPTION AND NUTRITION: RESULTS OF THE HOUSEHOLD AND SCHOOL SURVEYS

3.1 Introduction

This chapter presents the findings of the Household and School Children surveys. It discusses consumption: for all households (excluding large farmers and urban households) in the four survey areas; by land ownership category; by fisheries ecological zone (FEZ); in terms of species diversity; by source of catch, and by whether the fish was caught or bought. The chapter also includes information about the nutritional value of fish sepeices commonly consumed in Bangladesh.

3.2 Fish Consumption

3.2.1 Quantity Consumed

As Table 3.1 shows, total annual fish consumption in the four study areas was 8,188 tons. Consumption peaked in Cycle 3, when it reached 43 percent of the total, and it was lowest during Cycle 2, when only 24 percent of the total was consumed. Surma-Kushiyara, in the Sylhet *haor* area, exhibits a different seasonal pattern than the other study areas. Consumption was highest there during Cycle 1, probably reflecting the relatively longer time required for the *haors* to drain after monsoon season. This likely resulted in peak fishing in Cycle 1 rather than in Cycle 3 as occurred in the other areas.

The relative importance of small fish, catfish, snakeheads, and shrimp in terms of their contribution to total consumption is about the same in all seasons. Except in Meghna-Dhonagoda, *hilsha* are only eaten during the last two cycles, which coincide with the onset and recession of floods. As a percentage of total consumption, carp are relatively more important during the first and second cycles, despite the fact that a greater quantity of it is eaten during Cycle 3 than during Cycle 2.

Overall, small fish are eaten more than any other species, accounting for 43 percent of the fish consumed. Catfish and major carp, the second most commonly consumed, accounted for only 13 percent each; *hilsha* and shrimp, 9 percent each; snakeheads, 7 percent; eels, 6 percent; and tilapia, 4 percent.

Table 3.2 shows that the average fish consumption per household for the full year was 52 kg. This amounts to 991 grams per household per week, or 142 grams per day. The average daily per capita consumption rate is 24 grams per day (5.8 people per family). This estimate excludes consumption by urban households as well as large farmers, who, although small in number, have the highest per capita consumption of all food items, including fish. In 1991 the national average for fish consumption was 22 grams, slightly below this study's estimate (BBS 1992). If urban and large farm households were to be excluded from the government figure it would be considerably lower than 22 grams; therefore, fish consumption may be significantly higher than previously thought.

Of the four areas, Tangail had the lowest level of fish consumption. Daily consumption per person in that area was only 11 grams in Cycle 1, 6 grams in Cycle 2, and 18 grams in Cycle 3, an

Table 3.1 Total Household Fish Consumption by Fish Type* (metric tons)

Area	Small Fish	Cat-fish	Snake-heads	Major Carp	Other Carp	Tilapia	Shrimp	Hilsha	Eels	Total
Full Year										
Tangail CPP	223	65	56	37	7	6	51	107	39	577
Surma-Kushiyara	534	233	152	139	22	4	96	77	16	1.247
Singra	433	287	117	351	18	16	147	73	148	1.555
Meghna-Dhonagoda	2,301	487	285	543	2	301	413	472	308	4.809
Total	3,491	1,072	610	1,070	49	326	707	728	511	8.188
Percent	43	13	7	13	1	4	9	9	6	
Cycle 1										
Tangail CPP	56	30	27	17	2	1	36	0	15	181
Surma-Kushiyara	179	113	70	88	22	4	33	1	4	487
Singra	110	124	66	170	1	9	79	0	67	616
Meghna-Dhonagoda	869	158	82	168	0	101	95	28	34	1.435
Total	1.214	425	245	443	26	115	244	29	120	2.720
Percent	45	16	9	16	1	4	9	1	4	-
Cycle 2										
Tangail CPP	26	18	17	10	2	4	4	13	7	94
Surma-Kushiyara	219	79	36	22	0	0	34	24	4	419
Singra	55	57	5	93	1	5	24	16	16	266
Meghna-Dhonagoda	480	54	48	156	0	122	139	266	4	1.148
Total	780	209	106	281	3	132	201	318	31	1.926
Percent	41	11	6	15	0	7	10	17	2	
Cycle 3										
Tangail CPP	141	17	12	10	3	1	11	94	17	302
Surma-Kushiyara	135	41	47	29	0	0	29	52	8	341
Singra	268	105	46	88	16	2	44	57	65	673
Meghna-Dhonagoda	952	275	154	219	2	77	178	178	270	2.226
Total	1.496	438	259	346	20	80	262	381	360	3.542
Percent	42	12	7	10	1	2	7	11	10	

Source: Household Survey
*Excludes dry fish.

Table 3.2 Household Fish Consumption

Area	Total (kg)	Weekly (gm)	Daily (gm)	Daily/ Capita (gm)
	Full Year			
Tangail CPP	22	432	62	11
Surma-Kushiyara	42	813	116	18
Singra	41	797	114	21
Meghna-Dhonagoda	73	1,398	200	32
Average	52	991	142	24
	Cycle 1			
Tangail CPP	7	414	59	11
Surma-Kushiyara	16	952	136	22
Singra	16	920	131	24
Meghna-Dhonagoda	22	1,246	178	30
Average	17	979	140	24
	Cycle 2			
Tangail CPP	4	210	30	6
Surma-Kushiyara	14	833	119	19
Singra	7	395	56	10
Meghna-Dhonagoda	17	1009	144	24
Average	12	705	101	17
	Cycle 3			
Tangail CPP	12	671	96	18
Surma-Kushiyara	11	653	93	15
Singra	19	1102	157	29
Meghna-Dhonagoda	34	1,939	277	45
Average	22	1,294	185	31

Source: Household Survey

average of 11 grams for the entire year. In contrast, the highest consumption was in the Meghna-Dhonagoda area, 45 grams daily per capita in Cycle 3, and an average of 32 grams for the whole year. Consumption in Singra drops off sharply from 24 grams daily per capita in the first cycle to only 10 grams in the second, a consequence of *beel* drainage, drying up of rivers, and late monsoon rains. In Singra, per capita fish consumption was high compared with Surma-Kushiyara. This may be due to the fact that the Singra FCD/I project embankments were frequently breached or cut.

Data on dried fish consumption were gathered during Cycles 2 and 3. Significant quantities of it were eaten in Surma-Kushiyara and Meghna-Dhonagoda. On average, 1.25 kg was consumed per household in Meghna-Dhonagoda over the eight-month period. This amounts to 5.2 grams per household per day, or slightly less than one gram per person per day. In the Surma-Kushiyara area, the average consumption of dried fish was 0.67 kg per household, and almost all of that consumption occurred during the third cycle.

3.2.2 Fish Consumption Relative to Other Foods

The importance of fish in the diet compared to other food items is illustrated in Figure 3.1. On average, households consumed fish 3.5 days per week, compared to 2.1 days for pulses, and 0.5 days for meat. Only vegetables and rice were consumed more frequently than fish, 6.3 and 6.8 days, respectively. Eighty-five percent of households ate fish at least once during the week, compared to 72 percent that ate pulses, and 26 percent that ate meat. Data are similar for all three cycles, except that fish consumption fell from 3.9 days per week in Cycle 1 to less than 3.2 in Cycle 2, reflecting seasonal scarcity. Pulse consumption increased from 1.4 days per week in the Cycle 1 to 2.6 in Cycle 2 and remained near that level during Cycle 3.

The seasonality of household nutrition is reflected in the figures. During flood recession, only 1.2 percent of households reported that they did not eat vegetables or any of the listed sources of protein during the week. The percentage of households in this circumstance was highest (8.1 percent) in Cycle 1.

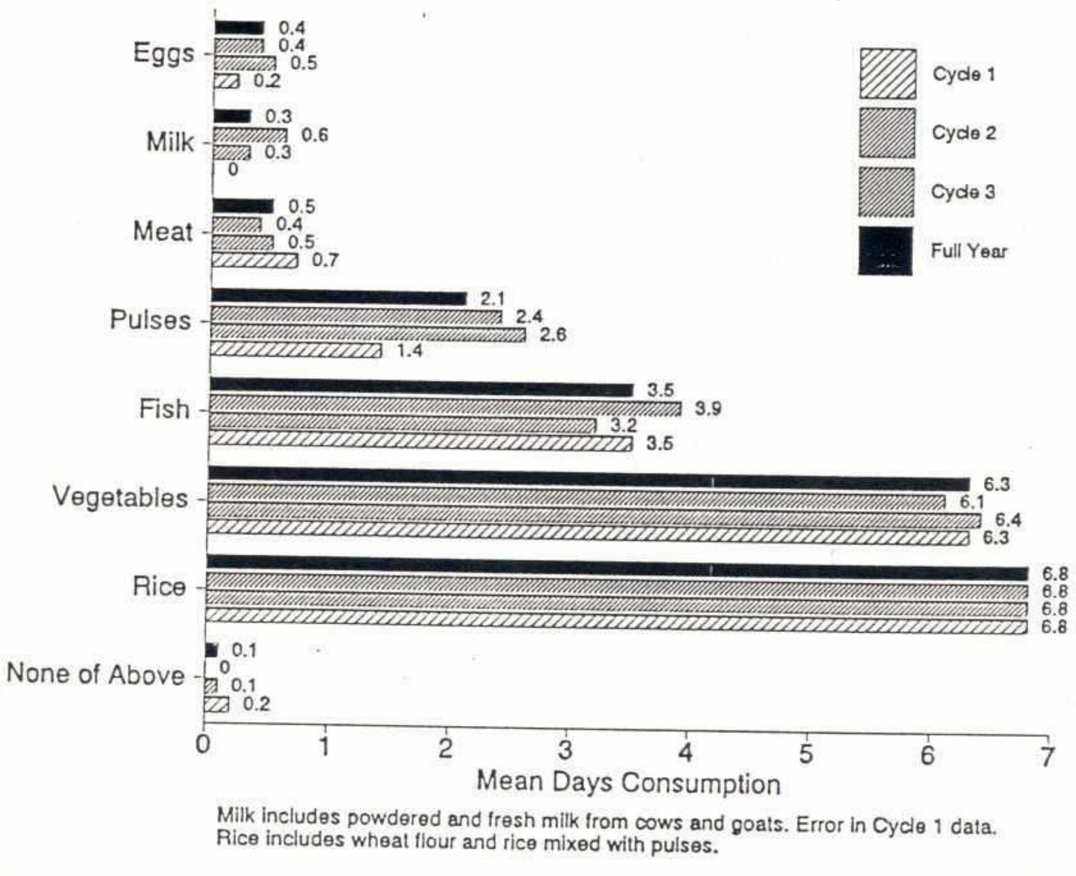


Figure 3.1 Comparison of Food Item Consumption

Nearly all households ate rice every day of the week, while a yearly average of 5 percent consumed only rice. Exclusive rice consumption dropped as low as 1 percent during Cycle 3.

Considering the frequent consumption of vegetables, fish, and pulses, the diet of the households studied is diverse, although not luxurious.

3.2.3 Consumption by Vulnerable Groups

A well-balanced diet is especially important for nursing mothers, pregnant women, and young children. The consumption patterns of these vulnerable people were separately studied in the Household Survey and the findings are presented in Table 3.3. Fish was consumed at least one day per week by 82 percent of nursing mothers, 74 percent of pregnant women, 78 percent of children aged two to five, and 36 percent of children under two years old. The mean days per week that fish was eaten was 3.0 for nursing women, 2.3 for pregnant women, 2.9 for children aged two to five, and 1.1 for children under two.

Fish was an important source of protein, vitamin A, and calcium for nursing mothers, pregnant women, and children above two years of age (see Section 3.2.6). Pregnant women consumed 37 species, compared with 71 for nursing mothers and children two to five years old. Children under two consumed 52 species (Appendix 4). Fish was second in importance only to mother's milk as a source of protein and vitamin A for children under two years old.

Appendix 5 shows weekly consumption of food items for mothers and children. Fish followed rice and vegetables as the most commonly consumed foods. Pulses were next in importance. Meat and egg consumption were negligible.

A comparison of the diet of vulnerable people to that of the entire household indicates that nursing mothers and children aged two to five years are eating slightly less fish, meat, and eggs than some other groups in the household, presumably men. Pregnant women, however, are eating much less well than the rest of the household.

3.2.4 Consumption by Social Strata

Per capita consumption for landless and marginal farmers is compared with the same data for small and medium farmers in Table 3.4. The fact that there is no difference in consumption levels for the two groups in the Meghna-Dhonagoda area may reflect the relative abundance of fish in the area.

In the other three areas, consumption by small and medium farmers exceeded that of landless and marginal farmers by 27 percent in Tangail, 87 percent in Surma-Kushiyara, and 76 percent in Singra. The greatest disparity between the two groups is during the period of least abundance, Cycle 3 in Surma-Kushiyara (145 percent), and Cycle 2 in Tangail (60 percent) and Singra (143 percent). Perhaps when capture fish are least available, small and medium farmers have sufficient income to maintain higher consumption levels by purchasing fish from the market, whereas poorer households simply do without.

The survey found that landless and marginal farmers (82 percent of the households) consumed an average of 47.7 kg of fish, of which 5.3 kg (11 percent) was major carp, 2.1 kg was tilapia (4 percent), and 40.3 kg (85 percent) was capture fish. The small and medium farm households consumed 69.1 kg of fish per household, of which 12.5 kg (18 percent) was carp and 56.6 kg (82 percent) was capture fish. Thus, both groups primarily depend on capture fish for nutrition. Overall, carp account for 13 percent of the fish consumed, while other fish account for the remaining 87 percent. Of course, not all carp are culture fish, so it can be said that roughly 90 percent of the fish consumed by rural landless, marginal, small, and medium farm households is provided by the capture fishery (Appendix 6).

In terms of fisheries ecological zones (FEZs), there does not seem to be a consistent pattern in all areas for all cycles. In Tangail, consumption

Table 3.3 **Weekly Food Consumption for Vulnerable Groups**

Food Item	Cycle 1		Cycle 2		Cycle 3		Full Year	
	%	Mean days	%	Mean days	%	Mean days	%	Mean days
Nursing Mothers								
Vegetable	99	6.2	100	5.9	99	5.4	99	5.8
Fish	84	3.0	71	2.4	90	3.6	82	3.0
Pulse	58	1.4	83	2.6	74	2.3	72	2.1
Meat	27	0.6	23	0.4	21	0.3	24	0.4
Egg	15	0.2	20	0.3	17	0.3	17	0.3
None of above	11	0.2	17	0.3	0	0.0	9	0.2
Rice*	98	6.5	100	6.6	100	6.7	99	6.6
Pregnant Women								
Vegetable	83	4.3	93	4.0	82	4.7	86	4.3
Fish	71	1.4	60	1.6	91	3.9	74	2.3
Pulse	46	0.8	83	1.9	68	2.0	66	1.6
Meat	29	0.5	17	0.2	9	0.1	18	0.3
Egg	8	0.1	10	0.0	23	0.3	14	0.1
None of above	13	0.2	27	0.4	14	0.3	18	0.3
Rice*	79	4.4	93	4.7	100	5.6	91	4.9
Children (age 2-5)								
Vegetable	96	5.9	95	5.3	98	5.2	96	5.5
Fish	80	2.8	67	2.3	87	3.5	78	2.9
Pulse	54	1.2	80	2.5	75	2.3	70	2.0
Meat	28	0.5	27	0.5	23	0.4	26	0.5
Egg	13	0.2	20	0.3	18	0.3	17	0.3
None of above	16	0.3	16	0.3	15	0.3	16	0.3
Rice*	97	6.3	97	6.2	100	6.5	98	6.3
Children (age <2)								
Vegetable	53	2.4	46	2.1	44	1.7	48	2.1
Fish	32	0.9	31	0.8	44	1.5	36	1.1
Pulse	21	0.5	35	0.9	32	1.0	30	0.8
Meat	12	0.3	8	0.1	10	0.1	10	0.2
Egg	11	0.2	6	0.1	4	0.1	7	0.1
None of above	45	2.3	26	1.4	12	0.5	28	1.4
Rice*	53	2.9	54	2.8	63	3.6	57	3.1

Source: Household Survey

*Includes wheat flour and rice mixed with pulses.

Table 3.4 Daily Per Capita Fresh Fish Consumption by Land Ownership (grams)

Area	Cycle 1	Cycle 2	Cycle 3	Mean
Landless and Marginal				
Tangail CPP	10	5	17	11
Surma-Kushiyara	19	16	11	15
Singra	22	7	22	17
Meghna-Dhonagoda	31	24	44	32
Small and Medium				
Tangail CPP	14	7	20	14
Surma-Kushiyara	28	30	27	28
Singra	29	17	43	30
Meghna-Dhonagoda	29	26	52	37

Source: Household Survey

was highest in the FEZ 2 (riverside) areas and about the same in the FEZ 1 (*beel*) and FEZ 3 (upland) areas, as Table 3.5 shows. In Surma-Kushiyara consumption was about the same in the FEZ 1 and FEZ 2 areas. The FEZ 3 areas had the lowest consumption in the first and third cycles but the highest in the second cycle. In the Singra area, consumption was highest in the FEZ 1 area and lowest in the FEZ 2 area. Overall, the classification of households by FEZ proved not to be very informative.

3.2.5 Meghna-Dhonagoda Consumption

Households surveyed in Meghna-Dhonagoda area were stratified according to their location—inside or outside of the project. As Table 3.6 shows, there were remarkable differences in fish consumption during all three cycles depending on household location. The daily per capita consumption for households inside the project was 43 percent lower than for those that were outside.

The greatest disparity was among the landless and marginal farmers. Marginal farm households inside the project consumed 45 percent less than those that were outside. The condition of the landless group was even worse: per capita consumption among households inside the project was 58 percent lower than it was for those that were outside.

The diversity of species consumed by households also varied depending on household location (Appendix 7). Among the households inside the project, 90 percent consumed cultured species. Only 68 percent of families outside the project did so. Inside the project, 52 percent of households consumed tilapia compared with 21 percent of those outside the project. Carp consumption was higher outside the project, both in terms of percentage of households and in quantity. The low level of fish consumption among families inside the project

Table 3.5 Household Fish Consumption by FEZ (kg)

Area	FEZ 1	FEZ 2	FEZ 3	Avg.
Full Year				
Tangail CPP	23	26	18	22
Surma-Kushiyara	43	43	38	42
Singra	58	28	30	41
Cycle 1				
Tangail CPP	9	8	5	7
Surma-Kushiyara	16	18	12	16
Singra	22	11	12	16
Cycle 2				
Tangail CPP	3	5	2	4
Surma-Kushiyara	13	14	21	14
Singra	11	2	6	7
Cycle 3				
Tangail CPP	11	13	11	12
Surma-Kushiyara	13	11	6	11
Singra	25	16	13	19

Source: Household Survey

Table 3.6 Meghna-Dhonagoda Fish Consumption (g/person/day)

Area	Cycle 1	Cycle 2	Cycle 3	Full Year
Inside Project	19	20	36	24
Outside Project	43	30	56	42
Average	30	24	45	32

Source: Household Survey

may have been a result of the availability of only a limited number of fish species.

Sources of fish catch, like fish consumption, varied depending on whether a household was inside or outside the project area. A comparison of data (Appendix 7) from the Meghna-Dhonagoda area reveals that households outside the project area caught most of their fish (40 percent) in the floodplain, followed by ponds (28 percent) and *khals* (12.4 percent). Inside the project area the highest percentage of the catch (35 percent) came from the river, followed by ponds (27 percent) and *khals* (26.3 percent). The higher riverine catch inside the project was probably due to the location of three sample villages close to an embankment that provided easy access to the river. This is reinforced by the fact that the river catch for the other three villages, located far from the embankment, was only 2.6 percent.

Both inside and outside, ponds contributed the second greatest source of fish in the Meghna-Dhonagoda area. The composition of the pond catch, however, varied depending on household location inside or outside the project. Inside the project, tilapia (44 percent) was the predominant culture species, followed by carp (6 percent). Fifty percent of the pond catch was made up of small and other fish. Outside the project, small and other fish (86 percent) dominated the pond catch, followed by carp (13.2 percent). The tilapia catch was negligible, only 0.4 percent. It appeared from the findings that tilapia played major role in inside pond fishery although half of the catch was non-cultured species. On the other hand, most of the ponds outside are dependent on flooding for production, and carp are more common than tilapia among cultured species.

3.3 Nutrients and Fish Species Diversity

Table 3.7 shows how many species and what weight of fish was consumed as well as the number of days and meals per week fish was eaten in each survey area. The results are based on data collected for only one week in each of the three survey cycles. Even this limited amount of data, however, indicates that large numbers of species were consumed in every area, ranging from 49 in Singra to 60 in Meghna-Dhonagoda.[1] A total of 75 species were consumed by the households in the four study areas.

Ranking the species consumed offers a perspective on the relative importance of each to the overall diet of rural people. Capture fish, particularly small species, are important sources of nutrition. The Household Survey found that 43 percent of all fish consumption consists of small species, while only 13 percent is carp. Table 3.8 shows the 10 species consumed in greatest quantity for each cycle and the entire year. Of the listed species, only two, silver carp and tilapia, are exclusively

Table 3.7 Household Species Consumption

Area	No. of Species	Consumption per Household: Amount (kg)	No. of Days/wk	No. of Meals/wk
Tangail CPP	54	0.3	2.2	3.1
Surma-Kushiyara	49	0.6	3.3	5.8
Singra	54	0.6	3.2	5.4
Meghna-Dhonagoda	60	1.1	4.4	9.4

Source: Household Survey

Table 3.8 **Species Ranking by Quantity Consumed**

Cycle 1	Cycle 2	Cycle 3	Year
Puti	Hilsha	Puti	Puti
Shrimp	Puti	Hilsha	Hilsha
Taki	Silver carp	Taki	Taki
Shing	Taki	Baicha	Shrimp
Tengra	Shrimp	Shrimp	Shing
Tilapia	Rui	Chanda	Silver carp
Silver carp	Shing	Koi	Rui
Koi	Tengra	Rui	Koi
Guchi baim	Tilapia	Boal	Tengra
Foli	Kachki	Kholisha	Tilapia

Source: Household Survey

culture fish, and shrimp, *puti, foli, koi, kachki, chanda,* and *kholisha*, are small capture species. Variations between cycles represent species seasonality, for example, *hilsha* ranked highest during monsoon season, which started in Cycle 2 and ended in Cycle 3. Capture fish also ranked high on the basis of number of days they were eaten, number of meals they were eaten, and the number of households that ate them (Appendix 9). This is probably because rural people can either catch these fish or purchase them in the small quantities they need and can afford from the market.

The fish species consumed in Bangladesh differ widely in their nutritional value. Species like *hilsha* are rich in fat, while a number of small fish species, particularly *mola* and *dhela*, contribute significant levels of vitamin A to the diet. *Puti*, the most commonly consumed fish in the study, is high in protein and calcium. All small fish make a significant contribution to dietary calcium.

The nutritional value of some of the most commonly consumed fish species was recently assessed by Dr. Shakunatala Thilsted of the Research Department of Human Nutrition of the Royal Veterinary and Agricultural College in Copenhagen (Thilsted 1993). The study analyzed eight commonly consumed small fish and shrimp species, as well as silver carp and *rui*. Each was assessed, in both cooked and raw conditions, for protein, fat, ash, energy (calories), vitamins, and calcium content. In addition, the fatty acid content of *puti*, silver carp, and *hilsha* was assessed.

Table 3.9 shows the results of the analysis of fish cooked in the traditional manner with spices and vegetables. The protein contributions of the various species were roughly the same, varying only from 7.8 percent in small shrimp to 12.8 in *dhela*. Fat content varied more widely: *hilsha* was 13.6 percent fat; *dhela*, 6.9 percent; small shrimp, 2.6 percent; *mola*, 4.8 percent; and *puti*, 4.4 percent. The fat percentages of silver carp (3.5) and *rui* (2.1) were relatively lower than for other fish. Likewise the energy contribution was low for silver carp, 327 kJ/100g, and *rui*, 278 kJ/100g, when compared with other species.

The nutritional difference between species was most marked for vitamin A. Vitamin A deficiency remains a serious health problem in Bangladesh. One of the most visible of its effects is nutritional blindness, but a recent study also found that,

Table 3.9 **Nutrient Contents of Selected Species (Cooked)**

Species	Protein (%)	Fat (%)	Ash (%)	Energy kJ/100g	Vit-A RE/100g	Calcium mg/100g
Puti	9.8	4.4	3.1	366	41	642
Small shrimp	7.8	2.6	2.2	344	-	252
Mola	10.3	4.8	3.7	676	1182	696
Dhela	12.8	6.9	4.3	499	949	927
Mixed small fish	10.5	5.1	4.3	386	78	639
Ruhi	11.0	2.1	4.5	278	38	571
Hilsha	11.6	13.6	2.4	733	18	714
Silver Carp	10.1	3.5	3.7	327	8	285

Source: Thilsted, S. 1993. (Memo)

"children with vitamin A deficiency have a risk of mortality 4-12 times higher than non-deficient children. Other studies have shown that children with vitamin A deficiency have higher risk of anemia, diarrhoea, and respiratory disease than non-deficient controls" (Helen Keller 1990).

Fish is an efficient source of vitamin A because it contains retinol and essential fatty acids. Those fatty acids, which are not found in vegetable sources of the nutrient, are required for the body to efficiently absorb vitamin A. Therefore, although vegetables can help prevent vitamin A deficiency, fish can be more effective in that regard. *Mola* and *dhela*, the study found, have especially high levels of vitamin A, and mixed small fish also have a high level of vitamin A. On the other end of the scale, small shrimp did not contain perceptible amounts of the vitamin, and *rui* and silver carp made the least contributions. The fish that were highest in fat were *puti*, *mola*, and *dhela*; silver carp and *rui* had the lowest fat content. *Hilsha* and *puti* are particularly rich in the fatty acids required for vitamin A absorption.

The calcium value of small fish, *dhela*, *mola*, and *puti*, and mixed portions was also much greater than for silver carp and *rui*. The calcium comes from eating small fish bones. It should be noted that since it is common practice to remove bones from portions of fish served to small children, the amount of calcium in fish eaten by children may be somewhat lower than it is for adults.

The Thilsted study found that *mola* and other species contributing vitamin A to the diet depend on migration from the rivers to the floodplain to maintain a production (see Chapter 5). The loss of lateral migration routes results in reduced production of these species. It also appears that species used in hatchery-based open water stocking programs, such as silver carp and *rui*, provide less vitamin A, calcium, and fat than the species commonly consumed by the rural poor. Much of the difference in vitamin A and calcium benefit of eating fish is related to the eating of "whole" small fish, while larger fish are deboned and organs removed before eating. It is estimated that silver carp consumption would have to increase from 50 to 84 grams daily per capita to make up for the nutritional value of just one species in the diet. Long-term strategies focusing on deficiencies in vitamin A and other nutrients should include efforts to restore and improve habitats of small fish.

3.4 Fish Catch

River flows and floodplain inundation were abnormally low in 1992, the year of this study. The highest flow of the Jamuna at Sirajganj was 13.25 m;[2] the previous low at that location was 13.46 m in 1976. The mean peak flow between 1964 and 1991 was 13.96 m, and the highest peak flows occurred in 1988 (15.11 m), 1984 (14.62 m), and 1987 (14.57 m). The effect of low flows on capture fishery is reflected in the results of this study. In Tangail, for example, the fish catch for 60 surveyed households in six villages was only 75 kg during the first half of December 1992; the catch in the second half of December 1991 for the same households was 119 kg.

3.4.1 Source of Catch

Table 3.10 summarizes the source of catch for major species groups (see also Appendix 10). Except for *hilsha*, which are caught only in rivers and canals, every species group is caught in every source. The floodplains, followed by ponds and canals, are the most important source of small fish. *Beels* and the floodplains are the most important for shrimp. Major carp species are taken from all sources, but mostly from ponds (78 percent). Most catfish are caught in *beels* and ponds. Snakeheads are pretty evenly distributed over all sources, but rivers are of least importance for the species.

Although the pond catch includes the most carp species and tilapia, it also includes species of small fish, catfish, shrimp, snakeheads, and eels. This shows that ponds are not used primarily for fish culture. Rather, they also depend on annual inun-

Table 3.10 Source of Catch by Species Group (percent)

Species Group	River	Canal	Beel	Floodplain	Borrow Pit	Pond
Small fish	8	14	13	29	11	25
Shrimp	17	11	33	24	6	9
Catfish	8	5	32	11	6	38
Snakeheads	4	18	19	25	10	23
Eels	26	4	42	5	6	18
Major carp	2	3	11	5	2	78
Other carp	7	0	51	31	3	8
Tilapia	0	0	0	1	3	96
Golda chingri	96	0	0	0	0	4
Hilsha	98	2	0	0	0	0
Total	11	11	21	21	8	29

Source: Household Survey

Table 3.11 Source of Catch by Area (percent)

Area	River	Canal*	Beel	Floodplain†	Borrow Pit	Pond
Tangail CPP	14	13	31	5	26	11
Surma-Kushiyara	4	15	8	41	10	22
Singra	7	3	42	9	5	34
Meghna-Dhonagoda	18	18	<1	27	9	28
Total	11	11	21	21	8	29

Source: Household Survey
*Includes canal and drain.
†Includes floodplain and haor.

dation for replenishment in order to provide the diversity of species for household consumption.

The source of total fish catch in each of the four areas is summarized in Table 3.11. In the Tangail area, most of the household catch is from the *beels* (31 percent) and the group consisting of canals, drains, and borrow pits (26 percent). The floodplains are least important in this area. The major source of catch in Surma-Kushiyara is the floodplain. *Beels* and ponds are the most important sources in Singra. Ponds, canals, and the floodplains are equally important in the Meghna-Dhonagoda area. Overall, ponds account for 29 percent of the household catch; *beels*, 21 percent; floodplains and *haors*, 21 percent; and canals, drains, and borrow pits, 19 percent. The sources most adversely affected by flood control and drainage projects, which are canals, *beels*, and floodplains, together provide 61 percent of the catch.

Fish production from ponds also may be severely depleted by FCD projects, because ponds are restocked each year by natural flooding. The amount of fish caught from ponds by species group was: small fish, 445 tons; catfish, 366; snakeheads, 114; shrimp, 47; eels and others, 73; and carp, 245.

Assuming all carp were culture fish, they account for only 19 percent of the total catch from ponds. The other 81 percent are from capture fisheries, which are dependent on annual inundation. The small fish production from ponds, of course, is

Table 3.12 Fish Caught, Sold, and Bought (tons)

Area	Caught	Sold	Caught & Consumed	Bought	Total Consumed
Tangail CPP	179	22	156	397	553
Surma-Kushiyara	881	311	570	590	1,160
Singra	1,997	1,501	495	775	1,271
Meghna-Dhonagoda	1,498	428	1,070	3,481	4,550
Total	4,554	2,262	2,292	5,243	7,535

Source: Household Survey

much greater than the amount caught for human consumption because small fish are the food supply of catfish.

3.4.2 Fish Caught and Fish Bought

A large amount of the fish catch is sold rather than being consumed directly as Table 3.12 indicates. In Singra 75 percent of the catch is sold, and in Surma-Kushiyara 35 percent is sold. Thus, in addition to its importance in family nutrition, fishing is a major source of household income in these areas (Table 3.13). The average value of fish consumed by households was Tk. 610, and the average value sold was Tk. 618. Landless households averaged Tk. 484 from fish sales, while the total value of fish consumed or sold was Tk. 966 per household. By way of comparison, the average monthly income declared by landless people in the 30 villages surveyed by FAP 14 was about Tk. 1,600 per household (FPCO 1992).

Small farmers seem to benefit most by participation in subsistence fishing. On average for the four areas, the value of subsistence fishing to this group was Tk. 1,700 per household. There is considerable variation between the survey areas: In Surma-Kushiyara the value for small farm households was Tk. 1,838, and in the Singra area the highest value was Tk. 3,597 (Appendix 11).

The quantity of fish caught and bought for consumption by socioeconomic category is shown in Table 3.14. The landless purchase the least quantity of fish per household. Small farmers are very similar to the landless both in purchases and the amount of catch consumed by the household. As one would expected, medium farmers consume the most fish and purchase more than those owning less land. Marginal farm households catch more than the other groups, and they purchase more than the small farm households.

Table 3.13 Annual Household Income from Subsistence Fishing

Category	Caught (t)	Sold (t)	Value per Household (Tk.) Consumed	Sold	Total
Landless	2,198	1,100	482	484	966
Marginal	1,295	626	866	835	1,700
Small	551	330	591	1,033	1,624
Medium	510	207	919	624	1,543
Total	4,554	2,262	610	618	1,228

Source: Household Survey

Except for carp and snakeheads, about two-thirds of the fish consumed are purchased, and one-third are caught (Table 3.15). The relationship is reversed for snakeheads: 59 percent of what is consumed is caught. In the case of carp, 80 percent of the fish consumed are purchased and only 20 percent of those caught are consumed by the household. Detailed results by species group on the amount of fish caught, sold, and bought for household consumption are presented in Appendix 12.

Table 3.14 Fish Caught, Sold, and Bought by Social Group

	Caught (kg)	Sold (kg)	Caught & Consumed (kg)	Bought (kg)	Total Consumed (kg)
Landless	23	11	11	28	40
Marginal farmer	40	19	21	39	60
Small farmer	39	24	16	35	51
Medium farmer	36	15	22	54	75
Total	29	14	15	33	48

Source: Household Survey

Table 3.15 Fish Caught and Bought for Household Consumption (percent)

Species Group	Caught	Bought
Small fish	34	66
Catfish	27	73
Snakeheads	59	41
Eels	48	52
Major carp	20	80
Other carp	25	75
Tilapia	25	75
Shrimp	40	60
Golda chingri	6	94
Hilsha	2	98
Total	30	70

Source: Household Survey

3.5 School Children

A special survey of school children in Classes II and III was conducted in 42 classes at 38 schools. There were 1,556 students in attendance, almost equally divided between boys and girls, on the day the classes were surveyed during Cycle 1. The major occupations of the children's parents or guardians were: landowner, 6 percent; owner/cultivator or sharecropper, 40 percent; laborer, 15 percent; service/business, 24 percent; fishing, 3 percent; and rickshaw puller, 3 percent.

A larger number of students were in attendance during subsequent cycles: 1,929 during Cycle 2 and 1,961 during Cycle 3. The percent of students that ate fish for breakfast on the day surveyed or at dinner the previous evening was:

- Cycle 1: breakfast, 46; dinner, 64
- Cycle 2: breakfast, 33; dinner, 46
- Cycle 3: breakfast, 48; dinner, 62

These simple results show the importance of fish in the children's diet. Even during the leanest period of availability, one third of the students had fish for breakfast, and almost half ate fish during the previous evening meal. When fish are more abundant, as during the other two cycles, almost half of the children had fish for breakfast, and nearly two thirds ate fish for dinner. The children reported consuming 50 species of fresh fish in these two meals during Cycle 3.

NOTES

1. The species-by-species detail of the catch by source is in Appendix 8.

2. Bangladesh Water Development Board, annual peak daily water level at Station 49, Jamuna River at Sirajganj, 1964 to 1992.

Chapter 4

FISH MARKETS AND ECONOMICS

4.1 Introduction

This chapter on fisheries economics examines employment patterns in the study area, giving particular attention to fishing employment. It also analyzes the market prices of fish during the study period. The unusually low inundation of the study year did not affect the results of the first two cycles, but because the third cycle catch was far below normal, fish prices in the markets were pushed abnormally high during that period. The chapter also discusses calculating the replacement value of fisheries loss.

4.2 Employment

Employment during the tl ee cycles is compared in Table 4.1 (details are in Appendices 11 and 13). The number of people engaged in work during the seven-day period that the households were surveyed increased slightly from a mean of 1.45 people per household in Cycle 1 to 1.62 per household in Cycle 2, and then decreased slightly during Cycle 3, to 1.57. Per household, the mean number of people over age four in Cycle 1 was 5.03, and the number not engaged in income-generating activities was 3.58.

Table 4.1 Comparison of Household Employment Patterns

	Cycle 1		Cycle 2		Cycle 3	
	Total	Mean/HH	Total	Mean/HH	Total	Mean/HH
No. of People	789,370	5.03	791,763	5.04	813,450	5.18
Working: Non-household	561,348	3.58	537,250	3.42	566,521	3.61
Working: Household	228,022	1.45	254,514	1.62	246,929	1.57
Work*						
Agriculture	103,612	0.66	123,880	0.79	96,272	0.61
Fisheries	42,732	0.27	49,839	0.32	54,448	0.35
Other	118,566	0.76	105,892	0.67	122,154	0.78
Ag. & Fisheries	-	-	18,208	0.12	7,812	0.05
Ag. & Other	-	-	4,981	0.03	2,325	0.01
Fisheries & Other	-	-	3,908	0.02	362	0.00
Total†	264,910	-	306,708	-	283,373	-
All Agriculture‡	-	-	131,272	0.84	98,973	0.63
All Fisheries	-	-	65,330	0.42	61,106	0.39
All Other Income	-	-	110,546	0.70	123,880	0.79

Source: Household Survey

*Number of people reporting an activity for one or more days.

†Some interviewees reported more than one work activity in a week.

‡Number of people reporting the activity alone or in combination with other activities.

Work distribution data cannot be fairly compared between Cycle 1 and the other cycles because of improvements made to the survey questionnaire following review of the first cycle results.[1] Of the 228,022 people engaged in work during the week, 103,612 (45 percent) worked in agriculture at least one day, 42,732 (19 percent) fished, and 118,566 (45 percent) engaged in one or more other activities. Income-generating activities increased somewhat during Cycle 2: of those reporting work for one or more days during the week, 52 percent worked in agriculture, 26 percent in fisheries, and 43 percent in other work. Eleven percent of those working reported multiple income-generating activities for at least one day of the week.

The number of people engaged solely in fishing increased between Cycles 2 and 3, but the number of those who fished along with other income-generating activities decreased, so that, overall, participation in fishing fell off slightly during Cycle 3. This is abnormal; usually fishing increases during the third cycle because fish are most abundant then. The amount of part-time or subsistence fishing was probably lower than normal in 1992 because of the extremely low river flows.

The number of people involved in fishing increased during Cycle 3 in Singra but declined in the other three areas. Although the number of people fishing declined overall, the time each person spent fishing actually increased, and therefore the fishing effort per household increased slightly from 1.13 to 1.18 days per week. As for individual study areas, fishing effort decreased substantially in Tangail and Surma-Kushiyara, while it increased in the other two areas.

Although agricultural participation rates are fairly uniform among the four survey areas, household involvement in fishing ranges from only 10 percent in Tangail to 45 percent in Surma-Kushiyara during Cycle 2.

Work activity in the four survey areas is compared in Table 4.2. Of the study areas, Meghna-Dhonagoda had the highest percentage of people engaged in fishing and Tangail had the lowest percentage. For all four areas, out of 8.3 days in which work was reported, 12 percent of the working days were spent fishing and 43 percent were spent on agriculture.

Employment in fisheries and agriculture by age and sex is shown in Table 4.3. Overall, the mean number of people engaged in fishing per household is 0.40, 0.73 per household worked in agriculture. Young children are much more involved in fishing than in agriculture: Of 11,805 children aged five to 10, a mean of 0.08 per household participated in fishing compared to only 0.03 per household that participated in agriculture. In the 11 to 17 age group, about the same number engaged in each activity, while those over age 17 tended to work more in agriculture.

Table 4.2 Days of Agriculture and Fishing Work Per Week*

	Agriculture		Fishing		Other		Total
Area	Mean	%	Mean	%	Mean	%	Mean
Tangail CPP	2.6	32	0.2	3	5.3	67	8.0
Surma-Kushiyara	3.5	36	0.9	9	5.5	57	9.6
Singra	4.6	52	1.2	13	3.1	36	8.8
Meghna-Dhonagoda	3.4	45	1.3	17	3.2	41	7.6
Average	3.6	43	1.0	12	4.0	48	8.3

Source: Household Survey

*Some people took part in more than one activity per day.

Table 4.3 Household Employment in Fisheries and Agriculture by Age and Sex

Age Group	No. of People*†			
	Male	Female	Total	Mean/HH
	Fishing			
5-10	8,146	3,660	11,805	0.08
11-17	14,283	3,298	17,581	0.11
18-55	27,446	2,187	29,632	0.19
>55	4,098	103	4,201	0.03
Total	53,971	9,247	63,218	0.40
	Agriculture			
5-10	2,035	1,022	3,057	0.02
11-17	13,125	2,064	15,189	0.10
18-55	73,180	7,183	80,363	0.51
>55	15,917	597	16,514	0.11
Total	104,257	10,866	115,123	0.73

Source: Household Survey

*Reported fishing or agriculture one or more days per week.

†No. of households equals 157,006.

Fisheries also provide more employment for female children. There were 6,958 females aged 5 to 17 employed in fishing and only 3,086 working in agriculture. Overall, 15 percent of females are involved in fishing, and 40 percent of those are in the 5 to 10 age group.

4.3 Fish Markets and Economics

In the following section, the value of fisheries is discussed according to some commonly accepted measures of value: market prices, economic or shadow prices, replacement cost by stocking or culture fish, and replacing nutritional loss. As will be seen, there are criticisms that any measure of value is inadequate from a distribution or equity standpoint. That is because poor people depend on the capture fishery as a source of food and livelihood. The poor are unlikely to benefit by any scheme so far proposed to mitigate the loss of capture fishery by stocking or culture fishery.

4.3.1 Market Prices

The monthly average prices for five fish species groups in a'l four study areas are listed in Table 4.4. Sı 'l fish, which account for 43 percent of consump ion, start at their lowest price of Tk. 33.8/kg in December and peak at Tk. 64.9/kg in June. By November the price declines to Tk. 36.0/kg.

Small shrimp are the least expensive group of fish, starting at an average price of Tk. 18.4/kg in December 1991 and peaking at Tk. 55.3/kg in April. Catfish are the most costly fish of those listed, starting at Tk. 41.8/kg in December and peaking at Tk. 77.0/kg in June. With the single exception of the partial month of December 1991, the lowest prices for small fish, shrimp, and catfish occurred in November.

The effect of scarcity on prices during the flood recession of 1992 is apparent in the comparison of

Table 4.4 **Monthly Average Prices of Species Groups (Tk./kg, 1991-92 prices)***

Month	Small fish	Shrimp	Cat-fish	Snake-heads	Carp
December 16-31	33.8	18.4	41.8	37.2	32.2
January	42.9	25.0	54.0	44.5	52.4
February	46.2	34.9	62.8	46.9	55.5
March	44.3	38.6	62.3	44.7	61.5
April	48.7	55.3	53.2	49.1	40.7
May	51.3	44.7	70.3	49.5	55.2
June	64.9	47.0	77.0	55.8	67.0
July	50.4	35.5	68.0	50.1	50.1
August	45.7	32.3	63.5	39.8	39.0
September	40.4	31.9	84.5	48.1	62.3
October	47.2	32.3	53.2	45.1	51.5
November	36.0	22.6	50.1	36.4	56.8
December 1-15	45.7	30.0	60.3	33.7	58.8
Average	46.5	35.4	62.5	45.5	53.1

*Weighted mean based on quantity sold at each price.

prices for the first half of December 1992 and the second half of December 1991. Prices of small fish were 35 percent higher, shrimp were 63 percent higher, catfish 44 percent higher, and carp 83 percent higher. Only snakeheads were selling for less. Of course, part of this difference is because of general price inflation, but that probably was not more than 10 percent. Therefore, in real terms prices appear to have been much higher in the latter part of 1992.

The price ratios of small fish to average quality rice, *mossuri, khesari,* and potatoes in the same markets averaged for all study areas are plotted in Figure 4.1. The average ratios over the 12-month period are: small fish to rice, 4:1; small fish to *mossuri,* 1.7:1; small fish to *khesari,* 3:1; and small fish to potato, 6.2:1.

In all cases except potatoes, the fish to commodity price ratio is lowest in December and peaks in June, reflecting the seasonal scarcity of fish. Rice and pulse prices are seasonally stable compared to fish because they are easily stored between harvests. The fish to potato price ratio is highest in January, February, and March because potatoes are abundant at that time. Potatoes are about twice as expensive the rest of the year, when they are marketed out of cold storage.

4.3.2 Regional Variation

There is variation in prices among the four areas, and the best illustration of this is a comparison of prices in Tangail and Singra. Monthly average prices for representative species in Tangail and Singra are shown in Figure 4.2 and Figure 4.3. Tangail prices clearly show a seasonal increase reflecting scarcity of supplies from March through September, while in Chalan Beel the same general trend exists, but prices throughout the year are much lower and the trend less steep. Carp prices are fairly constant at around Tk. 40/kg in Singra, while in Tangail they start at Tk. 54/kg in January and increase to between Tk. 70/kg and Tk. 85/kg from March through June, drop to Tk. 66 in July, and then go higher, to Tk. 98 in August and Tk. 122 in September. The price differences between the two areas probably reflect: the abundance of supply in Chalan Beel, and perishability, distance, and cost of transport to Dhaka; and low production in Tangail, and proximity to Dhaka.

Monthly rice prices are more stable than fish and there is less variation between the two regions because rice is less perishable and more easily transported than fresh fish. On average, rice prices are Tk. 1.6 lower in Singra than in Tangail.

The combination of the above factors results in much different fish to rice price ratios for the four survey areas. The price ratio of small fish to average quality rice was about the same (3:5) in the first four months, December, January, February, and March (Figure 4.4). The ratio began to

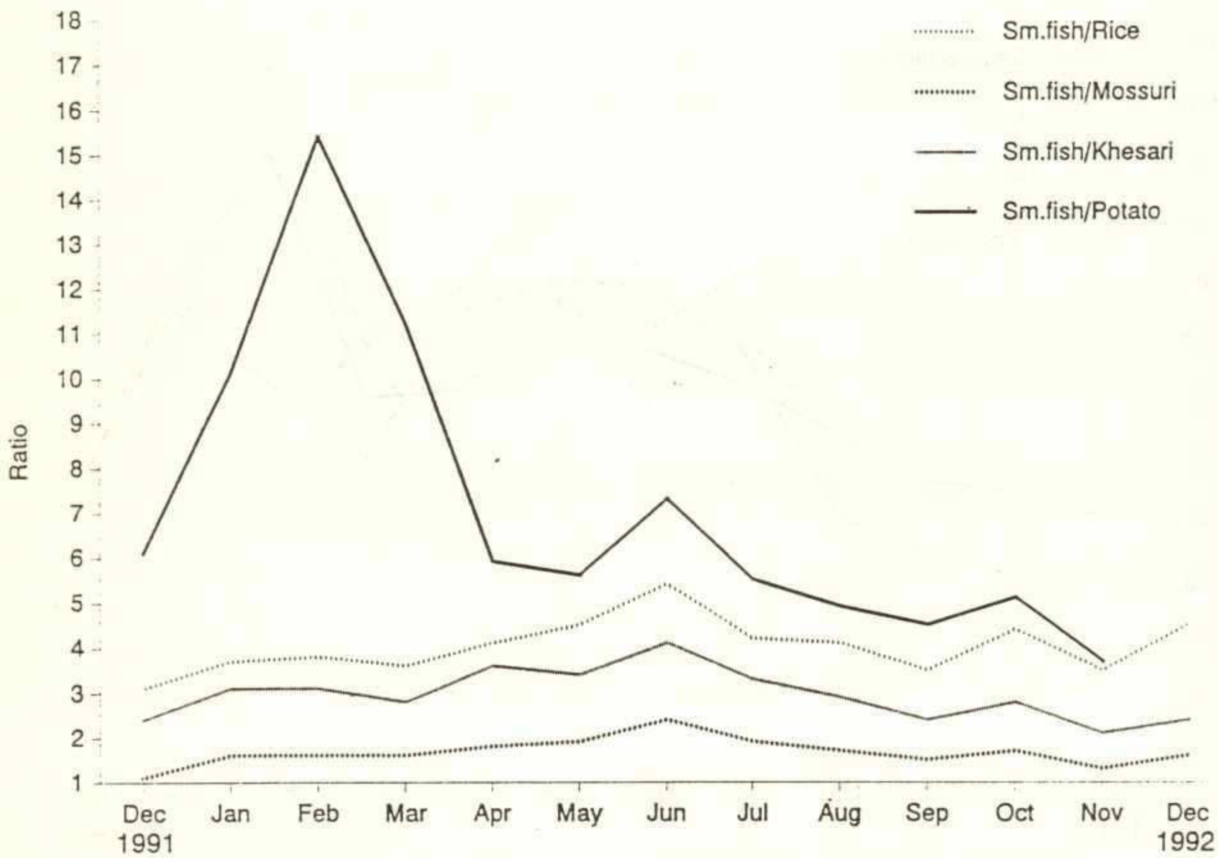


Figure 4.1 Small Fish/Commodity Price Ratio

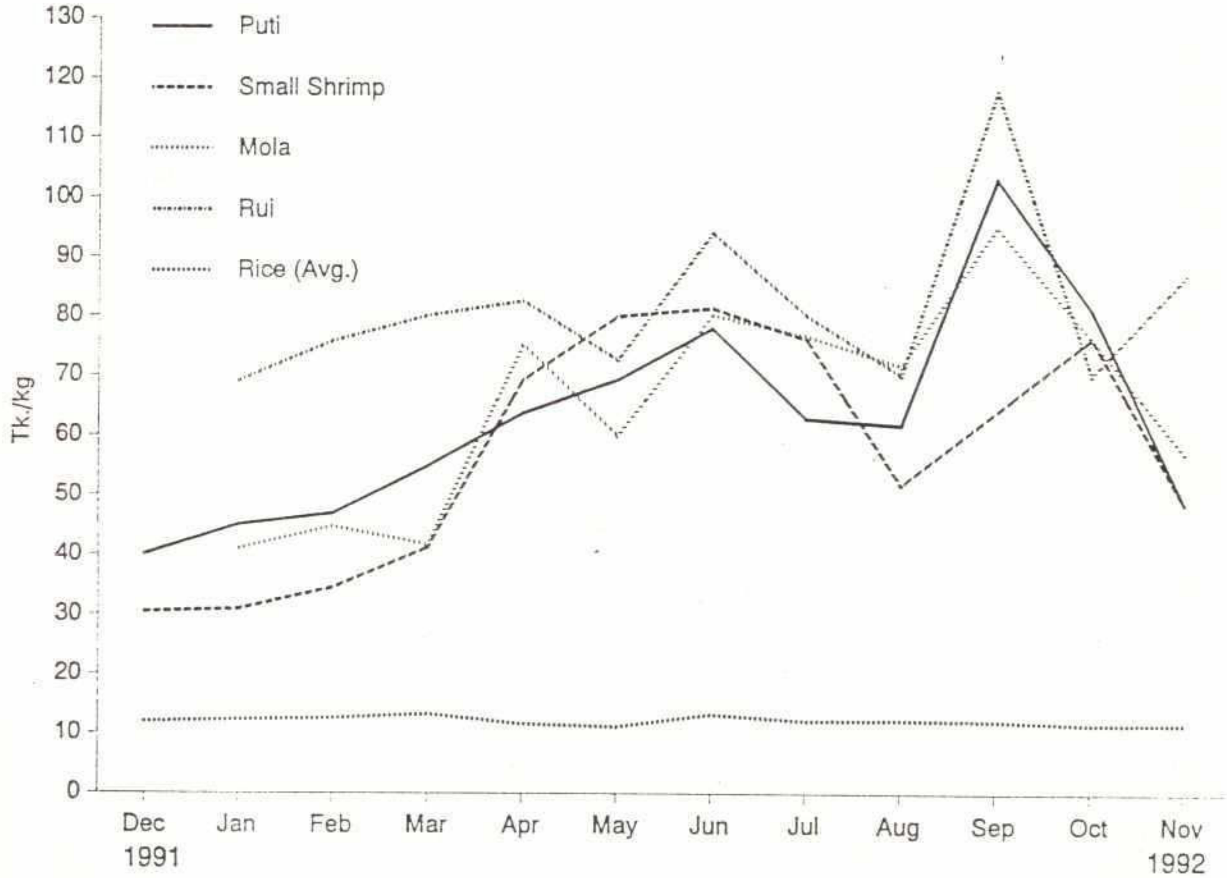


Figure 4.2 Price of Fish in Tangail CPP Area

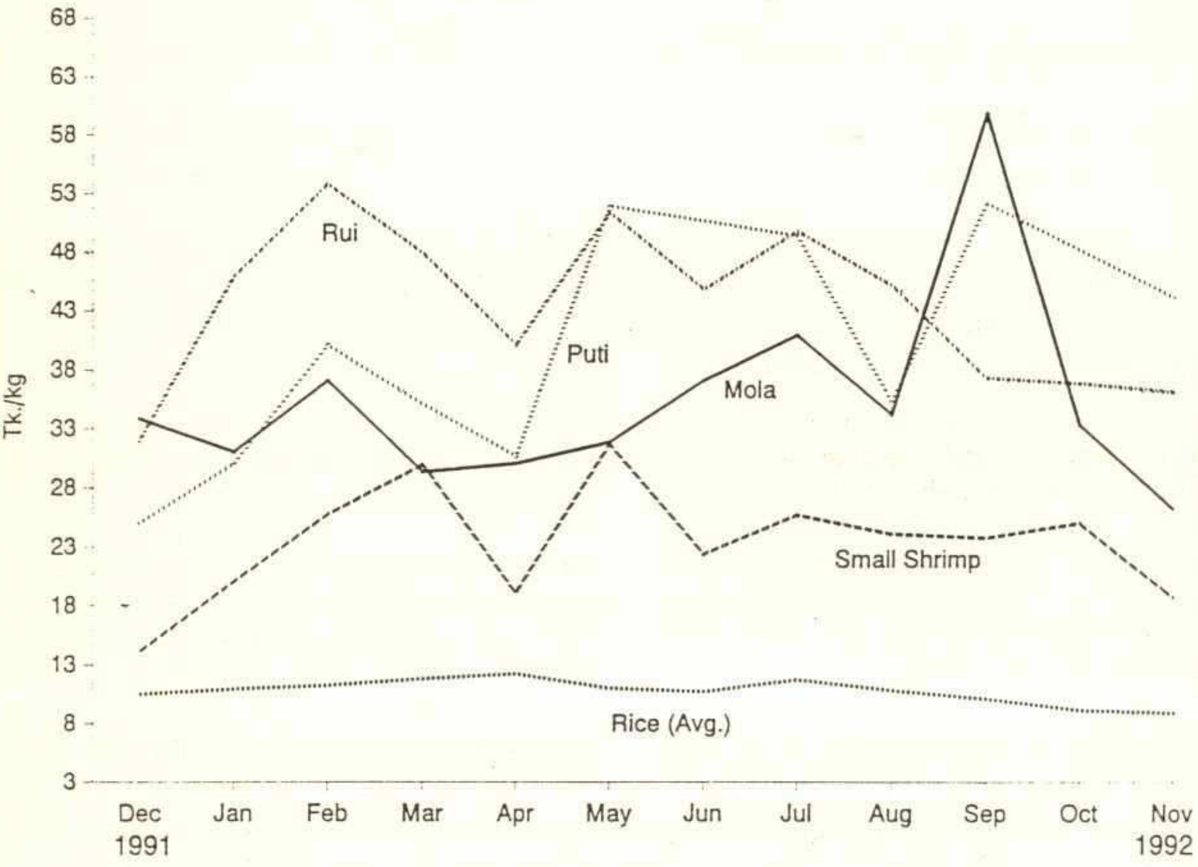


Figure 4.3 Price of Fish in Chalan Beel Area

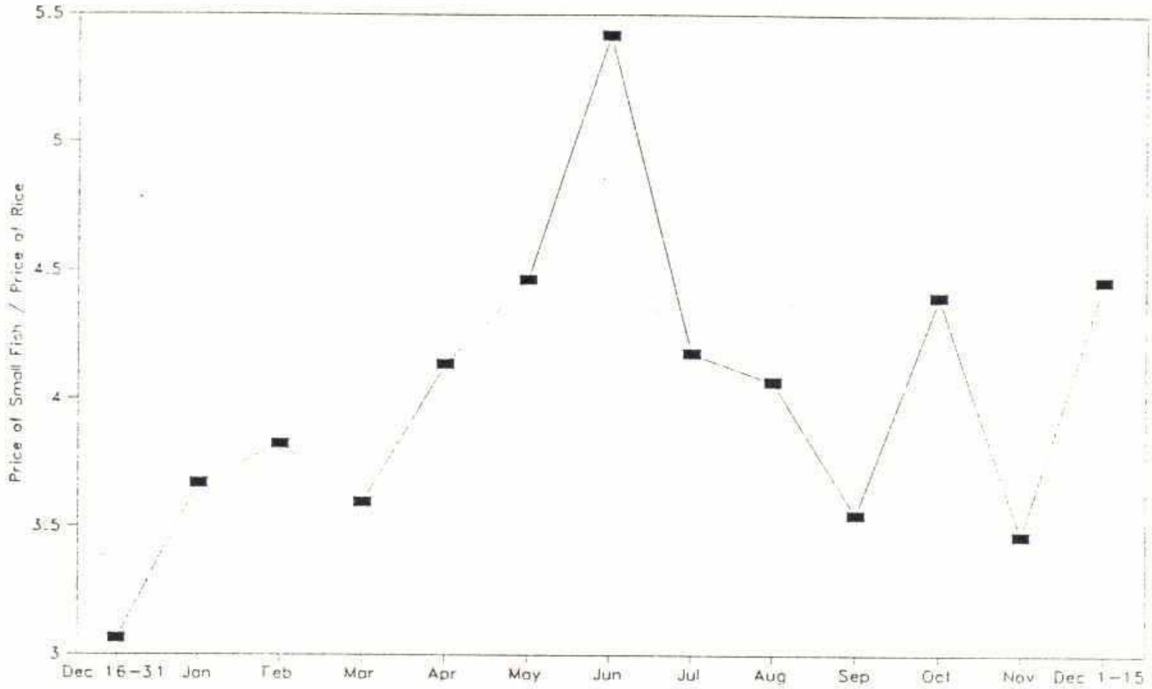


Figure 4.4 Small Fish to Rice Ratio

increase sharply in April, and by June it had reached the peak (5:4) and then it started to fall from July through September (3:4). The ratio again increased in December after fluctuating somewhat in October (4:5) and November (3:3). The ratio in December 1991 was much lower compared to December 1992.

Monthly prices by species group, and for other commodities for the four study areas are in Appendix 14, and price to commodity ratios are in Appendix 15.

The average annual prices are summarized by major species groups in Table 4.5.[2] These market prices are converted to economic prices in Table 4.6 using the scarcity premium of 1.25, and the standard conversion factor of 0.87. Of course, the scarcity premium has no empirical basis, but it does represent acknowledgement of the argument

Table 4.5 Average Prices* for Species Groups by Area (Tk./kg, 1991-92 prices)

Species	Tangail	Surma-Kushiyara	Singra	Meghna-Dhonagoda	Mean
Small fish	64.0	48.5	37.0	45.6	46.5
Shrimp	56.3	37.0	23.3	39.0	35.4
Catfish	87.1	68.0	45.4	61.3	62.5
Snakeheads	65.6	45.3	40.6	41.1	45.5
Carp	77.5	61.6	38.1	54.1	53.1

*Weighted average based on quantities sold at markets surveyed in the four areas.

Table 4.6 Economic Prices* for Species Groups by Area (Tk./kg, 1991-92 prices)

Species	Tangail	Surma-Kushiyara	Singra	Meghna-Dhonagoda	Mean
Small fish	69.6	52.7	40.3	49.6	50.5
Shrimp	61.3	40.2	25.4	42.4	38.4
Catfish	94.7	73.9	49.4	66.7	68.0
Snakeheads	71.3	49.3	44.1	44.7	49.4
Carp	84.3	67.0	41.4	58.9	57.7

*Average prices from the previous table multiplied by a scarcity premium of 1.25 and standard conversion factor of 0.87.

that real prices of fish are likely to be higher in the future.

4.3.3 The Economic Value of Survey Area Fisheries

The Interim Report of the Tangail Compartmentalization Pilot Project (FAP 20), estimated present annual fish production in the project area is 420 tons annually, of which 40 tons are from aquaculture (FPCO, Compartmentalization, 1992). Losses of capture fisheries were estimated under 12 potential scenarios to range from a minimum of 47 tons per year to 138 tons per year. The capture fishery was valued at the prices shown in Table 4.7.

The estimated value of lost capture fishery under Scenario 4, which results in the highest predicted loss of 138 tons, is Tk. 6.85 million. Such an estimate of lost fisheries value would normally be considered sufficient for the cost-benefit analysis in a project feasibility study. And certainly the fisheries analysis in the proposed Tangail CPP project feasibility study improves on previous efforts. However, a recent technical paper produced by FAP 16 in collaboration with FAP 17 and FAP 2, finds this approach deficient on the following grounds:

> *There is widespread agreement that the floodplain and beel fisheries in Bangladesh are in decline. It is evident that FCD/I projects, which were designed without consideration of impacts on fisheries, have contributed to this decline. The projects have reduced the environmental capacity of the floodplains and disrupted the fish migration routes, leading to production loss and stock depletion through diminished reproduction and growth. The resultant diminished stock is far more susceptible to over fishing. This should be reflected in a higher real price for fish in FAP project cost-benefit analysis.* (FAP 17, 16, & 2 1992)

Therefore, an alternative approach is warranted. Such an approach should raise the market price out of consideration that future fish scarcity will result in higher real prices. In other words, in the future fish will become more valuable relative to other

Table 4.7 Value of Fish, Tangail CPP

Species	Tk./kg
Major carp	60
Minor carp	50
Catfish	90
Hilsa	100
Large shrimp	120
Small shrimp	40

Source: FAP 20, 1992.

commodities than is currently the case. This view was apparently sufficiently convincing for economists on the Panel of Experts of the Flood Plan Coordination Organization, who agreed to a premium of a 1.25 ratio applied to fisheries market prices, reduced by the standard conversion factor .87, which is applied generally to nontraded (international) commodities in the absence of a specific conversion factor (Smith 1992).

4.3.4 Replacement Value

Resources are often valued on the basis of what it would cost to replace them. A rough estimate has been made of the cost of increasing fish production through a stocking program being developed under the Third Fisheries Project. The estimated cost per kilogram of fish production under this program is Tk 12.5/kg, assuming a yield to input ratio of 9:1.[3] This is a very preliminary estimate, just to illustrate the approximate magnitude of cost. If output is only half of what is expected, the cost will still be only about half of the market price of carp.

There are very preliminary indications that yields of wild fish are declining in some parts of the Third Fisheries project area. This suggests that part of the increase in carp yield could be at the expense of wild species production. Under these conditions output should be considered as net production based on carp output minus the reduction of wild stocks in a given year. The impact would be compounded in future due to the loss of reproducers in subsequent generations of wild fish species.

The principal of how even a slight increase in mortality as a result of an intervention such as flood control or stocking can have a dramatic effect on fish populations is illustrated by Wootton's discussion of mortality early in the life cycle:

> *Because of the high fecundities of fishes, slight differences in the mortality rates of the eggs and larvae can produce major differences in the number of juveniles produced. A simple calculation illustrates this. Assume that two cohorts of spawners each produce 10^7 eggs. The eggs and larvae of one cohort experience...a survival rate of 90.5%. After 60 days there are 24,787 survivors. The eggs and larvae from the other cohort have a daily mortality rate of 0.05, that is a survival rate of 95.1%. After 60 days there are 497,871 survivors. In practice it might be difficult to detect the difference between the two survival rates, yet the absolute numbers of recruits produced differs by over 400,000.*

Increasing stocked species increases competition for finite food supplies for other species. Furthermore, the fingerlings of stocked species are too large to serve as a food source for many predator fish, particularly during immature stages, when they feed on wild fry. More information is needed on the extent of this displacement effect in order to calculate the cost of stocking based on the incremental increase in output, i.e., total production of all fish species with stocking, minus total production of all species without stocking.

Although fish stocking appears to be a profitable method of boosting carp production, most of the benefits of the increased productivity are going to relatively wealthy people: landowners, leaseholders, and middlemen. The fish are being sold in large markets, and are not available to most fish-consuming families.

Another possibility for estimating the replacement value of capture fish is to use the cost of culture fishery. The estimate of this cost using semi-intensive technology is Tk 20/kg, as shown in Table 4.8. Although culture fishing is very profitable, from a social point of view, the displacement of capture fishery production from natural ponds should be considered in the cost estimate.

Table 4.8 Estimated Cost of Culture Fishery (Tk., 1991 prices)

Item	Cost
Pond rental (1 bigha, 0.1336 ha)	2,000
Draining/poisoning	600
Liming	200
Manuring	1,300
Fish fry	500
Fish feed	2,300
Laborers, fishing	1,000
Miscellaneous	500
Subtotal	8,400
Bank interest @ 16%	1,344
Total cost	9,744
Cost/kg (500 kg yield)	20

Source: Manual on Integrated, Semi-intensive Fish Culture in Bangladesh (Bangla), Field Document, FAO/UNDP Project BGD 87/045/92, 30 June 1992.

As in the case of the stocking program, relatively few families would benefit by a transition from capture to culture fisheries. Participation in pond culture is limited by the number of ponds, multiple ownership, cost of inputs, and entrepreneurial risk. Both the management and capital required are beyond the means of most families. When a pond is converted to culture fishery, it often means a loss of access by poor people to capture fisheries (Minkin 83).

NOTES

1. During Cycle 1 respondents were recorded as working in fisheries or agriculture only when that was their sole work. If a respondent did both or some other activity, his employment was classified "other." Thus, the numbers of people employed by fishing and agriculture were under-reported in Cycle 1. The problem was subsequently corrected.

2. The FAP 17 Technical Paper also recommends basing prices on seasonal averages, rather than using the lower prices that occur at the period of peak abundance during flood recession.

3. Personal communication with Keith Thompson, Third Fisheries Project, 15 December 1992.

Chapter 5

FISH MIGRATION

The inland freshwater water fish community of Bangladesh is dependent on and strongly influenced by seasonal variations in its rivers and floodplain systems. Key among those influences is the effect of the hydrological cycle on fish migration. Almost every inland freshwater fish species in the Ganges-Brahmaputra floodplain migrates to fulfil some biological need, whether it be spawning, feeding, larval development, or early growth. Each of these activities requires migrating to a specific habitat. Sustainable population balance, species diversity, and fish production in the floodplain river ecosystem also are heavily dependent on migration. In general, fish engage in two types of migration: longitudinal, upstream and downstream in river channels; and lateral, back and forth between the river and the floodplains (Figure 5.1).

5.1 Fish and Floodplain Rivers

This study sought to verify the migration of fish species and their dependence on flooding, as well as to learn more about the dynamics of the fish population in the floodplain river systems of the four study areas.

The entire floodplain fish community suffers from extreme stress during the dry season. Just before the onset of monsoon season, when most of the seasonal wetlands are dry, fish take shelter in perennial wetlands like rivers and *beels*, which also reach their lowest stage at that time. In the Chalan Beel area, this survey found, floodplains and *kuas* (small ponds excavated by land owners for the purpose of trapping fish) were almost completely dry, and hardly any fish survived in them. In Tangail, seasonal *beels* had dried up and perennial *beels* had been intensively fished by leaseholders and villagers.

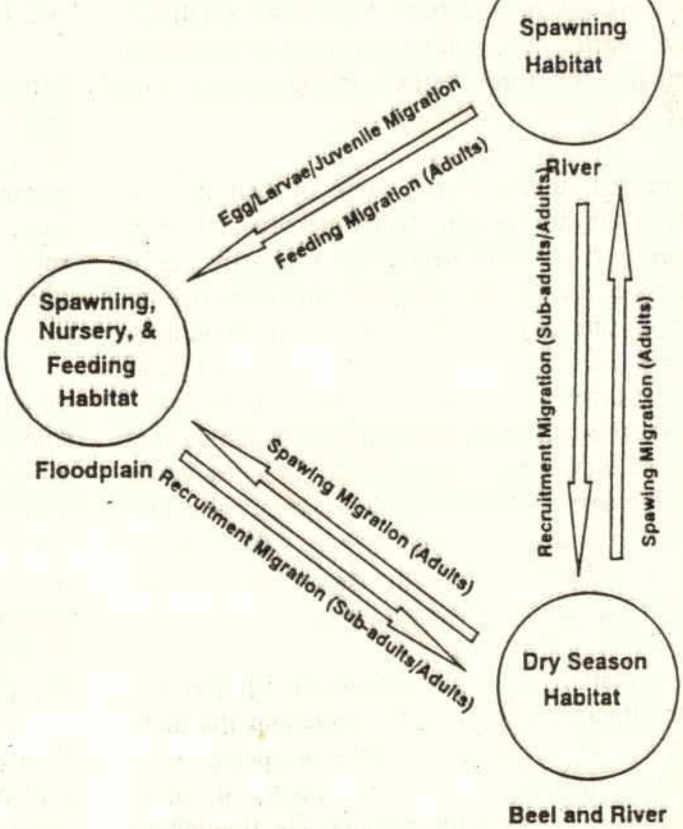


Figure 5.1 Migration Pattern of Floodplain Species

The rivers, on the other hand, are relatively safe areas during the dry season, supporting a reserve of mature fish for monsoon season recruitment. These "fish in the bank" ensure that stocks of any species are not "overdrawn" in the reduced dry season habitat.

This study monitored fish catch in selected river segments in Tangail and Chalan Beel, as well as in three perennial *beels* in Tangail, to determine the diversity of fish species in dry season habitats. Major portions of the Tangail rivers (Dhaleswari, Lohajong, and Pungli) and Chalan Beel (Gur) were dry preceding the monsoon season except for some pools in the river channels. A total of 44 species were found in those remaining pools: 12 species of catfish, 21 small fish, six carp, three eels, and two snakeheads.

An analysis of the catch from three *beels* in Tangail during May and June found only 13 species in small quantities: two snakeheads *(taki* and *cheng)*, two eels *(guchi* and *boro baim)*, six small fish (*puti, bailla, koi, chanda, kholisha,* and small shrimp), and three catfish *(shing, magur,* and *tengra)*.

Compared to the parent stock of fish in river during the dry season, fish diversity and abundance in *beels* were negligible, primarily due to the reduction of *beel* size and intensive fishing. Fishing intensity usually increases in floodplains during late monsoon when water starts to recede. At that time, perennial *beels* and flood-fed ponds and borrow pits often are pumped dry and most of the fish they contain are caught. As a result, the fish biomass in floodplain *beels* drastically falls except in some deeper *beels* where a few species, mostly air-breathing catfish, snakeheads, eels, and small fish, remain (see Chapter 6).

The migration study also monitored fish diversity in the inundated floodplain throughout the monsoon period. A greater number of species were found there than in the rivers, *beels*, or canals (which had 33 migrating species). The floodplains yielded a total of 55 species: 15 catfish, 7 carp, 27 small fish, three eels, and three snakeheads. In addition to the fish species identified, the study found many in-migrating fish larvae and eggs, which were not identified.

Although the stocks of fish in premonsoon river pools were low, as soon as the water level and flow increased during the monsoon, the entire fish community in the river systems mixed and moved onto the floodplain, colonizing the habitat. This accounts for the rich species diversity found on the floodplain.

5.2 Migration

The findings of the migration study reveal that the floodplain species migrate for three purposes: reproduction (including spawning, nursing, and feeding), to find winter refuge, or to find suitable dry season habitat.

5.2.1 Spawning Migration

Most fish in the Ganges-Brahmaputra river system leave their dry season refuge before or during early monsoon and move toward their spawning grounds. The spawning destination varies from species to species. Some prefer the river channels, some newly inundated floodplains, and some stagnant pools. Spawning is timed with temperature rises, rainfall, and increased water flow.

Major carp *(Catla catla, Labeo rohita, Labeo calbasu, Cirrhinus mrigala)* begin their longitudinal migration between March and May, moving from their dry season habitat of *beels* and the lower reaches of rivers to upstream areas of the Ganges and Brahmaputra, where they spawn from May to August. Of all the rivers in Bangladesh, the Brahmaputra has the richest stock of major carp (Tsai and Ali 1986).

Most catfish species, notably *boal (Wallago attu)*, *aair (Mystus aor)*, varieties of *tengra (Mystus spp.)*, and *rita (Rita rita)*, migrate from river to floodplain for spawning in early monsoon. In the

Table 5.1 Migrating Species Caught in Kakura Khal (March 13-May 17, 1992)

Species	Number	Total wt. (kg)	Av. wt. (kg)
Boal	598	2,291	3.8
Aair	114	444	3.9
Rita	32	79	2.5
Goinnaya	92	60	0.7
Mrigal	14	40	2.9
Kalibaush	11	26	2.4
Rui	8	23	2.9

Surma-Kushiyara area (Map 6, next page) many mature *boal, tengra,* and *aair* were observed ascending against heavy current through the Kakura Khal as they moved from the Surma River to the floodplain between mid-March and May (Table 5.1).

Species that remain in *beels* throughout the dry season, such as *koi, singh, magur, puti, gutum, guchi,* and snakeheads, probably start spawning as soon as water inundates the lowlands around the *beels*. As the water rises, these species migrate locally and laterally to floodplains for spawning, feeding, and growth.

Many species, such as *mola, puti,* small shrimp, *koi, taki, shing, khalisha, guchi,* etc.—usually considered sedentary and able to spawn in the stagnant water of *beels*, pools, ponds—were found migrating from river to floodplain even against heavy currents during pre- and early monsoon. All of these species may have a tendency to move to the biologically productive floodplain ecosystem for spawning and subsequent feeding even though they are able to spawn in stagnant waters.

In all four study areas, mature eels laden with eggs, many species of small fish, and small shrimp carrying eggs migrated from river to floodplain during early monsoon both against and with the water current.

In the four study areas, 24 to 33 species were observed actively or passively migrating from river to floodplain during pre- and early monsoon. Most were commonly consumed species.

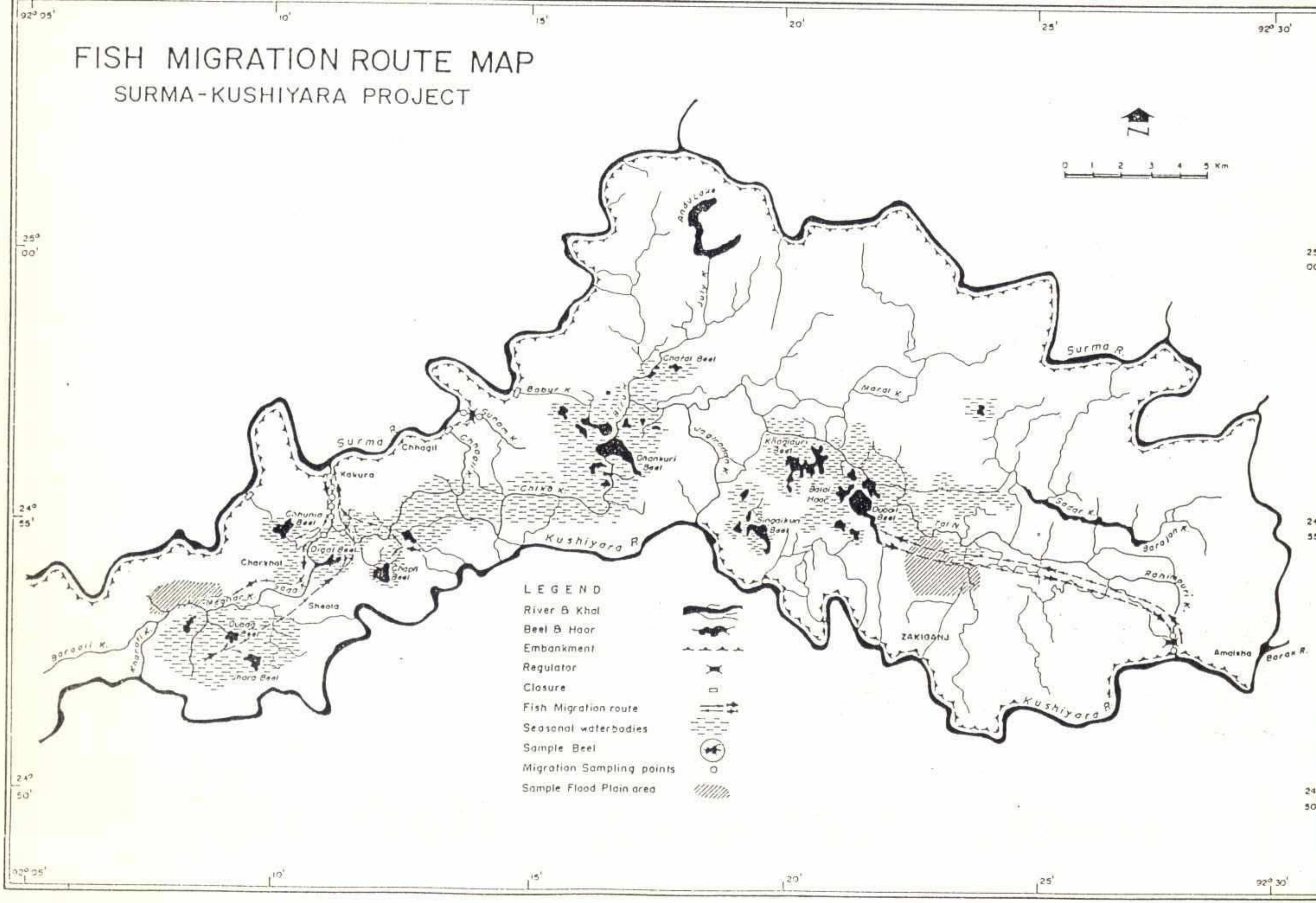
The highest level of lateral spawning migration occurred during the first few days of the influx of early monsoon rain waters. Appendix 16 lists the fish species found migrating through canals in the four study areas.

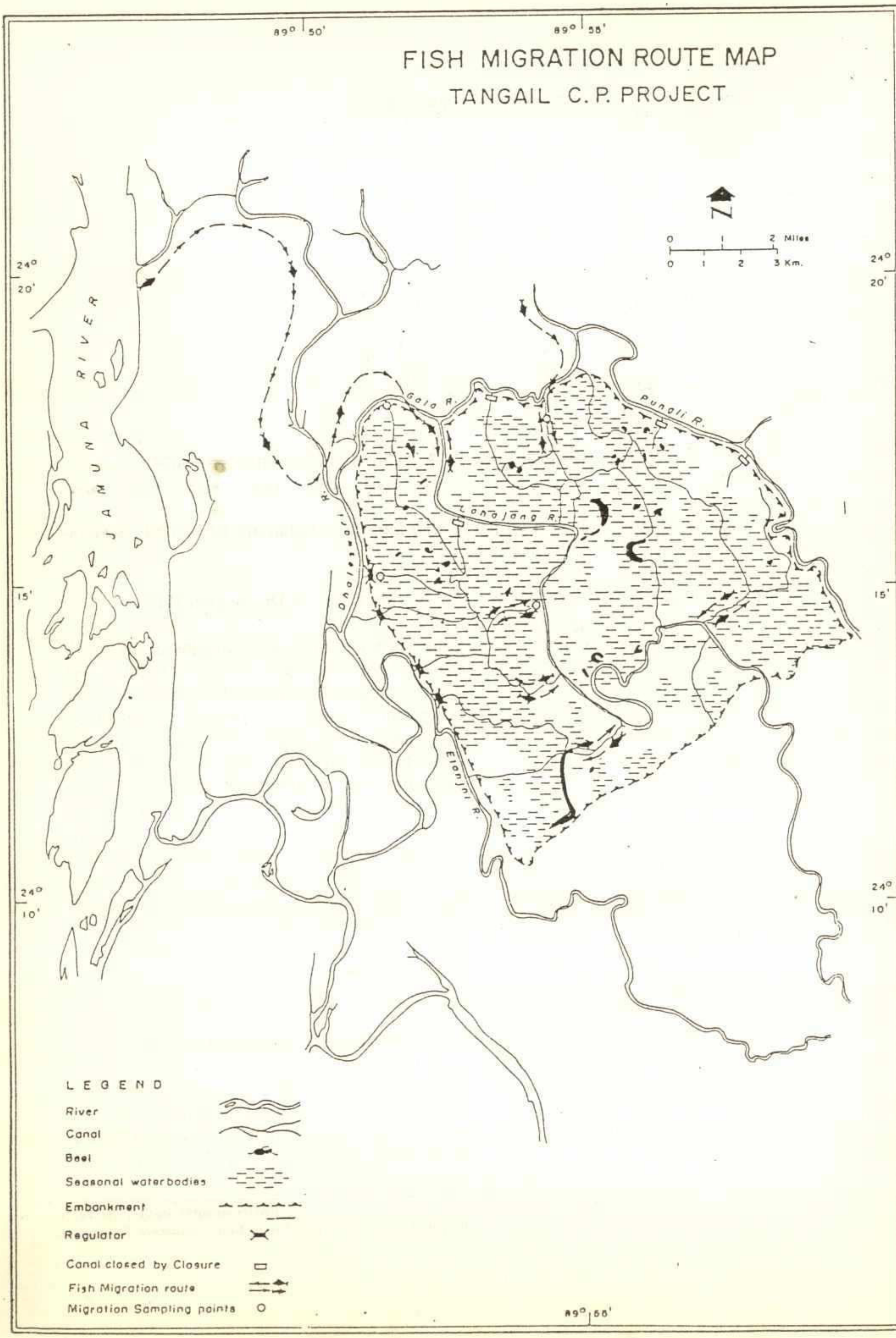
5.2.2 Migration to Nursery and Feeding Ground

Between March and May, water levels in *beels* and rivers increase with the pre-monsoon rains, eventually inundating nearby floodplains. Organic and inorganic by-products of dry season agriculture enter the water, providing essential nutrients for the biological productivity of the micro-level aquatic ecosystem. As water levels continue to rise during the monsoon, decomposed plant and animal residues also enter the inundated floodplain. These residues enhance the rapid growth of fish food organisms in the floodplain ecosystem, making it a suitable nursery habitat that is conducive to the spawning, feeding, and growth of fish.

After spawning in upstream rivers, adult major carp migrate downstream and then laterally onto floodplains to feed. The spawn and early fry are gradually swept downstream to small rivers and are dispersed through canals onto the floodplains for early growth and feeding.

During the study, larvae migrating from the Lohajong River to the floodplain were monitored in the Tangail area (Map 7, previous page). Larvae were trapped in Sadullahpur Khal and Gaizabari Khal from July 1 through September 7, 1992, but monitoring was done only on days when the water flowed toward the project area. Appendix 17 details the number of larvae trapped on each sampling date. Among the larvae trapped were major carp, eels, *bailla, aair, boal, chanda, chela,* and others that could not identified.


FISH MIGRATION ROUTE MAP
SURMA-KUSHIYARA PROJECT
N
0 1 2 3 4 5 Km
92° 05'
10'
15'
20'
25'
92° 30'
25° 00'
24° 55'
24° 50'
Surma R.
Kushiyara R.
Chatal Beel
Dhankuri Beel
Babur K.
Sunam K.
Chhagli
Kakura
Chika K.
Chhunia Beel
Digal Beel
Chapti Beel
Charkhai
Sheola
Dubag Beel
Shara Beel
Baraoil K.
Kharati K.
Marai K.
Khagiaduri Beel
Balai Haor
Dubai Beel
Singaikuri Beel
Sadar K.
Barajan K.
Rahimpuri K.
ZAKIGANJ
Amalsha
Barak R.
LEGEND
River & Khal
Beel & Haor
Embankment
Regulator
Closure
Fish Migration route
Seasonal waterbodies
Sample Beel
Migration Sampling points
Sample Flood Plain area



FISH MIGRATION ROUTE MAP
TANGAIL C.P. PROJECT
89° 50'
89° 58'
24° 20'
15'
24° 10'
N
0 1 2 Miles
0 1 2 3 Km.
JAMUNA RIVER
Gala R.
Pungli R.
Lohajang R.
Dhaleswari R.
Elanjani R.
LEGEND
River
Canal
Beel
Seasonal waterbodies
Embankment
Regulator
Canal closed by Closure
Fish Migration route
Migration Sampling points

Fish larvae, predominantly of the major carp species, were found in the Jamuna and Dhaleswari rivers from late May through mid-August, and their numbers peaked in June (FPCO October 1992). The Tangail project area, however, which is fed by the Lohajong River via the Dhaleswari, was not inundated until July because of siltation at the confluence of the two rivers and because the canals connecting the project area to the Dhaleswari were blocked by dykes or closed regulators. Figure 5.2 shows that larval density peaked eight times in the Lohajong River between July 2 and September 7. Were it not for the blocked accesses to the Dhaleswari, there may have been a peak in June as well, and the first peaks in July might have been even higher. These peaks indicate that the fish spawn in batches, perhaps coinciding with rainfall or other environmental factors that can trigger spawning.

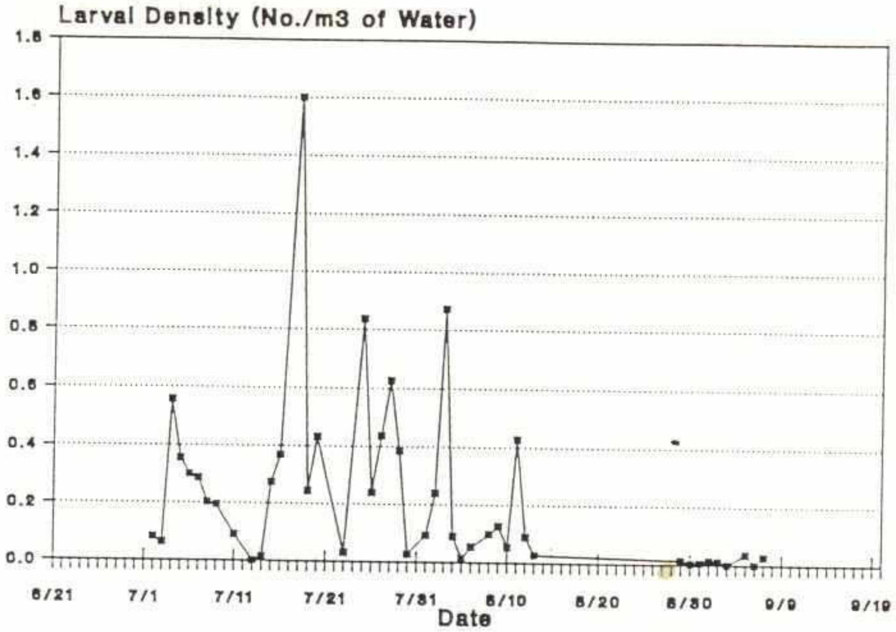


Figure 5.2 Density of Fish Larvae in Lohajong River (July-September 1992)

In addition to larvae, numerous fish eggs also were trapped as they entered the floodplain. It is assumed that laterally migrant fish, resident in rivers, spawn upstream in the inundated land on either side of the rivers. Their eggs are then swept downstream and through the canals to the floodplain along with the larvae.

Early in the monsoon season, young *aair* also were found in the canals, indicating that this species might spawn early in rivers as well as in the floodplain. Kushiyara River fishermen confirm that finding, saying that the *aair* build nests near the river shore prior to monsoon (March-April), and after spawning, their fry migrate to the floodplains for feeding and growth.

5.2.3 Migration to Dry Season Habitat

After spending three to six months in the floodplain, all fish species (young, subadults, and adults) migrate back through the canals to the river along with the receding floodwater. This migration is predominantly passive. The adults of some riverain fish (carp and some catfish) may start migrating back to the river earlier than other species. When the floodwater recedes, some of the fish also migrate to, or are trapped in, local, relatively deep *beels*, borrow pits, ponds, and other perennial water bodies in the floodplain basin. Fish shelter in rivers and perennial water bodies for the entire dry season, at which time they become vulnerable to over-fishing, disease, and harsh environmental conditions.

5.3 The Role of *Khals* in Migration

Khals (canals) are crucial in providing access for fish migration during early and late monsoon. The study found that immigration begins with the initial influx of river water during the first few days and weeks of early monsoon. Emigration back coincides with the peak recession of water from the floodplain to the rivers during the last few days and weeks of late monsoon.

While fish were observed using *khals* as migration routes at both times, they presumably could also migrate at high flood stage when riverbanks overspill. This could not be confirmed, however. Because of the abnormally low flooding during the study year, none of the four study areas had any incidence of riverbank overspill. Fish were observed migrating only through canals and public cuts in embankments (particularly in Polder C in Singra; Map 8, next page). This leads to the conclusion that *khals* and embankment breaches are the only reliable routes for the lateral migration of fish.

5.4 Migration Obstruction

Fish migration can be obstructed in three ways: by infrastructures, through siltation, and by flooding extremes.

5.4.1 FCD and FCD/I Projects

FCD and FCD/I projects are designed to protect an area from river flooding, improve drainage and irrigation, and increase cropping intensity. Typical projects have three major components:

- Embankments to control overbank spills.
- *Khal* closures to control entry of river floodwater.
- *Khal* regulators to control entry and drainage of floodwater.

All three of these interventions negatively effect fish migration.

In Tangail CPP, Baruha, Kalibari, Barta, Suruj, and other areas *khals* have been closed by embankments along the Dhaleswari, Pungli, Lohajong, and Elanjani rivers. In addition, water flow in the Darjipara, Fatepur, Indro Belta, and Baro Belta canals is controlled by regulators. Despite the low level of flooding during the study year, those regulators were closed during monsoon months for unspecified reasons. As a result, fish eggs, larvae, and adults could not migrate to the floodplain from the Dhaleswari and Elanjani rivers.

In the Surma-Kushiyara area, Babur Khal, Chagli Khal, and many other canals, have been closed by the embankment along the right bank of the Surma River. Moreover, water flow is regulated in Rahimpuri Khal and Sunam Khal. During the monsoon months these regulators are closed most of the time. In early monsoon, numerous fish of different species were seen moving toward *khals* from the Surma and Kushiyara rivers. These fish were stopped by the regulators and collected on the river side of the closed canal. Most of the fish were then caught by villagers and local fishermen.

5.4.2 Siltation

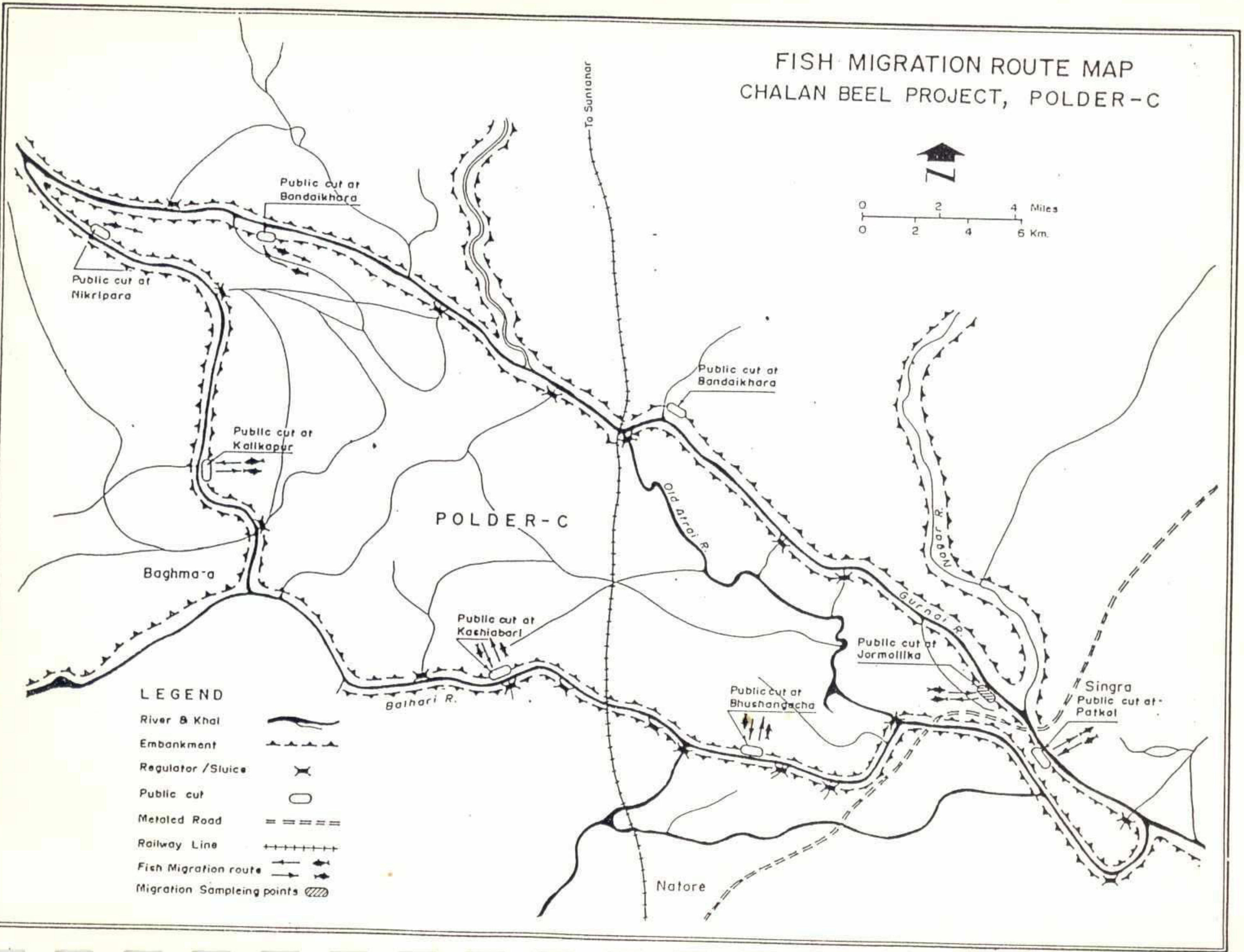
Heavy siltation in *khals* and riverbeds can also have serious negative effects on migration timing and, in some cases, make fish more vulnerable to capture by fishermen. In the Surma-Kushiyara area, for example, the siltation of the Karati Khal and Napit Khal delayed the filling of the water channel and therefore held up fish migration.

In a more severe instance, siltation at the confluence of the Jugni Khal in Tangail kept the canal completely dry during the monsoon months. People living on either side of the canal reported that it is usually inundated during monsoon, providing them with a productive fishing spot during that time.

At the confluence of the Lohajong and Dhaleswari rivers heavy siltation caused a late influx of floodwater into the Lohajong and its distributary *khals*. This in turn reduced water volume and inhibited the timing of fish migration.

5.4.3 Controlled Flooding

The study found that fish migration is closely synchronized with the annual flooding cycle.


FISH MIGRATION ROUTE MAP
CHALAN BEEL PROJECT, POLDER-C
N
0 2 4 Miles
0 2 4 6 Km.
To Suntanar
Public cut at Bandaikhara
Public cut at Nikripara
Public cut at Kalikapur
POLDER-C
Baghma-a
Public cut at Kashiabari
Batharl R.
Public cut at Bandaikhara
Old Atrai R.
Gurnai R.
Nagar R.
Public cut at Jormollika
Public cut at Bhushangacha
Singra
Public cut at Patkol
Natore
LEGEND
River & Khal
Embankment
Regulator /Sluice
Public cut
Metaled Road
Railway Line
Fish Migration route
Migration Sampleing points

Presumably, therefore, late flooding or reduced flooding under the controlled flooding management concept of FCD projects would hamper the biological activities of fish by delaying migration, limiting the time for migration, and reducing the time and area for dispersal, feeding, and growth.

5.4.4 Fishing During Migration

Apart from the hindrances already mentioned, fishing in the *khals* during migration was also observed to hamper fish in their efforts to spawn, feed, and move to dry season habitats.

Where FCD projects and roads have blocked most *khals*, migration has become more perilous, as the only routes through the canal are blocked by nets and traps. In Surma-Kushiyara, for example, the only functioning canal, Kakura Khal, carries the total burden of drainage and is the only avenue for fish migration. Fishing in this area is done by almost completely blocking the *khal* with bamboo fences and traps. During early monsoon, some small fish can migrate through the large mesh nets, but most larger fish are caught. During the late monsoon migration, however, the fishing barriers are designed to trap all sizes of fish. Such fishing practices adversely affect the replenishment of river stock that is crucial to the following year's reproduction.

5.5 Consumption and Migration

The Household Survey found that most of the fish that was consumed by the rural poor consisted of non-cultured species, and that those species were caught from the floodplain, *beels*, and other flood-dependent water bodies. The migration study documented that most of the species consumed by households were migratory. The species were found in rivers, canals, on the floodplain, and in *beels*. Traps set in *khals* to monitor migration found that most species groups migrated from the river to the floodplain and back for spawning, as well as for other purposes.

It seems clear, then, that *beel* and floodplain fisheries production (which constitute the major portion of inland production) is dependent on regular annual flooding by river water. Interventions disrupting migration jeopardize fish production and, thus, have an impact on consumption.

Chapter 6

SUBSISTENCE FISHING SURVEY

6.1 Introduction

The economic and nutritional benefits of fishing are not limited to professional fishermen and their families. As Chapter 4 shows, many other people fish on a subsistence level, either consuming their catch or selling it for cash income. For those people, as well as for professional fishermen, the open water capture fisheries of the floodplain are a vital resource. The annual renewal of floodplain fisheries through inundation is essential for the survival of floodplain people, whose lives are attuned to the natural cycle of the monsoon. Seasonal and perennial water bodies, such as rivers, *beels*, *khals*, ditches, floodplains, and borrow pits, are particularly valuable common-property resources for the rural poor. To better understand the role of the capture fishery, this study was undertaken to examine rural household participation in subsistence fishing.

Following a census, a total of 10 fishing households were selected from each of six sample mouzas in each of the four study areas. The fishing activities of these 240 households were then monitored for 12 months in three cycles, starting December 15, 1991, and running through December 14, 1992.

6.2 Household Participation

The survey found that 85 percent of the households in the census said they fished during the year (Figure6.1). Of those, 63 percent said they fished for consumption, and 22 percent were professionals who depended on fishing for their livelihood at least part of the year. Overall, Singra and Tangail had the highest percentage of fishing households, 89 percent each, and Matlab had the lowest, 76 percent. In all areas except Singra, the percentage of subsistence fishing households exceeded that of professional fishing households by substantial margins. Large parts of Singra, which is in the Chalan Beel area, are flooded during monsoon season, and it therefore offers considerable com-

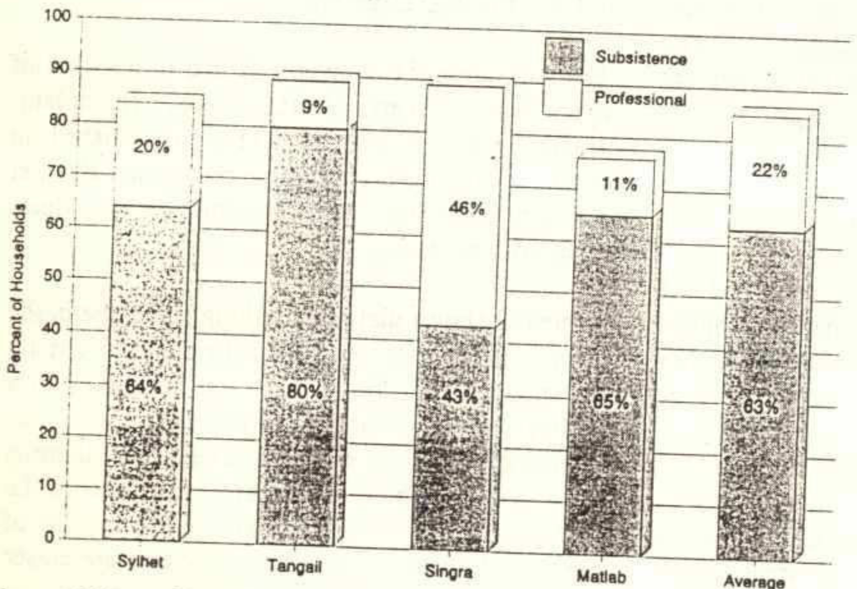


Figure 6.1 Subsistence and Professional Fishing Households

Table 6.1 Individual Participation in Fishing

Study Area	No. in Household	Percent Fishing	Adults (%)	Children (%)
Tangail	316	48	58	42
Singra	371	39	60	40
Matlab	306	36	62	39
Sylhet	382	22	89	11
Total	1,375	35	65	35

mercial fishing opportunities. Since professional fishermen tend to live in clusters, the result simply indicates the existence of such groups in the sample area.

The study also examined the fishing activities of individual household members (Table 6.1). The highest level of individual participation was in Tangail, where 48 percent of the household members fished. By contrast, in Sylhet only 22 percent of the family did so. Overall, 35 percent of household members participated in fishing. Since the average household consisted of 5.7 members, that means two members of each household engaged in fishing. Although the Subsistence Fishing Survey did not determine the percentage of women involved in fishing, according to the Household Survey, about 15 percent of women, including female children, fished (see Chapter 4). The Subsistence Fishing Survey found that 35 percent of those fishing were children.

6.3 Seasonal Fishing Patterns

Since open water capture fisheries resources are heavily influenced by the seasonal hydrologic cycle, how intensely people fish and where they fish varies from season to season.

6.3.1 Fishing Intensity

Figure 6.2 illustrates the seasonal changes in fishing intensity for the four survey areas. These patterns have several things in common. The most intense fishing generally occurs during the monsoon (June through September) and post-monsoon (October through January) seasons, and it reaches a peak between October and November. Fishing is usually least intense just prior to the onset of the rains, and the lowest level of fishing occurs during the pre-monsoon months, varying from March through June, depending on the location. Sylhet has a pattern markedly different from that of the other areas. In Sylhet fishing was at its minimum in February and March, then it sharply increased during April and remained at near peak level through October. This pattern may be attributable to early monsoon rains in that area and to the large areas of deep, prolonged flooding that are common in Sylhet. The pattern in Tangail is also worth note since it is relatively flat, showing sustained fishing that hovered around 80 percent of the households for most of the year. This is explained by the fact that there are about 13 *beels* of varying size within the Tangail area, only three or four of which are leased to professional fishermen, and even in those the poor are allowed to fish for consumption. The rest remain unleased, giving subsistence fishermen free access to the resource.

6.3.2 Fishing Location

The study found that people fished in all sorts of open water—rivers, *khals*, *beels*, floodplain, ditches, and borrow pits. They also fished in ponds, including both culture ponds and derelict ponds that had been restocked through the effects of flood inundation.

Table 6.2 shows that most fishing was done in the floodplain and *beels*, but this is inconsistent among the study areas. In Matlab, for example, *beel* fishing was insubstantial, while in Tangail it was the principal source of catch. The reason there is so little river fishing in Tangail is that most of the Lohajong River is dry for four to five months of the year. Moreover, the sample mouzas are closer to *beels*, *khals*, and floodplains than to rivers.

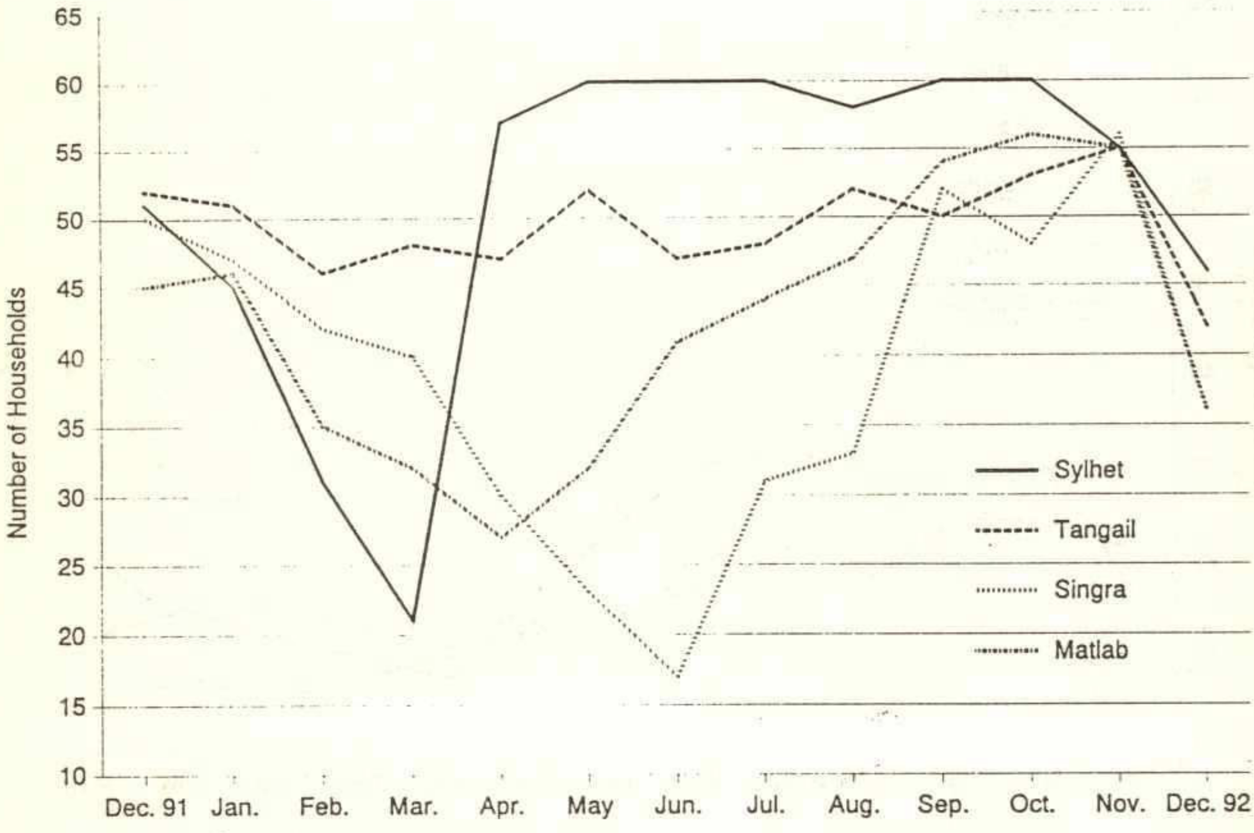


Figure 6.2 Seasonal Participation in Subsistence Fishing

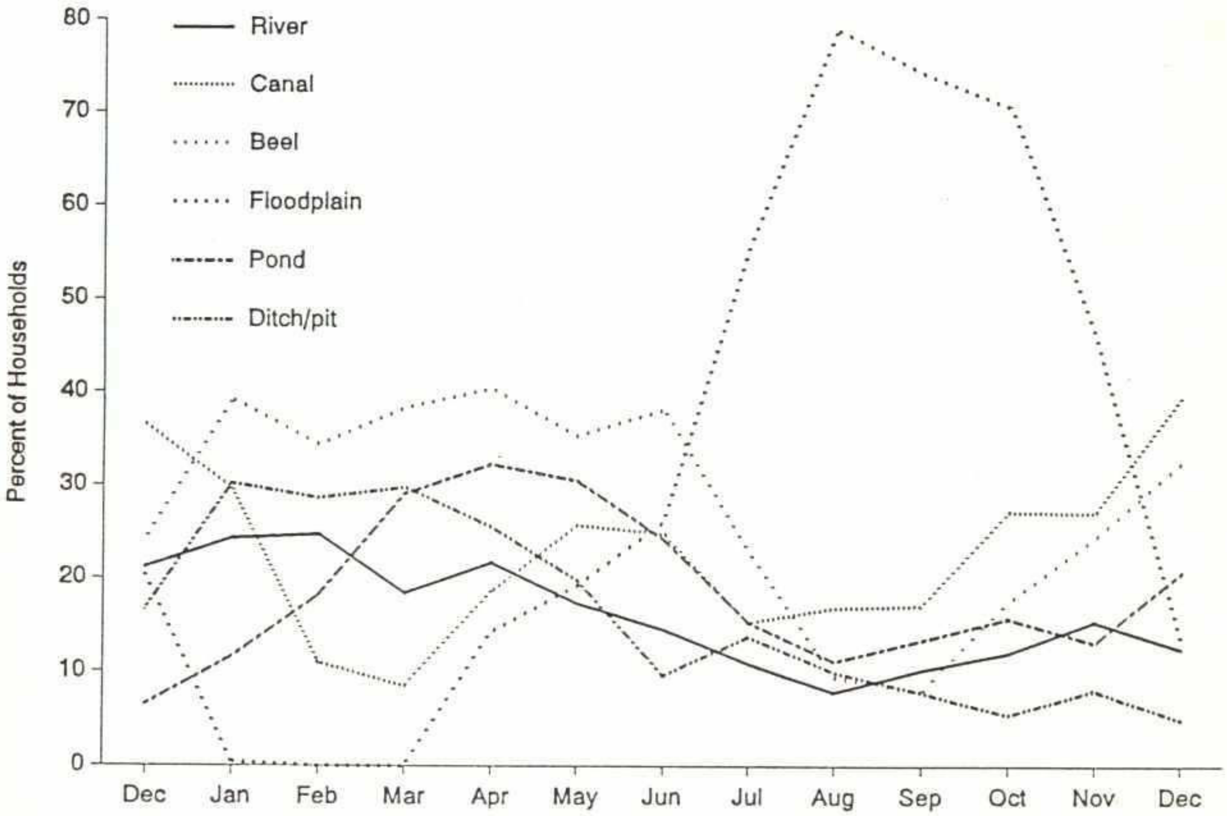


Figure 6.3 Seasonal Patterns in Fishing Location

Table 6.2 **Fishing Grounds**

Location	Sylhet HH (%)	Sylhet Days	Tangail HH (%)	Tangail Days	Singra HH (%)	Singra Days	Matlab HH (%)	Matlab Days	Average HH (%)	Average Days
Floodplain	93	1,788	92	515	90	2,398	82	1,862	89	1,641
Beel	62	436	98	1,588	57	564	10	20	57	652
Khal	97	956	53	216	53	515	73	839	69	631
River	48	581	20	31	53	1,069	47	574	42	564
Pond	82	423	55	93	57	266	63	399	64	295
Ditch/pit	82	281	72	341	72	361	47	180	68	291

Figure 6.3 shows the seasonal change in the location of fishing grounds. River fishing peaks prior to the rainy season, while *khals* are most heavily fished early and late in the monsoon. Fishing in ponds, ditches, borrow pits, and *beels* predominantly occurs in the months following monsoon, but *beel* fishing tapers off sooner. Floodplain fishing peaks during and just after monsoon. Except in the Tangail area, the largest percentage of households fished in the floodplain. This is because floodplain water bodies are unleased and anyone can have access to them.

6.4 Quantity of Fish Caught

By a sizable margin, the largest average amount of fish caught during the survey period was 120 kilograms per household in Singra. This was followed by Sylhet, with 47.8 kg; Matlab, with 39.2 kg; and Tangail, with 20 kg. The catch for all four areas averaged 56.8 kg per household for the year. The average number of fishing days exhibited the same pattern: Singra averaged 86.2 days per household for the year, Sylhet had 74.3 days, Matlab averaged 64.5 days, and Tangail had 46.4 days. The average for all four areas was 67.9 days.

Table 6.3 shows the quantity of fish caught by subsistence fishing households. The largest amount of fish was caught in Singra followed by Sylhet, Matlab, and Tangail. The rich open water resources in Singra and Sylhet, specifically Chalan Beel in Singra and the Sylhet *haor* basin, contributed to the larger catches in those areas. The data also shows that the Tangail *beels* were particularly productive for that area, while in Sylhet, Singra, and Matlab floodplains provided the most fish.

Table 6.3 **Quantity of Fish Caught by Subsistence Fishing**

Source	Singra kg	Singra %	Sylhet kg	Sylhet %	Matlab kg	Matlab %	Tangail kg	Tangail %	Total kg	Total %
Floodplain	3,807	53	1,036	36	1,201	51	222	19	6,269	46
Beel	748	10	365	13	6	0	677	56	1,795	13
Khal	673	9	704	24	333	14	103	9	1,813	13
Pond	278	4	301	10	380	16	44	4	1,003	7
River	1,305	18	273	10	363	15	11	1	1,953	14
Ditch/pit	359	5	194	7	70	3	143	12	767	6
Total	7,173		2,873		2,354		1,200		13,599	

Table 6.4 **Types of Fish Caught by Subsistence Fishing**

Species Group	Singra		Sylhet		Matlab		Tangail		Average	
	kg	%	kg	%	kg	%	kg	%	kg	%
Small Fish	2,187	30	1,454	51	1,013	45	482	40	1,284	37
Catfish	1,901	27	603	21	345	15	213	18	766	22
Snakeheads	606	8	152	5	131	6	154	13	261	8
Eels	726	10	120	4	15	1	125	10	246	7
Carp	615	9	164	6	107	5	61	5	237	7
Small Shrimp	1,138	16	362	13	288	13	165	14	488	14
Large Shrimp	0	0	17	1	334	15	0	0	175	5
Total	7,173		2,871		2,234		1,200		3,857	

As discussed in Chapter 3, the open water fisheries of Bangladesh yield a wide variety of fish. This is also reflected in the data collected for subsistence fishing. Table 6.4 shows the catch composition for the households of the four study areas. In all areas, small fish predominated, followed by catfish. Large shrimp *(golda chingri)* contributed the least to the total catch and was found only in Matlab and Sylhet.

6.5 Fishing Gear Used

Field observations found that about 30 types of fishing gear was used for subsistence fishing. These were grouped into 11 categories based on similarities in shape, size, and fishing technique used. Hand-picking and the draining of water bodies, particularly ditches and borrow pits, were also observed. The data, shown in Table 6.5, indicate that low-cost cast nets, push nets, and gill nets were common among the fishing gear used. A few households fished by using such costly gear as the large dip net *(veshal jal)* and seine net *(ber jal)*, but they did so on a share basis.

6.6 Fishing Rights

Figure 6.4 shows the number of days when fishing occurred under particular property rights systems. Nine systems were covered in the survey:

Table 6.5 **Fishing Gear Used (percent of households)**

Gear	Singra	Tangail	Sylhet	Matlab	Average
Cast net	93	35	80	95	76
Push net	37	100	98	62	74
Gill net	63	25	45	50	46
Trap	43	10	80	45	45
Draining	47	27	82	15	43
Hand picking	23	53	23	15	29
Hook and line	30	30	28	25	28
Dip net (small)	3	67	3	15	22
Bag net	7	20	15	18	15
Drag net	25	5	3	0	8
Spear	3	2	3	17	6
Seine net	3	3	8	0	4
Dip net (large)	2	0	3	0	1

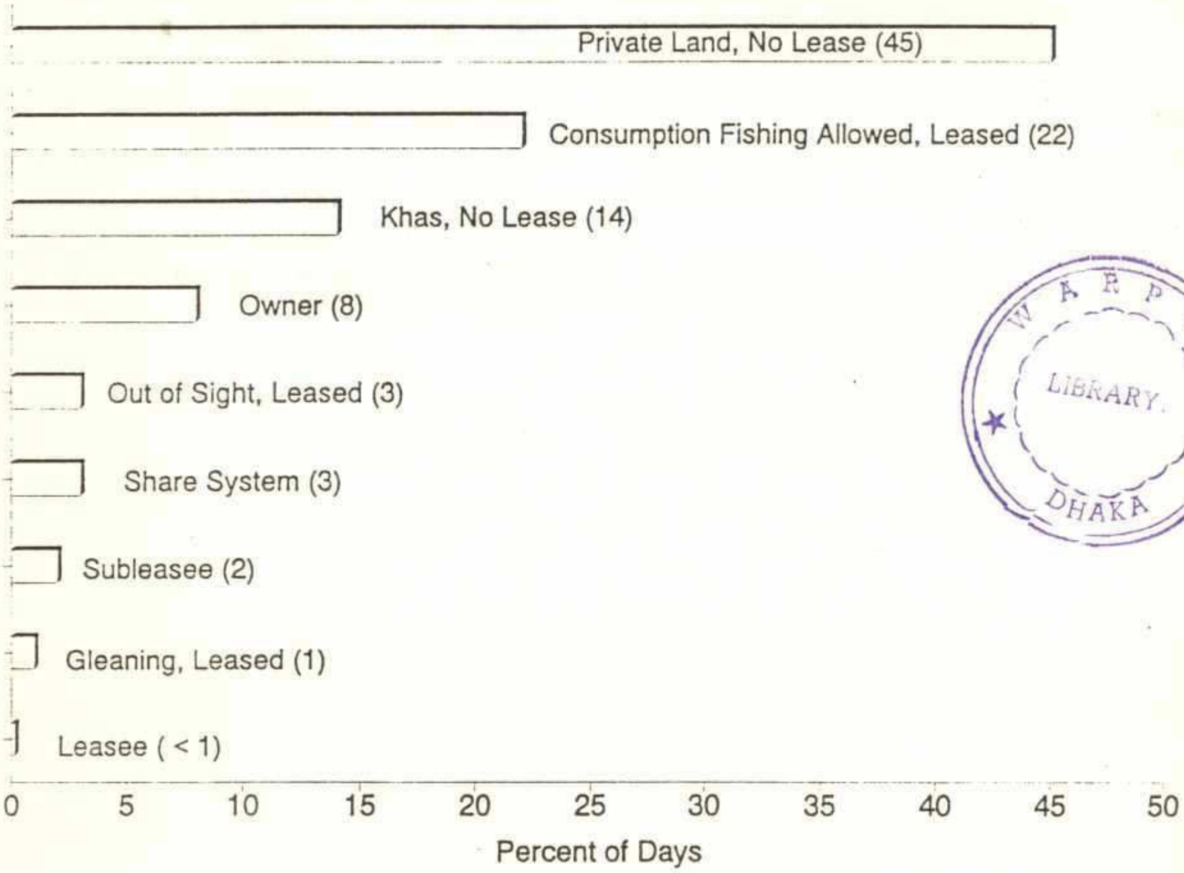


Figure 6.4 **Source of Catch by Fishing Rights**

1. Lease: The government of Bangladesh owns the water body and leases exclusive fishing rights under the official system to a person or organization.
2. Sublease: The person or organization leasing from the government has sublet a season's fishing rights to another entity.
3. Share system: Fishermen give a share of their catch to the lessor/owner of the water body.
4. Out-of-sight of lessor/owner: No fishing is legally permitted, but it is done clandestinely. Sometimes the lessor/owner overlooks consumption fishing by locals.
5. Consumption fishing: Local people have the right to fish openly for consumption.
6. Own water body: Fishing by the owner of the water body.
7. *Khas*/no lease: The government owns the water body, does not lease it, and allows open access.
8. Gleaning: People are allowed to pick up any fish left after the owner/lessor has harvested the fish. Harvest usually follows draining or pumping out the pond.
9. Private ownership/no lease system: The land is privately owned and will be farmed after water has receded. Fishing is allowed while the land is inundated.

Substantial subsistence fishing takes place on water bodies leased from the government. Forty-five percent of subsistence fishing occurs primarily on unleased private land, and 22 percent occurs on leased lands that allow local access for consumption fishing. The next most important source is public water bodies for which there is no lease. There are some variations between areas in the relative importance of rights. The share system is significant in Singra, but nowhere else. The leasing system that allows consumption fishing is most important in Tangail. *Khas* (government owned) water bodies without a fishing lease are second in importance to privately owned land in the Meghna-Dhonagoda area.

Fishing access to water bodies varies from location to location. People generally are allowed to fish freely during the monsoon season, but access usually is restricted from October *(Khartik)* to March *(Chaiytra)*. Fishing rights on rivers are commonly leased, although on some rivers the right to fish is attached to adjacent land, and the owners have free access to it. Most *beels* and canals are leased, and in some cases borrow pits are leased. In some places, even though the canal or *beel* is leased, local people are allowed to fish for home consumption.

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Chapter 7

FISH CATCH ASSESSMENT

7.1 Introduction

Floodplains and *beels* are key components of open water capture fisheries of Bangladesh. In 1989 the Department of Fisheries reported that floodplains contributed 44 percent to the annual total inland open water catch, and *beels* contributed another 11 percent (DOF 1989). The Catch Assessment Survey was designed to determine current levels of fish yield and species diversity in the floodplains and *beels*. The survey was conducted in proposed flood control project areas in Tangail, Singra, and Sylhet, and in Matlab; the floodplain catch was assessed outside the Meghna-Dhoṇagoda project.

7.2 Floodplain Catch Assessment

7.2.1 Fishing Season

The floodplain fishing season usually lasts four to six months, starting with the onset of monsoon season in June and continuing until November or December. In 1992, floodplain fishing started earliest in Sylhet, where it began in mid-June and continued until the middle of November. Fishing in Tangail started in early July and lasted until mid-November. The Singra season also started in early July, but a drainage canal that was closed to hold water for *boro* cultivation helped extend the fishing season to late December.

7.2.2 Fish Yield

The annual yield of fish for floodplain areas averaged 75 kg/ha (Table 7.1), which is higher than the national figure of 66 kg/ha (DOF 1988-89). The sizable yield of Singra can be attributed to the large number of rivers that feed vast areas of its Chalan Beel floodplain, which supports a rich aquatic ecosystem. This floodplain also apparently may support a larger number of people, since more part-time fishermen were observed operating here than in the other study areas. The much lower yield of Tangail is due to the fact that it had the latest and least flooding in 1992. However, according to FRSS statistics, the Tangail

Table 7.1 Floodplain Fish Yield

	Yield (kg)	Area (ha)	kg/ha
	Singra		
Teligram	15,862	230	69
Chalan Beel	14,307	121	118
Subtotal	30,169	351	86
	Sylhet		
Gastala	6,861	79	87
Hamindapur	3,351	50	67
Subtotal	10,212	129	79
	Matlab		
Charmukundi	2,074	25	83
Baispur	1,109	24	46
Subtotal	3,183	49	65
	Tangail		
Belta Raxit	3,769	67	56
Bhatchanda	1,926	67	29
Subtotal	5,695	134	43
Total	49,259	663	75

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district is the second lowest in floodplain fish production even in normal water years. Low fisheries productivity in Tangail may be a function of the very unique soil type occurring throughout this area of the country.

The table also shows that fish yield in each study area varied according to location. In Singra, for example, there was lower yield in Teligram than in Chalan Beel. Since Teligram is inside Polder C of the CPP project and Chalan Beel is outside, this may indicate that the polder is an impediment to fish migration. Additionally, access to fishing was restricted in Teligram for about eight weeks in July and August when the Department of Fisheries stocked the area with carp fingerlings. Chalan Beel experienced no limitations in access.

In Sylhet, the difference in yield between Gastala and Hamindapur floodplains may be due to differences in flood depth for the two areas. Gastala was flooded to more than one meter and is near Sada Khal and Kakura Khal, which are major migration routes for fish. Hamindapur, which flooded to less than one meter depth, is fed by Rahimpuri Khal, which has a regulator that blocks the flow of water as well as inhibiting the migration of fish.

The situation in Tangail was somewhat similar to that of Sylhet. The Belta Raxit floodplain had a flood depth of more than one meter, while the Bhatchanda floodplain flooded to less than one meter. The Belta Raxit is near Santosh Khal, one of the major canals along the Lohajong River, while Bhatchanda is fed by Sadullahpur Khal, which has much lower water flow.

The Charmukundi floodplain in Matlab had higher yield than Baispur largely because it was inundated longer. In Charmukundi flooding started in mid-June and lasted until the end of October, and in Baispur it was delayed until early August and lasted until the end of October.

7.2.3 Species Diversity

As was found in other parts of this study, small fish dominated among the species caught on the floodplains, although in Singra this was not the case, and fishermen there caught more catfish than small species, which may be a function of gear type and catch effort. There was considerable variation between areas on some other species, which reflects some of the ecological characteristics of the areas surveyed. As Table 7.2 shows, catfish occupied the second position in Sylhet and third in Tangail, which had a larger carp catch than other areas. The abundance of carp in the Tangail area is due to flooding by Jamuna and Dhaleswari rivers, which are known to be the richest natural source of carp spawn and fry in Bangladesh. The sizable quantity of large shrimp *(golda chingri)* in Matlab is an indicator of the abundance of the species in the Meghna River.

Table 7.2 Species Diversity in the Floodplain Catch (percent of total weight)

	Sylhet	Tangail	Singra	Matlab	Total
Small Fish	51	52	29	60	38
Catfish	14	15	32	3	24
Small Shrimp	13	6	13	4	12
Carp	1	16	11	0	9
Eels	5	6	11	1	8
Snakeheads	14	6	5	10	7
Large Shrimp	1	0	0	23	2

7.3 *Beel* Catch Assessment

7.3.1 Fishing Season and Methods

Beel fishing was studied only in Tangail, Sylhet, and Singra because Matlab has no *beels*. In addition, *beel* fishing in Singra was very different from that in Tangail and Sylhet, as will be discussed in this section.

In all three areas studied, *beel* fishing was largely concentrated in the post-monsoon period, starting in November and continuing until March, although in some *beels*, where leasing agreements allowed, fishing went on almost all year long.

Two of the Tangail area *beels*, Jugnidaha and Garaildaha, are leased to groups of fishermen. Those lessees fished the *beels* from December to April with some periods of inactivity. Additionally, many subsistence fishermen fished in Jugnidaha and Garaildaha *beels*. Their fishing was restricted by the lessees between July and November when the lessees restocked the *beels* with carp fry collected from the floodplain and *khals*. In Kola Pocha Beel, which was unleased, fishing continued almost year-round, interrupted only by a period of about 40 days during the months of June and July, which may have been because the long fishing season had depleted the amount of fish in the *beel*. Fishing was also stopped in September, when people switched to fishing in the floodplain.

The *beel* fishing season in Sylhet, where all the of the sample *beels* were leased to local people, started in late November and continued until mid-February.

The *beels* of Singra are different from those of Tangail and Sylhet. In Singra, after the floodwaters recede, many small bodies of water remain. These *kuas*, as the bodies are called locally, are ditches that have been excavated by landowners, and as the floodwaters recede, fish collect in them. The fish in the *kuas* are then harvested between the months of December and April.

Many methods were used to harvest fish from *beels*. In Tangail, it was done by repeated netting with seines and cast nets. Fishing in Sylhet was done by gradually draining the *beels* and using seines and cast nets. When the water reached its lowest levels bamboo traps *(polo)* were used and, when the *beels* were completely drained, hand-picking was employed to harvest the remainder of the catch. The Kakrakuri and Chatal *beels* were harvested to exhaustion in this manner. The Septi, Dubail, and Chunia *beels* could not be completely harvested during the study year because rainfall prevented the total draining of the *beels*.

7.3.2 Fish Yield

The overall annual yield of fish from the Sylhet and Tangail *beels* averaged 322 kg/ha (Table 7.3). The data for Tangail indicate that the leased *beels*,

Table 7.3 **Estimated Fish Yield from Sylhet and Tangail Beels**

Beel	Total (kg)	Area (ha)	kg/ha
	Sylhet		
Chatal	10,938	13	841*
Dubail	11,099	55	202
Kakrakuri	8,579	12	715*
Septi	4,959	24	207
Chunia	3,922	25	157
Subtotal	39,497	129	306
	Tangail		
Jugnidaha	2,862	7	409
Garaildaha	2,369	3.2	740
Kola Pocha	1,067	3	356
Subtotal	6,369	13.2	477
Total	45,795	142.2	322

*Completely harvested

Table 7.4 **Estimated Catch from Singra *Kuas***

Beel Name	No. of Kuas	Total (kg)	Kg/Kua
Teligram	104	29,869	287
Balubhara	16	1,844	115
Noorpur	6	769	128
Chaklay	5	483	97
Total	131	32,965	252

Table 7.5 **Diversity of Beel Species (percent)**

Species Group	Sylhet	Tangail	Singra	Average
Catfish	49	12	52	38
Small Fish	24	30	20	25
Carp	14	30	7	17
Shrimp	7	10	7	8
Snakeheads	4	12	8	8
Eels	1	5	6	4

Jugnidaha and Garaildaha, had higher production than the unleased *beel*. This may be due to the generally better ecological conditions in the leased *beels* as well as to annual stocking and better management by the lessees.

Since the average annual yield for the Sylhet *beels*, 306 kg/ha, is based in part on the incomplete harvesting of three *beels*, as noted above, that figure may be lower than it would be in a year when all the *beels* were fully harvested.

It is impossible to compare directly the yield of the Singra *beels* with that of the other areas because the *kuas* yield a much higher number of kilograms per hectare. The *kuas*, which range in size from an average of 0.06 ha in Balubhara Beel to 0.1 ha in Teligram Beel, have a mean size of 0.09 ha. As Table 7.4 shows, the average annual yield of Singra's *kuas* was 252 kg/kua, or, using the mean size of the *kuas*, about 2,800 kg/ha of *kua*.

7.3.3 Species Diversity

Of the species caught in the study *beels*, catfish predominated in Sylhet and Singra and small fish made up the majority of the catch in Tangail (Table 7.5). The relatively greater abundance of carp in Tangail is attributed to the stocking of *beels* with carp fry collected from natural sources. As previously noted, the area is also known to be a rich source of carp spawn and fry.

Chapter 8

CONCLUSIONS

8.1 Summary of Findings

8.1.1 Consumption

The average per capita consumption rate for the study period ranged from 11 g/day in Tangail to 32 g/day in Meghna-Dhonagoda. The overall average was 24 g/day; the national average in 1991 was 22 g/day. After rice and vegetables, fish was the food most commonly consumed by the surveyed households: 85 percent ate fish at least once a week, and the average household ate fish 3.5 days per week, compared to 2.1 days for pulses, and 0.5 for meat.

Nearly all of the households consumed rice every day of the week, while the percentage consuming only rice averaged 5 percent for the year and dropped as low as 1 percent during Cycle 3. Considering the frequency of consumption of vegetables, fish, and pulses, there is diversity in the diet, although it is not luxurious.

In the survey area, fish is the most important source of protein and an essential source of vitamin A and fat for pregnant and nursing women and for children over two years old. During Cycles 1 and 3, almost half of the school children surveyed had eaten fish for breakfast, and nearly two thirds had eaten it at dinner the previous evening. Even during the period of least availability, one third of the children had fish for breakfast, and almost half had it for dinner. During Cycle 3, school children reported consuming 50 species of fresh fish during these meals.

Capture fisheries account for 90 percent of the fish consumed by rural people. As might be expected, small and medium farmers consumed more fish than landless and marginal farmers, although the amounts varied between regions: in Tangail they consumed 27 percent more, in Surma-Kushiyara, 87 percent more, and in Singra, 76 percent more.

Fish consumption inside the Meghna-Dhonagoda project area was much lower than it was outside.

8.1.2 Source of Catch

Sixty-one percent of the subsistence fishery catch comes from *beels*, floodplains, *haors*, or canals—the sources most adversely affected by FCD projects. Another 29 percent of the catch comes from ponds, which also may be severely depleted by FCD projects. More than 81 percent of the pond catch is capture fish that are dependent on annual inundation.

8.1.3 Income and Employment

In addition to its importance in family nutrition, fishing is a major source of household income. The average value of fish consumed by households was Tk. 610, and the average value sold was Tk. 618, making the total value of subsistence fishing Tk. 1,228. For the landless, the cash income from selling fish averaged Tk. 484, and the value of fish consumed or sold was Tk. 966 per household, bringing the total value to Tk. 1,450.

In all four areas most people reported working in agriculture—3.6 days out of every 8.4 days. Fishing accounted for 1.2 days and other activities made up the remaining 3.9 days of work.

8.1.4 Employment in Fishing

The average number of people engaged in fishing per household in all four areas is 0.40 compared to 0.73 in agriculture. Children, particularly females, were more likely to participate in fishing than in agriculture.

8.1.5 Vulnerable Groups

Fish species diversity makes important contributions to the diets of children and pregnant and nursing mothers. Consumption of other animal food products is very low among these vulnerable groups, which are likely to be the first to suffer from nutritional loses resulting from reductions of floodplain fisheries.

8.1.6 Nutritional Value

The traditional mix of small fish, *hilsha,* and other species is richer in nutrients—including vitamin A, calcium, and fatty acids—than the narrow band of species promoted in carp stocking programs. It is difficult to make up for the loss of these species in the diet through other food sources. Losses of vitamin A due to decreases in floodplain fisheries can increase blindness and child mortality.

8.1.7 Fish Markets and Economics

There is considerable regional variation in the market price of fish. Lower prices reflect distance from, and limited access to, urban markets. The average market price for small fish was 47 Tk./kg; shrimp, 35 Tk./kg; catfish, 63 Tk./kg; snakeheads, 46 Tk./kg; and carp, 53 Tk./kg.

Assuming a 1.25 scarcity premium and standard conversion factor of 0.87, the average economic prices for species groups were: small fish, 51 Tk./kg; shrimp, 38 Tk./kg; catfish, 68 Tk./kg; snakeheads, 49 Tk./kg; and carp, 58 Tk./kg. These prices have increased in 1993, reflecting the scarcity of fish caused by the drought of 1992.

In all cases except potatoes, the fish-to-commodity price ratio is lowest in December and peaks in June, reflecting seasonal scarcity of fish.

The cost of culture fishery using semi-intensive technology is 20 Tk./kg. Culture fishing is very profitable, and opportunities for it will expand. As in the case of the stocking program, however, the rural poor benefit little from fish culture. Fish culture should be viewed as an addition but never replacement for open water fisheries.

8.1.8 Fish Migration

Almost every inland freshwater fish species in the Ganges-Brahmaputra floodplain migrates for spawning and growth. The major movements take place during early and late monsoon. Migration patterns, particularly those associated with spawning, are highly time-specific, probably synchronized with such environmental stimuli as temperature rise, rainfall, and water flow. The spawning destination varies from species to species. After spending three to six months in the floodplain, all fish species (young, subadults, and adults) migrate back to the river along with the receding flood water. Some of the fish also migrate to, or are trapped in, local, relatively deep *beels,* borrow pits, ponds, and other perennial water bodies.

The early monsoon migration peak, coinciding with the coming of the rains, consists of gravid catfish, particularly *aair* and *boal,* as well as *tengras* and *boro baim,* all of which presumably spawn in the floodplain. In addition, the eggs, larvae, juveniles, and adults of many other species use the floodplain for spawning, nursing, and feeding. Many species of small fish and shrimp, for example, which can breed in *beels* and stagnant pools, were observed migrating against the heavy current early in the monsoon season to reach the floodplain.

Distributary channels are the most important routes of migrating fish. Fish migration through the channels can be obstructed in three ways: by structures that block flow, through siltation, and by flood extremes.

FCD projects typically include embankments, closures, and regulators that interfere with fish migration. In Tangail, for example, regulators were closed during the monsoon months of 1992, when river flows were the lowest since 1964. These closed regulators blocked fish migration. In Surma-Kushiyara, two major *khals*, Rahimpuri and Sunam, were blocked by regulators that were closed during most of the monsoon season.

In Tangail, heavy siltation of the Jugni Khal hampered fish migration because it blocked canal access to the floodplain during the monsoon season. The reduction of access through canals has greatly increased the vulnerability of mature fish entering the floodplain.

In some channels, bamboo fences and traps are constructed in such a manner that few fish can pass. Blocking their migration adversely affects the replenishment of river stock needed for reproduction the following year.

Overspill migration during the peak monsoon period usually is less important than migration through distributary channels. Late flooding or reduced flooding under the controlled flooding embankment concept of FCD projects would hamper the biological activities of fish by delaying migration, limiting the time for migration, and shortening the time and area for dispersal, feeding, and growth.

8.1.9 Subsistence Fishing

Eighty five percent of the surveyed floodplain households were occupied at least part time with fishing. Of that number, 63 percent were subsistence fishermen. About 15 percent of the females surveyed (women and female children) engaged in subsistence fishing, and 35 percent of all those who fished were children.

Only 7 percent of the subsistence fishing catch was carp. Of the remaining 93 percent, the majority were species of small fish. Eighty six percent of the catch came from open water sources: 75 percent from floodplains, *beels*, *khals*, and borrow pits or ditches, all of which are dependent on flooding to replenish and sustain fish stocks. They are, therefore, also the most vulnerable to the adverse affects of FCD/I projects. The highest levels of subsistence fishing occur during and just following monsoon season.

Substantial subsistence fishing takes place on leased and non-leased water bodies. The common property fishing rights that most people rely on are often preserved by custom rather than guaranteed by law. The poor are vulnerable to the implementation of projects that fail to respect longstanding support for small-scale subsistence fishing. The introduction of stocking programs and FCD/I can dramatically reduce subsistence fishing when project authorities fail to recognize the local common property fishing heritage and system.

8.1.10 Floodplain and Beel Catch

The floodplains of Bangladesh comprise a rich ecosystem that supports the major biological activities of fish. The annual flooding of these areas plays a vital role in the sustenance of fish stock and the maintenance of species diversity in the country's open water fishery.

Although the estimated national catch from floodplains is 66 kg/ha (the figure usually used to calculate floodplain fisheries losses), this survey found the catch to be 75 kg/ha. Moreover, had Bangladesh not experienced abnormally low flooding in 1992, the yield likely would have been even higher. This leads to the conclusion that floodplain fisheries losses may be underestimated in the planning of FCD and FCD/I projects.

The floodplain catch was dominated by small fish species (38 percent), while the so-called economic species, catfish and carp, comprised less of the catch (24 percent and 9 percent, respectively).

The average yield from completely harvested *beels* in Sylhet was 778 kg/ha, and in Tangail it was 477 kg/ha. Once again, in both places the figures

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are higher than the estimated national figure of 412 kg/ha. So, *beel* fisheries losses, too, may be underestimated.

Unlike the floodplain catch, the *beel* catch was dominated by catfish, which made up 47 percent of the total. Still, small fish species were the second largest group in the catch, comprising 24 percent of the total, and carp made up 13 percent.

The average annual yield of floodplain areas was 73 kg/ha. Yields were lower in the Tangail area because of late and short-duration flooding. Small fish dominated among the species caught on the floodplain.

The average annual economic value of the floodplain fishery (based on 1991/92 prices) was 3,251 Tk./ha in Tangail, 4,256 Tk./ha in Surma-Kushiyara, 3,496 Tk./ha in Singra, and 3,119 Tk./ha in Matlab. The average value for the 663 ha of floodplain in four areas covered by the Fish Catch Assessment was 3,567 Tk./ha.

The overall annual yield of fish from the Sylhet and Tangail *beels* averaged 310 kg/ha. There was considerable variation in yields. Of the eight *beels* surveyed, three had yields in excess of 700 kg/ha and yields were less than 175 kg/ha in one of the *beels*.

The average annual economic value of fish caught from *beels* in Tangail and Sylhet was 20,473 Tk./ha. The values were considerably higher in some *beels*, ranging up to 56,900 Tk./ha.

8.2 Recommendations

The findings of this study lead to the following recommendations:

- Since species diversity is essential for food security, capture fisheries should be given priority in water resources planning.
- Free flow of water in distributary channels needs to be reestablished or improved to encourage recruitment of fish. Such measures will also reduce crop damage due to drainage congestion.
- Common property fishing rights should be respected in project design and implementation.
- Adequate (two years or more) study of social and biological aspects of subsistence fisheries is required to assess project impact on fish production and consumption.
- Investments in fish culture and fish stocking projects are not a substitute for the natural capture fishery.

In addition, the biology of most of the floodplain species of Bangladesh has not been adequately studied. Consequently, impact assessments of FCD/I projects inadequately quantify fisheries losses and incompletely estimate the effects of mitigation measures. To correct this problem, more detailed study of the country's fisheries is required. The following are some recommended avenues of inquiry:

- The spawning behavior of floodplain species relative to their environmental requirements.
- The timing and routes of migration, with particular attention given to the environmental factors that stimulate migration.
- The monthly variation in fish abundance and fish community structures in relation to the depth of water on the floodplains.
- The productivity of *beels* in relation to their physio-chemical and biological features, flooding patterns, and geographical distribution.

Migrating fish are vulnerable and dependent on the natural system for reproduction and growth. Only through preservation of the natural fishery habitat can the diversity of stock and productivity of capture fisheries be maintained. On a national scale, this habitat is irreplaceable. If the fisheries environments of Bangladesh continues to be disrupted, fish diversity will plummet, and people, particularly the poorest and most vulnerable, will

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have less fish to eat. The alternative to the natural fishery—stocking and culture programs—will fall short of addressing the problem and they will be costly to sustain, perhaps more costly than making accommodations for natural fisheries.

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Appendix II: DEMOGRAPHICS OF THE SAMPLE HOUSEHOLDS

1. Socioeconomic Class

The Socioeconomic Survey classified households according to their landholding status. Of the 520 households surveyed (130 in each of the four study areas), 60.4 percent were landless, 19.8 percent had marginal farms, 10.4 percent had small farms, and 9.4 percent had medium farms (Figure II.1, see Chapter 2 for an explanation of the categories).

2. Family Size and Composition

For the purpose of this study, a family consists of all the people living in a single unit and sharing a common kitchen. It therefore can include all immediate family members, resident members of the extended family, lodgers, and servants.

The Household Survey found that the size of the average family in the four study areas was 5.7 people, slightly larger than the national average of 5.32 (1991 population census). The landless families surveyed had an average of 5.2 members, marginal farm families consisted of 6.1 people, small farm families had 6.9, and medium farm families had 7.5 members. The overall trend varied little between the four study areas.

Under the severe economic pressure of landlessness, the traditional structure of the Bangladeshi family tends to give way. Younger male members

Figure II.1 Households in Each Social Stratum

Table II.1 Distribution of Family Types Among Social Strata (percent)

Family Type	Landless	Marginal	Small	Medium	All
Nuclear	75.2	58.7	37.8	42.9	65.0
Joint	21.2	36.5	52.8	46.9	30.0
Extended	3.6	4.8	9.4	10.2	5.0

Nuclear = father and/or mother plus offspring
Joint = nuclear plus in-laws and offspring
Extended = joint plus other related or unrelated people

of the family split off to form nuclear families of their own, hoping perhaps they can better provide for the smaller unit. As Table II.1 shows, these nuclear families are far more common among the landless than among the other strata.

3. Sex Ratio

Figure II.2 shows the male-female ratio for each of the study areas; the average for all four areas was exactly the same as the national average of 103 males to every 100 females (1991 population census).

The ratio was highest among the medium farm families (144) and lowest among small farm households (88). Several factors may account for this result. It is probably easier for solvent, medium farm parents to marry off their daughters, thereby decreasing the number of female members in their households. Conversely, young male members of small farm families often seek work that takes them away from home, reducing the relative number of males in the household.

4. Age Distribution

The 15 to 44 age group was the largest in the four study areas, constituting 42.6 percent of the population. This is very close to the national average of 39.5 percent (1981 population census). The second-largest age group was 5 to 14 years

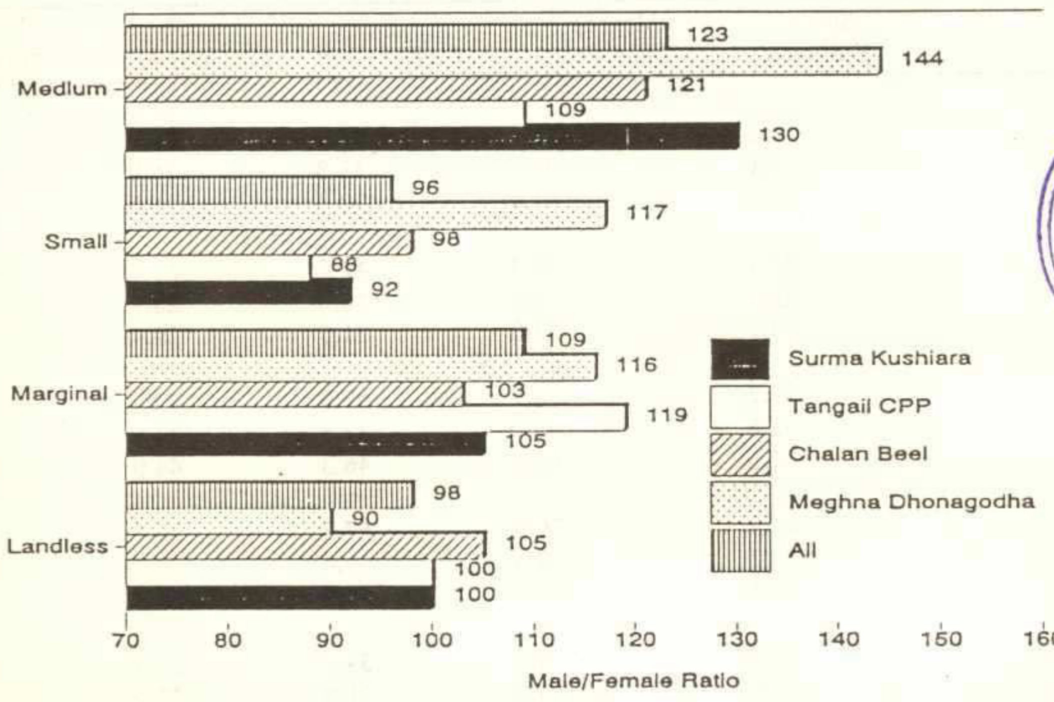

Figure II.2 Male/Female Ratio in the Study Area

Table II.2 Age Distribution of Household Members (percent)

Category	<5	5-14	15-44	45-64	>64
Landless					
Male	12.8	28.6	41.1	14.7	2.7
Female	14.9	32.4	42.2	9.3	1.2
Both	13.9	30.5	41.7	12.0	2.0
Marginal					
Male	10.6	32.5	38.3	13.7	4.9
Female	12.3	27.9	44.5	13.3	2.0
Both	11.4	30.3	41.3	13.5	3.5
Small					
Male	12.0	22.3	47.8	13.0	4.9
Female	8.9	28.3	42.9	16.2	3.7
Both	10.4	25.3	45.3	14.7	4.3
Medium					
Male	5.9	28.1	51.2	10.8	3.9
Female	13.9	26.1	40.6	17.0	2.4
Both	9.5	27.2	46.5	13.6	3.3
All					
Male	11.3	28.6	42.7	13.8	3.6
Female	13.5	30.2	42.6	11.9	1.8
Both	12.4	29.4	42.6	12.8	2.7

old (29.4 percent), followed by the 45 to 64 group (12.8 percent), the under 5 group (12.4 percent), and, finally, the over 65 group (2.7 percent). A detailed breakdown of the age distribution by study area and social group is in Table II.2.

5. Literacy

The average literacy rate for the four survey areas is 34.7 percent, significantly higher than the national figure of 23.8 percent (1991 Population Census). For this survey, literacy was defined as an ability to read, write, and count above Class II level. Among the landless, only 25.4 percent met the criteria, but among medium farm families, 53.4 percent were literate (Table II.3).

Female education is lower than that for males in every socioeconomic class. In the total sample, the female literacy rate is 26.9 percent.

Table II.3 Literacy Rates in the Survey Areas (percent)

Category	Surma-Kushiyara	Meghna-Dhonagoda	Tangail CPP	Chalan Beel	Total
Landless					
Male	24.0	48.1	27.4	25.9	31.7
Female	9.0	34.5	13.8	16.0	19.0
Total	16.8	41.1	20.7	21.0	25.4
Marginal					
Male	36.1	59.4	42.7	31.7	42.9
Female	30.1	45.4	16.2	26.9	31.6
Total	33.2	53.0	31.5	29.4	37.6
Small					
Male	57.2	76.7	59.0	49.9	58.7
Female	32.6	50.0	37.8	37.8	38.2
Total	44.3	63.8	46.3	44.0	48.2
Medium					
Male	44.9	76.0	67.3	62.1	60.8
Female	31.2	68.9	39.4	46.8	43.1
Total	39.5	73.4	54.9	55.9	53.4
All					
Male	33.3	55.9	39.6	38.9	41.5
Female	19.8	40.0	21.5	27.1	26.9
Total	27.0	48.1	30.7	33.2	34.5

Table II.4 Main Occupation of Household Head (percent)

Occupation	Landless	Marginal	Small	Medium	All
Farming	12.4	54.4	46.3	58.0	28.7
Agricultural labor	27.8	8.7	9.3	2.0	19.6
Fishing	1.9	1.9	0.0	0.0	1.5
Artisan	4.5	2.0	0.0	0.0	3.0
Nonagricultural labor	9.9	4.9	0.0	0.0	7.0
Transportation	5.5	3.9	3.8	0.0	4.4
Service	11.2	8.7	20.4	16.0	12.1
Business	14.7	4.9	7.4	10.0	11.5
Other	6.4	4.9	3.7	8.0	6.0

Although lower than the male literacy rate of 41.5, it is still higher than the national average of 16.0 percent. The lowest literacy rate is in Surma Kushiyara study area and the highest is in Meghna Dhonagoda.

6. Occupational Status

As would be expected in a rural area of Bangladesh, the main occupation of the survey households is agriculture. Of those surveyed, 23.5 percent are involved either in farming or agricultural labor (Table II.4). Among household heads, the figure is even higher, 48.3 percent (Table II.5). Only .5 percent of the adult population say they are employed in fishing, but 1.5 percent of the household heads claim it as their occupation.

Total employment is 47.6 percent, with male employment among the surveyed population standing at 86.4 percent, and total female employment at 4.9 percent. These figures vary slightly from the national figures of 61.3 percent, 63.0 percent, and 28.0 percent, respectively. This is likely the result of excluding large farmers and urban areas from the study.

Table II.5 Main Occupation of Adult Household Members (percent)

Category	Farming	Agricultural labor	Fishing	Artisan	Nonagricultural labor	Transportation	Service	Business	Other	Total
Landless										
Male	11.5	28.9	1.3	4.9	9.1	4.7	10.4	14.3	5.3	90.4
Female	0	0.7	0	0.7	2.8	0	0.7	1.2	1.2	7.3
Both	6	15.4	0.8	2.9	6.1	2.4	5.8	8	3.4	50.8
Marginal										
Male	40.6	11.2	1.1	3.2	5.9	3.7	13.4	3.7	2.7	85.5
Female	0.6	0	0	0	0.6	1.1	0.6	0.6	0	3.5
Both	21	5.7	0.5	1.6	2.3	2.5	7.1	2.2	1.4	44.3
Small										
Male	36.4	7.4	0	1.7	1.7	1.7	18.2	12.4	1.7	81.2
Female	0	0.8	0	0	0	0	0.8	0	1.7	3.3
Both	18.3	4.1	0	0.8	0.3	0.8	9.5	6.2	1.7	41.7
Medium										
Male	47.8	0.7	0	0	0	2.2	12.7	9	4.3	76.7
Female	0	0	0	0	0	0	0	0	0	0
Both	27.5	0.4	0	0	0	1.3	7.3	5.2	2.6	44.3
All										
Male	26.1	18.3	1	3.4	6.1	3.7	12.4	11.1	4.3	86.4
Female	0.1	0.5	0	0.4	1.6	0.2	0.6	0.7	0.8	4.9
Both	13.7	9.8	0.5	2	3.9	2.1	6.8	6.1	2.6	47.5

Appendix III: STATISTICAL INFERENCES

1. Per-capita fish consumption by socioeconomic group

Small and medium landholders consumed significantly more fish than marginal landholders and the landless. Mean consumptions were 26 g/person and 20g/person, respectively. n = 520 (t-test $p < .05$)

ANOVA showed that fish consumption varied significantly between the survey cycles for both socioeconomic strata. For both strata, minimum consumption occurred in Cycle 2 and maximum consumption in Cycle 3.

Survey Cycle	Landless & Marginal Mean g/person	Small and Medium Mean g/person
Cycle 1	21	27
Cycle 2	13	19
Cycle 3	25	31
N	1,251	309
F	17.6	5.1

2. Per-capita fish consumption by study area

ANOVA showed that fish consumption significantly varied between study areas. Mean per-capita consumption in Matlab was highest, at 34 g, and it was lowest in Tangail, at 11 g. Consumption levels in Singra were high in comparison to Surma-Kushiyara because the effectiveness of FCD/I projects was compromised by frequent breaching and public cuts in embankments.

Study Area	Mean Per-capita Consumption (g)
Tangail	11
Surma-Kushiyara	18
Singra	20
Matlab	34
N	520
F	30.0

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3. Per-capita fish consumption by Fishery Ecological Zone (FEZ)

The ANOVA found that per-capita fish consumption varied between Fishery Ecological Zones in Tangail, Surma-Kushiyara and Singra. The highest mean, 20 g/person, was in the beel areas and the minimum, 12 g/person, was in highland areas.

FEZ	Mean Per-capita Consumption (g)
Beel	20
Riverside	16
Highland	12
N	390
F	6.6

4. Per-capita fish consumption inside and outside of the Meghna-Dhonagoda project

Per-capita fish consumption was significantly different inside and outside of the Meghna-Dhonagoda embankment project in Matlab. Mean consumption inside was 24 g/person and outside it was 42 g/person. N = 130 t-test $p < .01$.

5. Regression analysis for species diversity and per-household fish consumption

The multi-variable regression analysis determined that 14 percent of the variability in per-household fish consumption could be explained by species diversity. When hilsha (which is riverain fish) was excluded from the calculation, 38 percent of the variability could be explained by species diversity.

RESULTS

A: Per-capita fish consumption for two socioeconomic groups

Group 1 = Landless & Marginal
Group 2 = Small & Medium

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	417	20.2285	21.249	1.041
Group 2	103	26.0652	20.401	2.010

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.08	.628	-2.52	518	.012	-2.58	161.15	.011

B:Per-capita fish consumption for the landless and marginal socioeconomic stratum in three study cycles

Group 1 = Cycle 1
Group 2 = Cycle 2
Group 3 = Cycle 3

Source	D.F.	Sum of Squares	Mean Squares	F Ratio
Between Groups	2	31836.1309	15918.0655	17.6615
Within Groups	1248	1124802.241	901.2838	
Total	1250	1156638.372		

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Group	Count	Mean	Standard Deviation	Standard Error	95 Pct Conf Int for Mean		
Grp 1	417	21.7261	37.9977	1.8608	18.0685	To	25.3838
Grp 2	417	13.4391	20.3041	.9943	11.4847	To	15.3936
Grp 3	417	25.5207	29.1165	1.4258	22.7179	To	28.3234
Total	1251	20.2286	30.4189	.8600	18.5414	To	21.9159

C: Per-capita fish consumption for the small and medium socioeconomic stratum in three study cycles

Group 1 = Cycle 1
Group 2 = Cycle 2
Group 3 = Cycle 3

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	8159.5370	4079.7685	5.1164	.0065
Within Groups	306	244003.4783	797.3970		
Total	308	252163.0153			

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Group	Count	Mean	Standard Deviation	Standard Error	95 Pct Conf Int for Mean		
Grp 1	103	27.1879	31.4022	3.0942	21.0506	To	33.3251
Grp 2	103	19.2859	24.3139	2.3957	14.5340	To	24.0378
Grp 3	103	31.7220	28.5469	2.8128	26.1428	To	37.3012
Total	309	26.0653	28.6131	1.6277	22.8624	To	29.2682

D: Per-capita fish consumption for four study areas

Group 1 = Chalan Beel
Group 2 = CPP Tangail
Group 3 = Sylhet
Group 4 = Matlab

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	3	34670.9876	11556.9959	30.0525	.0000
Within Groups	516	198433.2771	384.5606		
Total	519	233104.2647			

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Group	Count	Mean	Standard Deviation	Standard Error	95 Pct Conf Int for Mean		
Grp 1	130	20.4124	18.5741	1.6291	17.1893	To	23.6355
Grp 2	130	11.9047	10.5380	.9242	10.0761	To	13.7333
Grp 3	130	18.8242	20.8141	1.8255	15.2124	To	22.4361
Grp 4	130	34.3973	25.4749	2.2343	29.9767	To	38.8179
Total	520	21.3847	21.1930	.9294	19.5589	To	23.2104

E: Per-capita fish consumption by FEZ for three study areas

Group 1 = Beel
Group 2 = Riverside
Group 3 = Highland

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	3974.3357	1987.1678	6.6260	.0015
Within Groups	387	116062.5236	299.9032		
Total	389	120036.8592			

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Group	Count	Mean	Standard Deviation	Standard Error	95 Pct Conf Int for Mean		
Grp 1	150	20.5123	19.4680	1.5896	17.3713	To	23.6533
Grp 2	150	16.4995	17.8374	1.4564	13.6216	To	19.3774
Grp 3	90	12.1843	11.7000	1.2333	9.7338	To	14.6348
Total	390	17.0471	17.5664	.8895	15.2983	To	18.7959

F: **Per-capita fish consumption inside and outside the Meghna-Dhonagoda project embankment**

Group 1 = Inside Embankment
Group 2 = Outside Embankment

Independent samples of inside and outside of Meghna-Dhonagoda Project

t-test for: Per Capita Fish Consumption

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	60	27.4850	17.804	2.298
Group 2	70	40.3221	29.413	3.515

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
2.73	.000	-2.95	128	.004	-3.06	115.84	.003

G: **Regression analysis: Number of species consumed per household and fish consumed (g) per household**

X = Number of Species Consumed per Household
Y = Fish Consumed (g) Per Household

* * * * MULTIPLE REGRESSION * * * *

Multiple R	.37843
R Square	.14321
Adjusted R Square	.14155
Standard Error	120.49302

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	1257016.21785	1257016.21785
Residual	518	7520618.48396	14518.56850

F = 86.57990 Signif F = .0000

* * * * MULTIPLE REGRESSION * * * *

Variable	B	SE B	Beta	F	Sig F
NSPEC	15.598467	1.676384	.378427	86.580	.0000
(Constant)	61.517948	8.461490		52.858	.0000

H: **Regression analysis: Number of species (except hilsha) consumed per household and fish consumed (g) per household**

X = Number of Species (Except Hilsha) Consumed per Household
Y = Fish Consumed (g) Per Household

**** MULTIPLE REGRESSION ***

Multiple R	.62158
R Square	.38636
Adjusted R Square	.38518
Standard Error	94.22095

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	2895411.34506	2895411.34506
Residual	518	4598590.17503	8877.58721

F = 326.14845 Signif F = .0000

**** MULTIPLE REGRESSION ****

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	F	Sig F
N_I_SPC	16.748597	.927408	.621582	326.148	.0000
(Constant)	-24.776339	8.621843		8.258	.0042

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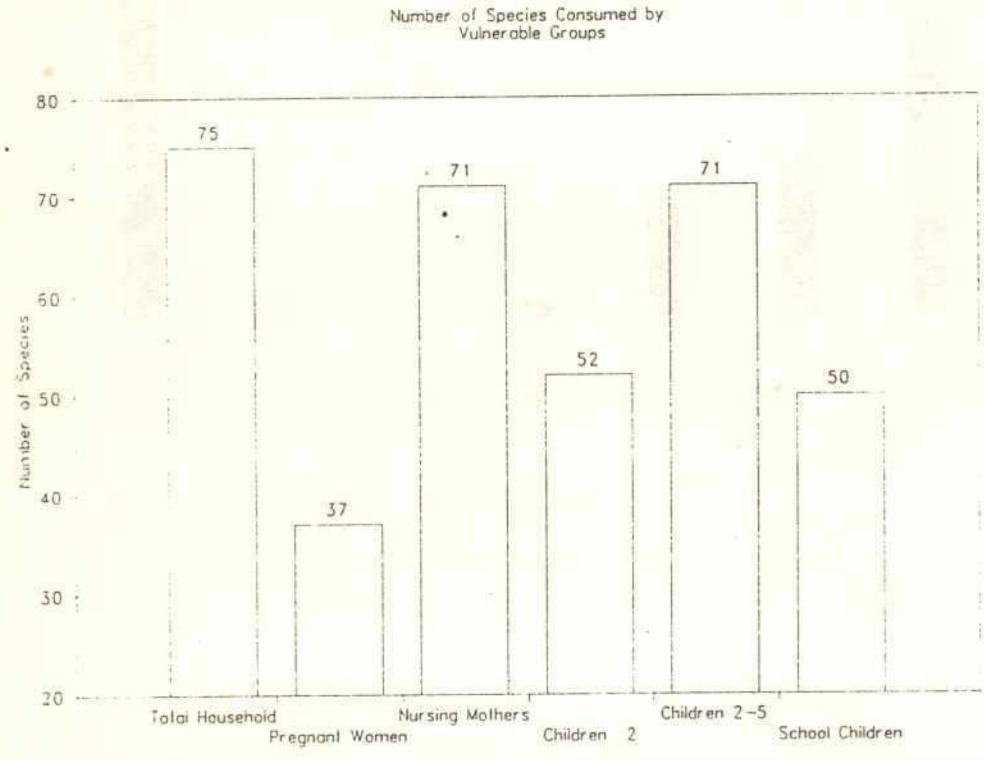
Appendix IV



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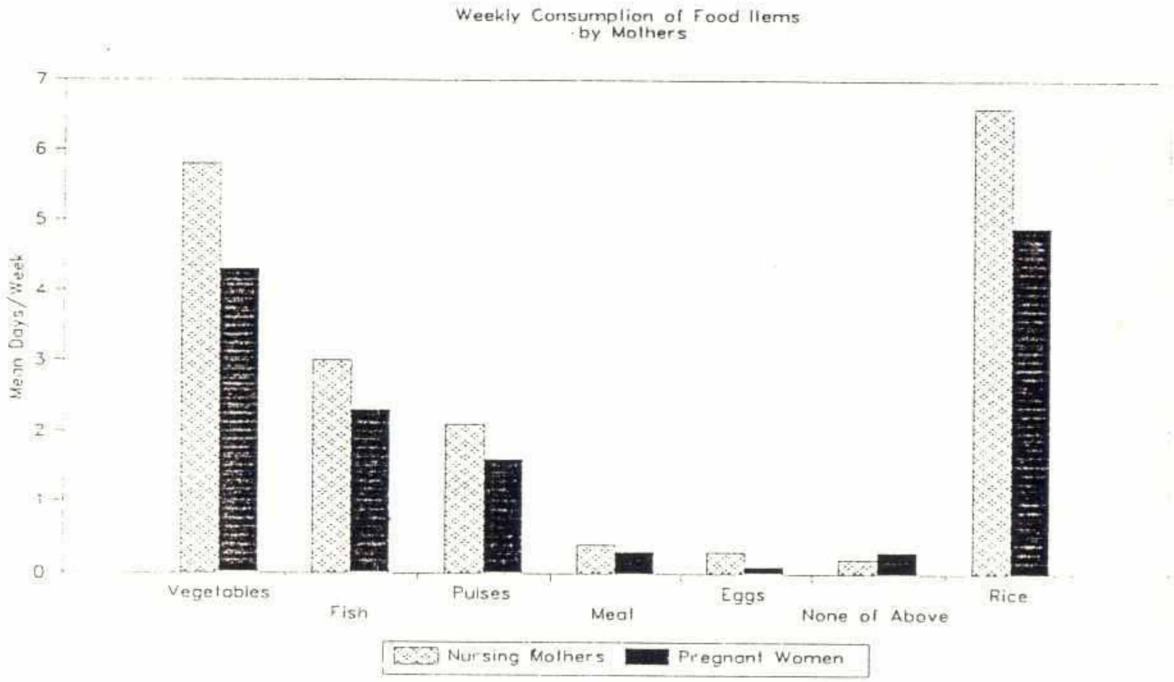
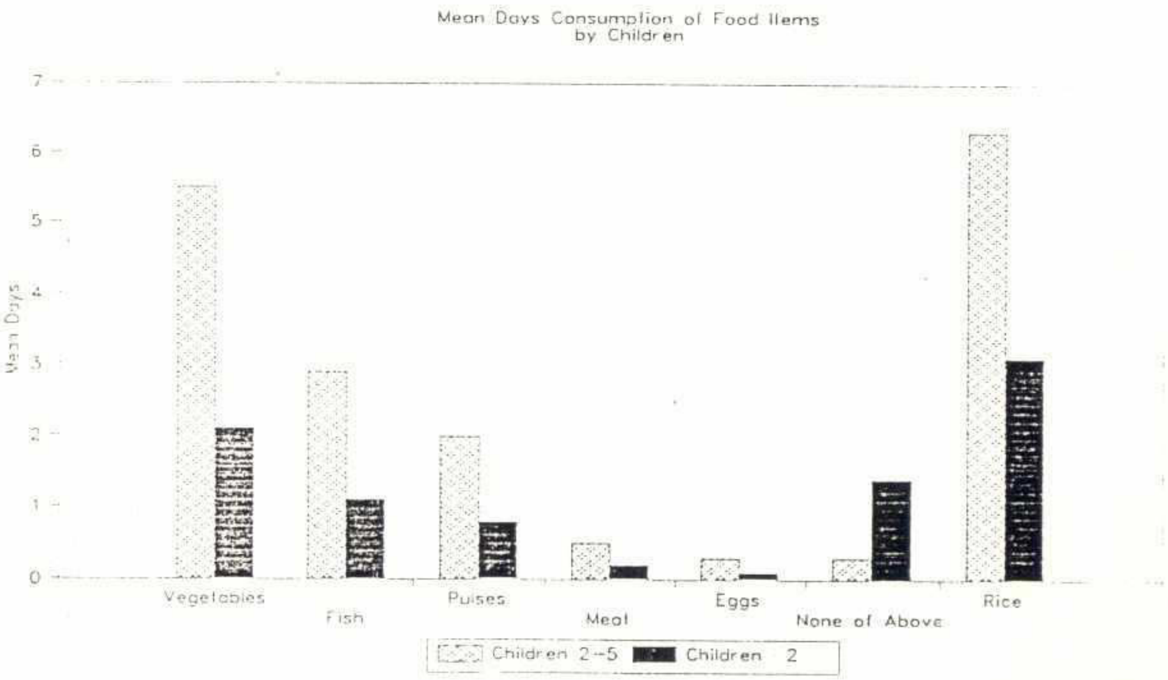
Appendix V





Appendix VI: Consumption of Culture and Capture Fish by Socioeconomic Category

Category	No. of House-holds	Total Consumption (mt)				Consumption/Household (kg)			
		Major Carp	Tilapia	Other	Total	Major Carp	Tilapia	Other	Total
All Areas									
Landless/Marginal	128,847	680	268	5,194	6,143	5.3	2.1	40.3	47.7
Small/Medium	28,159	337	58	1,552	1,947	12.0	2.1	55.1	69.2
Total	157,006	1,018	326	6,746	8,090	6.5	2.1	43.0	51.5
Tangail									
Landless/Marginal	21,044	20	2	361	383	0.9	0.1	17.1	18.2
Small/Medium	4,905	10	3	187	200	2.1	0.7	38.0	40.8
Total	25,949	30	6	547	583	1.1	0.2	21.1	22.5
Singra									
Landless/Marginal	26,676	171	11	640	822	6.4	0.4	24.0	30.8
Small/Medium	8,628	148	5	489	642	17.2	0.6	56.7	74.4
Total	35,304	319	16	1,129	1,464	9.0	0.4	32.0	41.5
Surma-Kushiyara									
Landless/Marginal	23,936	62	0	759	821	2.6	0	31.7	34.3
Small/Medium	6,194	65	4	383	452	10.5	0.6	61.9	73.0
Total	30,130	127	4	1,142	1,273	4.2	0.1	37.9	42.3
Meghna-Dhonagoda									
Landless/Marginal	57,191	427	255	3,435	4,117	7.5	4.5	60.1	72.0
Small/Medium	8,431	114	46	493	653	13.6	5.4	58.5	77.4
Total	65,622	542	301	3,928	4,770	8.3	4.6	59.9	72.7

Source: Household Survey

Appendix VII: Consumption and Catch in Meghna-Dhonagoda

A. Consumption (g/person/day)

Social Class	Location	Cycle 1	Cycle 2	Cycle 3	Full Year
Landless/Marginal	Inside	19	19	34	23
	Outside	44	30	56	42
	Average	31	24	44	32
Small/Medium	Inside	22	22	48	34
	Outside	39	31	57	41
	Average	29	26	52	37
All Classes	Inside	19	20	36	24
	Outside	43	30	56	42
	Average	30	24	45	32

B. Source of Catch (percent)

Location	River	Khal	Beel	Floodplain	Pond	Borrow Pit
Inside (far from river)	2.6	23.0	2.7	26.8	31.6	13.3
Inside (close to river)	40.0	26.8	0.0	2.9	26.5	3.8
Inside: Average	35.3	26.3	0.3	6.0	27.1	5.0
Outside	7.4	12.4	0.5	39.8	28.1	11.8

C. Species of Pond Catch (percent)

Location	Tilapia	Carp	Small & Other
Inside	44.0	6.0	50.0
Outside	0.4	13.0	86.0

D. Household Consumption of Cultured and Non-Cultured Species (percent)

Location	Tilapia		Carp		Small & Others	
	HH	Wt.	HH	Wt.	HH	Wt.
Inside	52	11	38	7	98	71
Outside	21	3	47	14	99	73

Appendix VIII: Species Source of Catch (tons)

Species	River	Canal	Beel	Floodplain	Pond	Borrow pit	Total
			Small Fish				
Bailla	18.6	13.3	3.5	38.4	1.9	1.6	77.2
Bheda	0.0	3.8	2.9	17.0	2.4	0.1	26.2
Bhetki	0.0	0.0	0.0	0.0	0.0	1.1	1.1
Boicha	0.7	48.8	6.5	8.0	20.7	4.9	89.5
Chaka	0.0	0.0	0.0	1.2	0.0	0.0	1.2
Chanda	9.1	12.0	17.4	9.8	9.0	29.9	87.1
Chapila	0.2	0.0	0.2	0.5	0.5	1.1	2.4
Chela	2.9	0.5	41.1	0.3	0.1	0.2	45.1
Cheua (red)	2.2	15.1	0.0	0.0	0.0	0.0	17.3
Cheua (white)	39.0	2.1	0.0	0.0	0.0	0.0	41.1
Dankini	0.1	13.8	0.3	18.5	0.7	7.8	41.2
Dhela	0.4	0.0	0.0	0.1	0.0	0.0	0.5
Faishya	0.0	0.0	0.0	0.0	10.8	0.0	10.8
Foli	2.0	2.8	9.8	12.7	13.8	13.7	54.7
Gutum	15.2	13.0	36.2	36.9	8.9	10.2	120.4
Kachki	1.2	0.0	0.0	0.0	0.0	0.3	1.5
Kaika	0.8	3.7	2.3	0.7	0.7	0.4	8.5
Khalla	0.3	0.0	0.0	0.0	0.0	0.1	0.4
Kholisha	0.1	14.3	20.1	31.9	25.0	38.9	130.3
Koi	2.1	18.7	34.5	34.7	78.5	37.5	206.0
Kuli Bailya	2.9	2.1	0.0	0.0	0.0	0.0	5.0
Mola	4.3	8.8	2.1	4.8	157.9	12.6	190.5

(continued)

Appendix VIII (cont.)

Species	River	Canal	Beel	Floodplain	Pond	Borrow pit	Total
Piali	5.4	0.0	1.8	0.0	0.0	0.0	7.2
Potka	0.0	0.0	0.3	0.0	0.0	0.0	0.3
Puti	36.0	92.9	41.2	347.4	66.2	45.8	629.5
Rani	1.8	0.0	0.0	0.1	0.0	0.0	1.9
Sar Puti	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Satranga	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thai Sar Puti	0.0	0.0	2.3	0.0	0.0	0.0	2.3
Tit Puti	0.8	0.0	0.0	0.0	0.1	0.0	0.9
Total	145.8	265.9	222.4	563.1	397.0	206.2	1800.4
			Catfish				
Aair	6.4	1.2	1.1	15.6	222.5	0.5	247.3
Baga Aair	0.0	0.0	2.4	0.0	0.0	0.0	2.4
Batashi	0.1	0.8	6.0	0.9	0.0	0.9	8.7
Boal	10.2	1.8	79.3	19.8	61.6	10.8	183.4
Bojori	0.2	0.5	2.0	0.5	0.0	0.0	3.3
Ghaura	0.7	0.7	1.5	0.0	0.0	0.0	2.9
Guji Aair	0.0	1.2	0.0	0.0	0.0	0.0	1.2
Gulsha	0.1	0.0	0.0	0.0	0.0	0.3	0.4
Kazoli	0.0	0.0	1.1	0.0	0.0	0.0	1.1
Magur	1.2	4.9	3.6	1.5	4.5	6.2	21.7
Pabda	0.0	0.8	2.0	1.8	2.0	3.9	10.5
Rita	10.6	0.0	5.3	1.0	0.3	0.0	17.2
Shilong	0.0	2.9	0.0	0.0	0.0	0.0	2.9

(continued)

Appendix VIII (cont.)

Species	River	Canal	Beel	Floodplain	Pond	Borrow pit	Total
Singh	17.5	22.1	136.2	26.9	56.2	24.8	283.8
Tengra	31.6	13.3	69.2	39.8	21.9	8.2	183.9
Total	78.6	50.2	309.6	107.8	369.0	55.6	970.8
				Snakeheads			
Cheng	0.0	0.8	0.0	0.0	0.0	0.0	0.8
Gajar	4.8	0.0	0.0	0.0	24.3	0.7	29.8
Shoil	7.3	34.1	60.3	0.7	37.8	1.2	141.4
Taki	9.0	50.4	29.1	125.6	51.6	48.2	314.0
Total	21.0	85.3	89.4	126.4	113.8	50.1	486.0
				Eels			
Bara Baim	56.0	1.1	1.4	6.4	9.7	1.4	75.9
Guchi Baim	17.9	10.5	108.6	15.9	40.3	15.8	208.9
Tara Baim	0.0	0.0	0.1	0.0	0.5	0.0	0.6
Total	73.8	11.6	110.1	22.3	50.5	17.1	285.4
				Major Carp			
Carpio	0.6	0.4	33.6	0.0	39.5	0.0	73.7
Catla	0.0	0.0	0.0	2.7	33.5	2.5	38.7
Kalibaush	0.2	0.0	0.8	2.9	19.2	0.0	23.0
Mrigel	4.5	0.8	0.2	1.1	37.6	2.3	45.8
Rui	1.0	8.9	1.3	7.6	63.1	0.0	81.9
Silver Carp	0.0	0.0	0.0	0.0	56.3	0.0	56.3
Total	6.3	9.1	35.8	14.2	249.1	4.8	319.4

(continued)

Appendix VIII (cont.)

Species	River	Canal	Beel	Floodplain	Pond	Borrow pit	Total
			Hilsha				
Illish	28.2	0.7	0.0	0.0	0.0	0.0	28.9
Total	28.2	0.7	0.0	0.0	0.0	0.0	28.9
			Small Shrimp				
Chatka Chingri	0.3	6.1	7.2	31.6	6.9	5.6	57.7
Gura Chingri	82.8	41.6	157.2	96.7	37.9	26.7	442.8
Kalo Chingri	4.5	1.2	0.4	0.1	1.5	0.2	7.9
Sada Chingri	0.1	8.5	3.0	0.8	1.1	0.0	13.5
Total	87.7	57.4	167.8	129.2	47.4	32.5	521.9
			Large Shrimp				
Golda Chingri	37.4	0.0	0.0	0.0	1.5	0.0	38.9
Total	37.4	0.0	0.0	0.0	1.5	0.0	38.9
			Other Carp				
Goinnya	0.0	0.0	0.0	0.5	0.0	0.0	0.5
Maha Shoil	0.0	0.0	0.0	0.3	0.0	0.0	0.3
Tatkini	1.6	0.0	12.0	6.5	1.9	0.7	22.6
Total	1.6	0.0	12.0	7.4	1.9	0.7	23.5
			Tilapia				
Tilapia	0.0	0.0	0.0	0.9	75.3	2.6	78.9
Total	0.0	0.0	0.0	0.9	75.3	2.6	78.9

Appendix IX: Species Ranked by Key Indicators

Amount Eaten	Number of Meals	Number of Days	Number of Households
Puti	Puti	Puti	Puti
Hilsha	Gura Chingri	Gura Chingri	Gura Chingri
Taki	Taki	Taki	Taki
Gura Chingri	Tengra	Tengra	Tengra
Singh	Singh	Singh	Chanda
Silver Carp	Koi	Koi	Mola
Rui	Hilsha	Hilsha	Hilsha
Koi	Chanda	Chanda	Singh
Tengra	Mola	Mola	Kholisha
Tilapia	Guchi Baim	Guchi Baim	Koi
Guchi Baim	Kholisha	Kholisha	Guchi Baim
Mola	Gutum	Gutum	Gutum
Boal	Chatka Chingri	Chatka Chingri	Bailla
Chanda	Bailla	Bailla	Chapilla
Kholisha	Chapilla	Chapilla	Chatka Chingri
Boicha	Tilapia	Tilapia	Foli
Shoil	Foli	Foli	Dankini
Mrigal	Rui	Rui	Boicha
Foli	Dankini	Dankini	Rui
Chapilla	Boicha	Boicha	Tilapia
Bailla	Boal	Boal	Mrigal
Chatka Chingri	Silver Carp	Silver Carp	Boal
Catla	Mrigal	Mrigal	Magur
Kachki	Kachki	Kachki	Chela
Chital	Magur	Magur	Silver Carp
Gutum	Shoil	Shoil	Kachki
Kali Baush	Pabda	Pabda	Batashi
Cheua (red)	Kali Baush	Kali Baush	Bojori
Magur	Chela	Chela	Pabda
Aair	Bojori	Bojori	Shoil
Bara Baim	Cheua (red)	Cheua (red)	Kali Baush
Dankini	Bara Baim	Bara Baim	Kaika
Carpio	Batashi	Batashi	Bara Baim
Bheda	Bheda	Bheda	Catla
Bojori	Catla	Catla	Cheua (red)
Pabda	Kaika	Kaika	Bheda
Cheua (white)	Aair	Aair	Aair
Poa	Cheua (white)	Cheua (white)	Tatkini

Appendix X: Source of Fish Caught

Species	River	Canal	Beel	Floodplain	Pond	Borrow Pit	Total
			All Areas				
Small Fish	146	266	222	563	397	206	1,800
Catfish	79	50	310	108	369	56	971
Snakeheads	21	85	89	126	114	50	486
Eels	74	12	110	22	51	17	285
Major Carp	6	9	36	14	249	5	319
Hilsa	28	1	0	0	0	0	29
Shrimp	88	57	168	129	47	33	522
Golda Chingri	37	0	0	0	2	0	39
Other Carp	2	0	12	7	2	1	24
Tilapia	0	0	0	1	75	3	79
Total	480	480	947	971	1,306	370	4,554
Percent	11	11	21	21	29	8	100
			Tangail				
Small Fish	16	17	32	8	7	25	105
Catfish	3	1	5	0	3	6	17
Snakeheads	2	0	4	0	0	4	10
Eels	1	3	4	0	1	1	10
Major Carp	0	0	0	0	3	3	7
Shrimp	2	3	11	0	1	7	24
Other Carp	1	0	0	0	0	1	2
Tilapia	0	0	0	0	3	1	4
Total	25	24	56	8	19	46	179
Percent	14	13	31	5	11	26	100
			Surma-Kushiyara				
Small Fish	11	61	35	210	57	56	430
Catfish	7	20	13	34	38	11	123
Snakeheads	4	36	17	78	44	13	192
Eels	0	1	0	6	1	1	8
Major Carp	5	0	1	0	41	0	46
Hilsa	12	0	0	0	0	0	12
Shrimp	0	14	7	33	14	3	71
Total	38	131	73	360	195	84	881
Percent	4	15	8	41	22	10	100

(continued)

Appendix X (cont.)

Species	River	Canal	Beel	Floodplain	Pond	Borrow Pit	Total
			Singra				
Small Fish	32	31	151	23	151	48	435
Catfish	44	8	292	64	310	20	738
Snakeheads	3	4	66	17	31	4	124
Eels	48	6	106	14	9	16	199
Major Carp	1	0	35	2	161	2	200
Shrimp	18	11	149	75	11	14	278
Other Carp	1	0	12	7	2	0	21
Tilapia	0	0	0	1	2	0	3
Total	145	59	811	202	676	102	1,997
Percent	7	3	41	10	34	5	100
			Meghna-Dhonagoda				
Small Fish	87	158	4	322	182	78	830
Catfish	25	22	0	10	18	19	94
Snakeheads	13	46	2	32	39	29	160
Eels	24	2	1	3	40	0	69
Major Carp	1	9	0	13	44	0	67
Hilsa	17	1	0	0	0	0	17
Shrimp	68	30	0	21	21	9	149
Golda Chingri	37	0	0	0	2	0	39
Other Carp	0	0	0	1	0	0	1
Tilapia	0	0	0	0	70	2	72
Total	272	267	7	400	415	137	1,498
Percent	18	18	0	27	28	9	100

Appendix XI: Household Income from Subsistence Fishing

Category		No. of Households	Caught (t)	Sold (t)	Value per Household (Tk.)*		
					Consumed	Sold	Total
				All Areas			
Landless		96,541	2,171	1,113	482	484	966
Small		32,306	1,278	642	866	835	1,700
Marginal		14,034	534	345	591	1,033	1,624
Medium		14,125	505	210	919	624	1,543
	Total	157,006	4,487	2,310	610	618	1,228
				Tangail			
Landless		18,177	101	22	286	81	368
Small		2,867	16	1	336	28	364
Marginal		2,755	23	4	458	88	545
Medium		2,150	31	2	899	56	956
	Total	25,949	171	29	361	74	435
				Surma-Kushiyara			
Landless		17,655	451	169	799	479	1,278
Small		6,281	231	133	779	1,060	1,838
Marginal		2,711	59	5	996	89	1,084
Medium		3,484	117	21	1,376	306	1,682
	Total	30,131	858	328	879	545	1,424
				Singra			
Landless		19,327	663	539	250	1,088	1,338
Small		7,349	618	461	831	2,446	3,278
Marginal		4,054	374	328	440	3,157	3,597
Medium		4,574	301	185	985	1,577	2,562
	Total	35,304	1,955	1,513	488	1,672	2,160
				Meghna-Dhonagoda			
Landless		41,382	956	383	636	417	1,053
Small		15,809	414	47	1,067	133	1,200
Marginal		4,514	78	8	710	84	794
Medium		3,916	56	2	637	21	657
	Total	65,621	1,503	440	745	302	1,047

*Using weighted average price based on quantities sold and market price per species group from Table 24.

Source: Household Survey

Appendix XII: Fish Caught, Sold, and Bought (tons)

Species	Caught	Sold	Caught & Consumed	Bought	Caught & Bought
			All Areas		
Small Fish	1,800	742	1,058	2,043	3,101
Catfish	971	700	271	728	998
Snakeheads	486	168	318	217	536
Eels	285	170	115	126	241
Major Carp	319	127	192	744	936
Hilsa	29	14	15	697	712
Shrimp	522	291	231	353	584
Golda Chingri	39	35	4	73	77
Other Carp	24	13	11	33	44
Tilapia	79	3	76	230	307
Total	4,554	2,262	2,292	5,243	7,535
			Tangail		
Small Fish	105	14	92	140	231
Catfish	17	4	13	50	63
Snakeheads	10	0	10	45	55
Eels	10	2	8	7	15
Major Carp	7	0	6	24	30
Hilsa	0	0	0	99	99
Shrimp	24	2	22	28	50
Golda Chingri	0	0	0	0	0
Other Carp	2	0	2	2	4
Tilapia	4	0	4	2	6
Total	179	22	156	397	553
			Surma-Kushiyara		
Small Fish	430	139	291	188	479
Catfish	123	39	84	130	214
Snakeheads	192	64	128	35	163
Eels	8	1	7	9	16
Major Carp	46	25	21	83	105
Hilsa	12	4	8	67	75
Shrimp	71	40	31	55	86
Golda Chingri	0	0	0	0	0
Other Carp	0	0	0	22	22
Tilapia	0	0	0	0	0
Total	881	311	570	590	1,160

(continued)

Appendix XII (cont.)

Species	Caught	Sold	Caught & Consumed	Bought	Caught & Bought
			Singra		
Small Fish	435	283	152	191	342
Catfish	738	644	93	155	248
Snakeheads	124	91	33	46	79
Eels	199	140	59	51	110
Major Carp	200	102	98	186	284
Hilsa	0	0	0	67	67
Shrimp	278	226	52	59	111
Golda Chingri	0	0	0	0	0
Other Carp	21	13	8	8	16
Tilapia	3	2	1	13	13
Total	1,997	1,501	496	775	1,271
			Meghna-Dhonagoda		
Small Fish	830	306	524	1,524	2,048
Catfish	94	14	80	393	473
Snakeheads	160	12	149	91	239
Eels	69	28	41	58	99
Major Carp	67	0	67	451	518
Hilsa	17	10	7	464	471
Shrimp	149	23	126	211	336
Golda Chingri	39	35	4	73	77
Other Carp	1	0	1	1	2
Tilapia	72	0	72	216	288
Total	1,498	428	1,070	3,481	4,551

Appendix XIII: Average Days of Work per Week (Cycles 2 and 3)

Category	Workers per Household*	People Working	Mean Days per Household: Agriculture	Fishing	Other	Total'
All Areas						
Landless	4.7	1.5	2.9	1.2	4.2	7.9
Marginal	5.4	1.6	4.6	1.4	2.3	8.0
Small	5.9	1.8	4.6	0.3	4.6	9.9
Medium	6.6	2.1	5.7	0.9	4.4	10.7
Average	5.1	1.6	3.6	1.2	3.9	8.4
Tangail						
Landless	4.2	1.4	1.5	0.2	5.3	6.9
Marginal	5.3	1.8	4.2	0.1	4.6	8.6
Small	6.7	1.6	3.5	0.0	5.2	8.5
Medium	8.3	2.5	6.7	0.5	4.5	13.2
Average	4.9	1.5	2.6	0.1	5.2	7.8
Surma-Kushiyara						
Landless	5.0	2.0	3.7	1.4	5.7	10.1
Marginal	5.4	1.6	3.8	0.8	3.4	7.7
Small	6.1	1.3	2.6	0.7	2.7	5.7
Medium	6.3	2.3	6.0	1.4	5.8	12.4
Average	5.4	1.9	3.9	1.2	4.9	9.5
Singra						
Landless	4.2	1.5	3.6	1.2	3.2	7.9
Marginal	4.7	1.5	3.6	1.5	4.4	7.4
Small	5.8	1.8	4.5	1.0	4.9	10.3
Medium	7.0	2.4	8.2	1.0	4.2	13.2
Average	4.8	1.6	4.3	1.2	3.4	8.8
Meghna-Dhonagoda						
Landless	5.0	1.4	2.7	1.5	3.5	7.4
Marginal	5.8	1.7	5.5	1.9	1.4	8.3
Small	5.4	2.1	6.5	1.2	5.3	12.8
Medium	5.3	1.3	1.2	0.9	3.0	5.0
Average	5.2	1.5	3.6	1.5	3.1	7.8

*All people over four years old were potential workers.

'Total days an activity was reported per household in a week. This is less the sum of the three activities listed because some people took part in more than one activity per day.

Source: Household Survey

Appendix XIV: Monthly Average Prices (Tk./kg, 1991-92 prices)

Month	Tangail	Surma-Kushi-yara	Singra	Meghna-Dhonagoda	Mean*
		Small Fish			
December 15-31	42.2	36.3	31.0	41.7	33.8
January	43.6	44.6	37.8	49.2	42.9
February	47.0	42.0	39.1	48.6	46.2
March	56.4	41.5	30.5	51.2	44.3
April	62.8	60.3	38.9	47.5	48.7
May	74.5	53.2	37.1	50.5	51.3
June	88.5	59.1	46.5	53.1	64.9
July	63.6	48.3	44.2	50.1	50.4
August	63.7	51.4	31.4	37.2	45.7
September	97.8	43.6	38.6	33.8	40.4
October	72.0	49.1	42.1	35.8	47.2
November	55.6	48.3	26.9	46.6	36.0
December 1-14	-	44.4	-	46.4	45.7
Average	64.0	48.5	37.0	45.6	46.5
		Catfish			
December 15-31	60.9	52.6	38.7	39.3	41.8
January	66.9	56.1	48.6	59.0	54.0
February	72.7	57.7	39.0	70.3	62.8
March	72.4	59.8	46.5	76.2	62.3
April	102.5	76.1	45.9	53.9	53.2
May	95.0	77.3	51.7	58.8	70.3
June	114.9	71.9	44.6	53.3	77.0
July	111.9	68.3	59.3	60.0	68.0
August	71.2	73.9	46.2	56.0	63.5
September	105.8	70.9	44.1	75.1	84.5
October	87.5	73.6	43.2	60.6	53.2
November	83.5	74.7	36.9	61.3	50.1
December 1-14	-	58.2	-	64.1	60.3
Average	87.1	68.0	45.4	61.3	62.5

continued

Appendix XIV (cont.)

Month	Tangail	Surma-Kushiyara	Singra	Meghna-Dhonagoda	Mean*
			Snakeheads		
December 15-31	37.4	40.0	36.9	-	37.2
January	48.1	44.7	40.9	45.7	44.5
February	45.8	45.9	42.1	48.9	46.9
March	54.4	44.5	33.9	61.5	44.7
April	66.3	50.0	47.2	38.1	49.1
May	66.8	50.7	41.9	50.5	49.5
June	72.6	53.9	39.8	37.5	55.8
July	75.9	48.6	44.3	42.1	50.1
August	90.0	43.6	29.1	40.0	39.8
September	112.8	40.0	58.6	22.4	48.1
October	64.8	45.4	43.6	36.7	45.1
November	52.0	56.8	28.5	36.4	36.4
December 1-14	-	-	-	33.7	33.7
Average	65.6	45.3	40.6	41.1	45.5
			Carp		
December 15-31	-	-	31.4	-	31.4
January	53.8	58.7	41.4	58.7	52.4
February	65.0	57.4	39.8	57.4	55.5
March	72.6	56.3	38.6	56.3	61.5
April	79.4	51.5	33.1	52.5	40.7
May	70.3	50.6	40.6	50.6	55.2
June	85.4	60.6	35.2	60.6	67.0
July	66.4	50.3	43.7	50.3	50.1
August	97.9	75.7	35.5	38.0	39.0
September	122.5	59.7	40.0	66.4	62.3
October	78.3	85.0	41.1	48.3	51.5
November	61.2	70.6	37.0	56.0	56.8
December 1-14	-	63.2	-	54.3	58.8
Average	77.5	61.6	38.1	54.1	53.1

continued

Appendix XIV (cont.)

Month	Tangail	Surma-Kushiyara	Singra	Meghna-Dhonagoda	Mean*
			Shrimp		
December 15-31	30.4	26.4	14.2	30.0	18.4
January	31.0	29.1	20.1	30.7	25.0
February	34.4	36.8	25.7	38.0	34.9
March	41.2	34.6	29.9	45.4	38.6
April	69.2	59.4	19.2	50.0	55.3
May	79.9	40.0	31.6	45.1	44.7
June	81.2	40.0	22.3	44.3	47.0
July	76.0	40.0	25.6	32.9	35.5
August	51.7	42.3	24.0	55.3	32.3
September	-	32.7	23.7	31.8	31.9
October	76.2	31.0	24.9	28.1	32.3
November	48.6	30.0	18.7	36.6	22.6
December 1-14	-	30.0	-	30.0	30.0
Average	56.3	37.0	23.3	39.0	35.4
			Average Rice		
December 15-31	11.9	10.0	10.5	11.8	11.0
January	12.2	11.2	11.0	12.5	11.7
February	12.6	11.3	11.3	13.2	12.1
March	13.2	12.1	11.8	12.2	12.3
April	11.7	11.8	12.2	11.5	11.8
May	11.1	12.0	11.1	11.8	11.5
June	13.2	11.7	10.8	12.3	12.0
July	12.2	12.0	11.7	12.4	12.1
August	12.2	11.8	10.0	11.0	11.3
September	12.2	12.4	9.5	11.5	11.4
October	11.5	11.3	8.5	11.6	10.7
November	11.6	11.0	7.6	11.4	10.4
December 1-14	-	11.5	-	9.0	10.3
Average	12.1	11.6	10.5	11.8	11.5

continued

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Appendix XIV (cont.)

Month	Tangail	Surma-Kushiyara	Singra	Meghna-Dhonagoda	Mean*
			Mossuri		
December 15-31	30.0	29.0	29.5	30.0	29.6
January	26.0	25.3	28.5	30.5	27.6
February	25.3	26.7	30.0	30.5	28.1
March	27.6	27.2	25.6	31.5	28.0
April	28.0	23.5	26.0	31.0	27.1
May	28.0	24.0	25.3	30.0	26.8
June	28.0	24.0	28.7	29.0	27.4
July	28.0	24.0	27.3	29.5	27.2
August	28.0	24.0	28.0	29.0	27.3
September	28.7	24.0	28.7	29.3	27.7
October	28.7	24.0	27.3	30.0	27.5
November	29.2	28.0	28.2	29.3	28.7
December 1-14	-	28.0	-	30.0	29.0
Average	28.0	25.3	27.8	30.0	27.7
			Khesari		
December 15-31	14.0	16.0	13.0	14.0	14.3
January	12.7	16.0	13.3	14.3	14.0
February	15.0	16.0	14.0	14.8	14.9
March	15.3	16.8	14.2	16.5	15.7
April	12.0	16.0	14.0	12.0	13.5
May	17.3	16.0	13.0	14.5	15.2
June	16.3	16.0	16.7	14.0	15.7
July	12.0	16.7	17.3	15.3	15.3
August	13.0	17.3	17.3	15.0	15.7
September	16.0	17.3	18.7	15.3	16.8
October	17.3	18.0	15.7	16.7	16.9
November	15.2	20.0	15.8	16.7	16.9
December 1-14	-	20.0	-	18.0	19.0
Average	14.7	17.0	15.2	15.1	15.5

continued

Appendix XIV (cont.)

Month	Tangail	Surma-Kushiyara	Singra	Meghna-Dhonagoda	Mean*
		Potato			
December 15-31	6.0	-	5.0	-	5.5
January	3.5	-	5.0	-	4.3
February	2.8	-	3.5	2.7	3.0
March	4.6	-	4.4	2.9	4.0
April	10.0	-	8.3	6.5	8.3
May	10.7	-	9.3	7.5	9.2
June	10.0	-	9.7	7.0	8.9
July	10.0	-	10.0	7.5	9.2
August	10.0	10.0	9.7	7.8	9.4
September	10.0	10.0	9.0	7.0	9.0
October	10.0	10.0	9.0	8.0	9.3
November	12.0	-	10.2	7.3	9.8
December 1-14	-	-	-	8.0	-
Average	8.3	-	7.2	6.0	7.5

*Weighted mean for fish based on quantity sold at each price. The mean for the other commodities is a simple average of the four areas.

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Appendix XV: Small Fish to Commodity Price Ratios

Month	Tangail	Surma-Kushiyara	Singra	Meghna-Dhonagoda	All
		Small Fish to Rice Ratio			
December 15-31	3.5	3.6	3.0	3.6	3.1
January	3.6	4.0	3.5	4.0	3.7
February	3.7	3.7	3.5	3.7	3.8
March	4.3	3.4	2.6	4.2	3.6
April	5.4	5.1	3.2	4.1	4.1
May	6.7	4.4	3.4	4.3	4.5
June	6.7	5.1	4.3	4.3	5.4
July	5.2	4.0	3.8	4.0	4.2
August	5.2	4.3	3.1	3.4	4.1
September	8.0	3.5	4.1	2.9	3.5
October	6.3	4.3	5.0	3.1	4.4
November	4.8	4.4	3.5	4.1	3.5
December 1-14	-	3.9	-	5.2	4.5
Average	5.3	4.2	3.5	3.9	4.0
		Small Fish to Mossuri Ratio			
December 15-31	1.4	1.3	1.1	1.4	1.1
January	1.7	1.8	1.3	1.6	1.6
February	1.9	1.6	1.3	1.6	1.6
March	2.0	1.5	1.2	1.6	1.6
April	2.2	2.6	1.5	1.5	1.8
May	2.7	2.2	1.5	1.7	1.9
June	3.2	2.5	1.6	1.8	2.4
July	2.3	2.0	1.6	1.7	1.9
August	2.3	2.1	1.1	1.3	1.7
September	3.4	1.8	1.3	1.2	1.5
October	2.5	2.0	1.5	1.2	1.7
November	1.9	1.7	1.0	1.6	1.3
December 1-14	-	1.6	-	1.5	1.6
Average	2.3	1.9	1.3	1.5	1.7

continued

Appendix XV (cont.)

Month	Tangail	Surma-Kushiyara	Singra	Meghna-Dhonagoda	All
Small Fish to Khesari Ratio					
December 15-31	3.0	2.3	2.4	3.0	2.4
January	3.4	2.8	2.9	3.5	3.1
February	3.1	2.6	2.8	3.3	3.1
March	3.7	2.5	2.2	3.1	2.8
April	5.2	3.8	2.8	4.0	3.6
May	4.3	3.3	2.9	3.5	3.4
June	5.4	3.7	2.8	3.8	4.1
July	5.3	2.9	2.6	3.3	3.3
August	4.9	3.0	1.8	2.5	2.9
September	6.1	2.5	2.1	2.2	2.4
October	4.2	2.7	2.7	2.1	2.8
November	3.7	2.4	1.7	2.8	2.1
December 1-14	-	2.2	-	2.6	2.4
Average	4.4	2.9	2.4	3.0	3.0
Small Fish to Potato Ratio					
December 15-31	7.0	-	6.2	-	6.1
January	12.4	-	7.6	-	10.1
February	16.6	-	11.2	18.2	15.4
March	12.3	-	6.9	17.8	11.2
April	6.3	-	4.7	7.3	5.9
May	7.0	-	4.0	6.7	5.6
June	8.9	-	4.8	7.6	7.3
July	6.4	-	4.4	6.7	5.5
August	6.4	-	3.3	4.8	4.9
September	9.8	4.4	4.3	4.8	4.5
October	7.2	4.9	4.7	4.5	5.1
November	4.6	-	2.6	6.4	3.7
December 1-14	-	-	-	5.8	-
Average	7.7	-	5.1	7.6	6.2

Appendix XVI: Fish Species Captured Migrating through *Khals*

	Surma-Kushiyara		Tangail		Singra		Matlab	
Species	In	Out	In	Out	In	Out	In	Out
Aair	√	√	√	0	√	0	√	√
Bacha	√	√	0	√	0	0	0	0
Bailla	√	√	√	√	√	√	√	√
Bajuri	0	0	0	√	√	√	0	0
Baluchata	√	√	0	0	√	√	0	√
Batashi	√	√	√	√	√	√	0	√
Bhangan	0	√	0	0	√	√	0	0
Boal	√	√	√	0	√	√	√	√
Bora Baim	√	√	√	√	√	√	√	√
Catla	0	√	√	√	√	0	√	0
Chaka	√	0	0	0	√	0	0	0
Chanda	√	√	√	√	√	√	√	√
Chapila	√	√	√	0	√	√	√	√
Chela	√	√	√	√	√	√	√	√
Chewa	0	0	0	0	0	0	√	√
Chital	0	0	0	0	0	√	0	0
Dhela	0	√	0	0	√	√	0	0
Fali	0	√	0	0	0	0	0	0
Flat fish	0	0	0	0	0	0	√	√
Gang Tengra	√	√	√	0	0	0	0	0
Ghaura	√	√	√	√	0	√	0	0
Golda	0	√	0	0	0	0	√	√
Gonia	√	√	0	0	√	√	0	0
Guchi Baim	√	√	√	√	√	√	√	√
Gulsha	√	√	√	√	√	√	0	√
Gutum	√	√	√	√	√	√	√	√
Kaika	√	√	0	√	√	√	√	√
Kajoli	0	0	0	0	0	0	√	0
Kalibaush	√	√	0	0	0	0	0	√
Khalisha	√	√	√	√	√	√	√	√
Kuli Baila	0	0	0	0	0	0	√	√
Meni	0	√	0	0	0	0	0	0
Mola	√	√	√	√	√	√	√	√
Mrigal	√	0	√	√	√	√	0	0
Pabda	√	√	0	0	√	√	0	√
Pahari Gutum	√	√	0	0	0	0	0	0
Puti	√	√	√	√	√	√	√	√
Rani	√	√	0	0	0	√	0	0
Rita	√	0	0	0	0	√	0	0
Ruhi	√	√	√	√	√	√	0	0
Silong	0	0	0	√	√	0	√	0
Small Shrimp	√	√	√	√	√	√	√	√
Taki	√	√	√	√	√	√	√	√
Tara Baim	√	√	√	√	√	√	√	0
Tatkini	√	√	√	√	√	√	0	√
Tengra	√	√	√	√	√	√	√	√
Total	33	36	24	25	30	31	24	26

Source: Migration Study

Appendix XVII: Estimated Number of Fish Larvae Entering the Tangail Floodplain through *Khals*

	Sadullahpur Khal		Gaizabari Khal		Darjipara Khal	
Date	Day	Night	Day	Night	Day	Night
1 July	0	0	2,215	0		
2 July	10,462	40,000	2,215	1,938		
3 July	2,308	1,846	1,800	831		
4 July	0	0	831	4,569		
5 July	0	0	415	0		
7 July	0	0	8,585	0		
11 July	0	0	0	277		
19 July	0	0	0	554		
20 July	6,462	0	0	1,108		
21 July	1,385	923	0	0		
22 July	0	7,385	0	554		
25 July	0	2,769	0	0		
26 July	6,462	10,154	0	0	**Darjipara**	
27 July	0	18,462	0	0	**Khal was**	
28 July	0	1,846	0	0	**closed by**	
29 July	923	6,462	0	0	**a regulator**	
30 July	0	3,692	0	0	**until**	
1 Aug	7,846	19,385	138	1,385	**August 30**	
2 Aug	0	0	138	1,662		
3 Aug	0	0	0	923		
4 Aug	0	0	0	1,108		
5 Aug	0	0	0	277		
6 Aug	0	0	0	2,492		
7 Aug	0	0	0	0		
8 Aug	0	0	0	554		
10 Aug	0	0	138	277		
11 Aug	0	0	0	554		
12 Aug	0	0	0	0		
13 Aug	0	0	0	831		
14 Aug	0	0	0	0		
15 Aug	0	0	0	554		
16 Aug	0	0	0	277		
29 Aug	0	0	0	831		
30 Aug	0	0	138	0		
31 Aug	0	0	0	0	0	277
1 Sep	0	0	0	0	415	30,185
2 Sep	0	0	0	0	7,477	49,569
3 Sep	0	0	0	0	277	554
4 Sep	0	0	0	1,108	415	0
5 Sep	0	0	0	277	0	0
7 Sep	0	0	0	277	0	0

Source: Migration Study

Appendix XVIII: Seasonal Patterns of Subsistence Fishing by Source of Catch

Source	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						Sylhet							
River	24	33	39	38	33	30	15	13	10	7	7	18	15
Canal	53	27	7	14	32	53	30	18	19	25	38	53	63
Beel	6	13	10	38	54	20	28	5	5	2	0	4	4
Haor/Floodplain	12	2	0	0	40	52	62	73	81	82	63	40	9
Pond	8	20	19	29	33	37	18	23	19	17	20	16	26
Ditch/Borrow pit	41	64	48	5	9	8	7	2	0	0	8	0	0
Total	51	45	31	21	57	60	60	60	58	60	60	55	46
						Tangail							
River	6	16	7	0	0	0	0	0	0	0	2	0	0
Canal	23	10	0	0	0	0	0	4	23	22	30	11	21
Beel	67	92	94	88	70	83	94	82	25	30	72	95	81
Haor/Floodplain	40	0	0	0	0	0	4	38	87	69	55	22	2
Pond	2	6	4	13	28	8	15	6	2	8	0	6	14
Ditch/Borrow pit	6	22	13	13	38	35	17	38	31	28	13	15	5
Total	52	51	46	48	47	52	47	48	52	50	53	55	42
						Singra							
River	32	28	33	28	33	22	53	29	18	17	23	27	28
Canal	26	38	14	3	10	0	24	19	3	4	10	14	25
Beel	20	43	14	10	3	9	0	0	0	0	0	0	67
Haor/Floodplain	16	0	0	0	0	0	0	48	85	87	96	80	0
Pond	6	2	19	40	27	52	41	10	6	10	6	4	3
Ditch/Borrow pit	10	11	38	53	47	30	12	16	3	6	0	9	11
Total	50	47	42	40	30	23	17	31	33	52	48	56	36
						Matlab							
River	24	22	26	22	22	19	15	7	6	17	18	16	8
Canal	44	46	26	25	33	34	46	21	17	17	27	31	44
Beel	0	2	3	0	0	6	5	0	0	0	0	0	0
Haor/Floodplain	11	0	0	0	0	3	10	61	75	67	71	42	3
Pond	11	20	34	41	44	41	37	18	15	19	34	27	39
Ditch/Borrow pit	9	26	20	16	15	9	5	2	4	0	0	9	6
Total	45	46	35	32	27	32	41	44	47	54	56	55	36

Source: Subsistence Fishing Survey