BANGLADESH FLOOD ACTION PLAN

NUTRITIONAL CONSEQUENCES OF FISHERIES BIO-DIVERSITY

ENVIRONMENTAL STUDY (FAP 16)

Prepared for

The Flood Plan Coordination Organization (FPCO)
of the
Ministry of Irrigation Water Development and Flood Control

March 1993

ISPAN
IRRIGATION SUPPORT PROJECT FOR ASIA AND THE NEAR EAST
Sponsored by the U.S. Agency for International Development

ISPAN

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AND THE NEAR EAST

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Stephen F Minkin
Study Director

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 bio-diversity 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 bio-diversity and related household nutrition.
- Assess the migration patterns of floodplain species.
- Ascertain seasonal variation of fish species and their market price.

The areas 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, 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 (Chapter 3). 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. Such subsistence fishing constitutes a hidden economy. Large numbers, perhaps millions of otherwise "unemployed" people work in this wageless labor system and produce food for their families by catching fish. This activity effectively subsidizes grain production by allowing

laboring families to obtain necessary levels of nutrients despite low and intermittent wages. Free and inexpensive fish also sustain agricultural laborers when agricultural work is not available.

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

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, particularly in terms of the country's 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 be fully 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 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. 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 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. And certainly, the fisheries analysis in the proposed Tangail project feasibility study is an improvement over what was done by MPO, or in previous FCD feasibility studies.

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 sea-

sonality, for example, ilish ranked highest during monsoon, 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. Children, particularly females, are more likely to be involved in fishing than 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; snake head, 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; snake head, 49; and carp, 58.

Although preliminary figures indicate that fish stocking may be an economically promising method of boosting fish production, most of the benefits of the increased productivity are going to relatively wealthy landowners, leaseholders, and middlemen. They 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, lose access to the ponds, to an important source of protein, and to an income-generating activity.

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 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 (snake head). Spawning is timed with temperature rises, rainfall, and water flow.

The early monsoon 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 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. 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 *khals* 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 through the *khals* to the river along with the receding flood water. 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 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.

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

The study found that the adults of 24 to 36 species of fish migrate through canals 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 the Bangladesh floodplain 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 floodplain 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 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. This leads to the conclusion that floodplain fisheries losses are routinely 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. 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*.

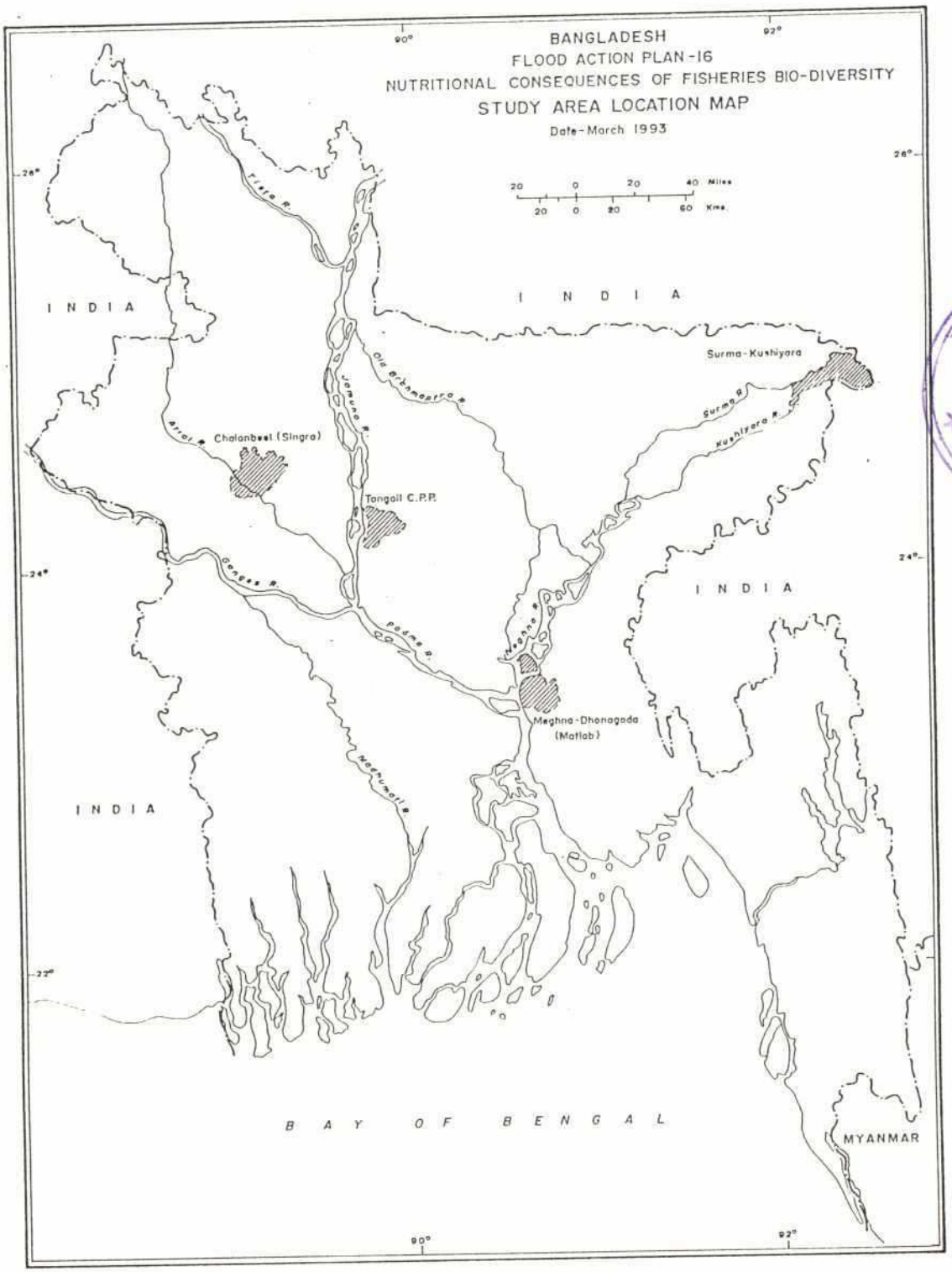
Unlike the floodplain catch, the beel catch was dominated by catfish, which made up 47 percent of the total. Still, small fish species were the second largest group in the catch, comprising 24 percent of the total, and carp made up 13 percent.

6. Recommendations

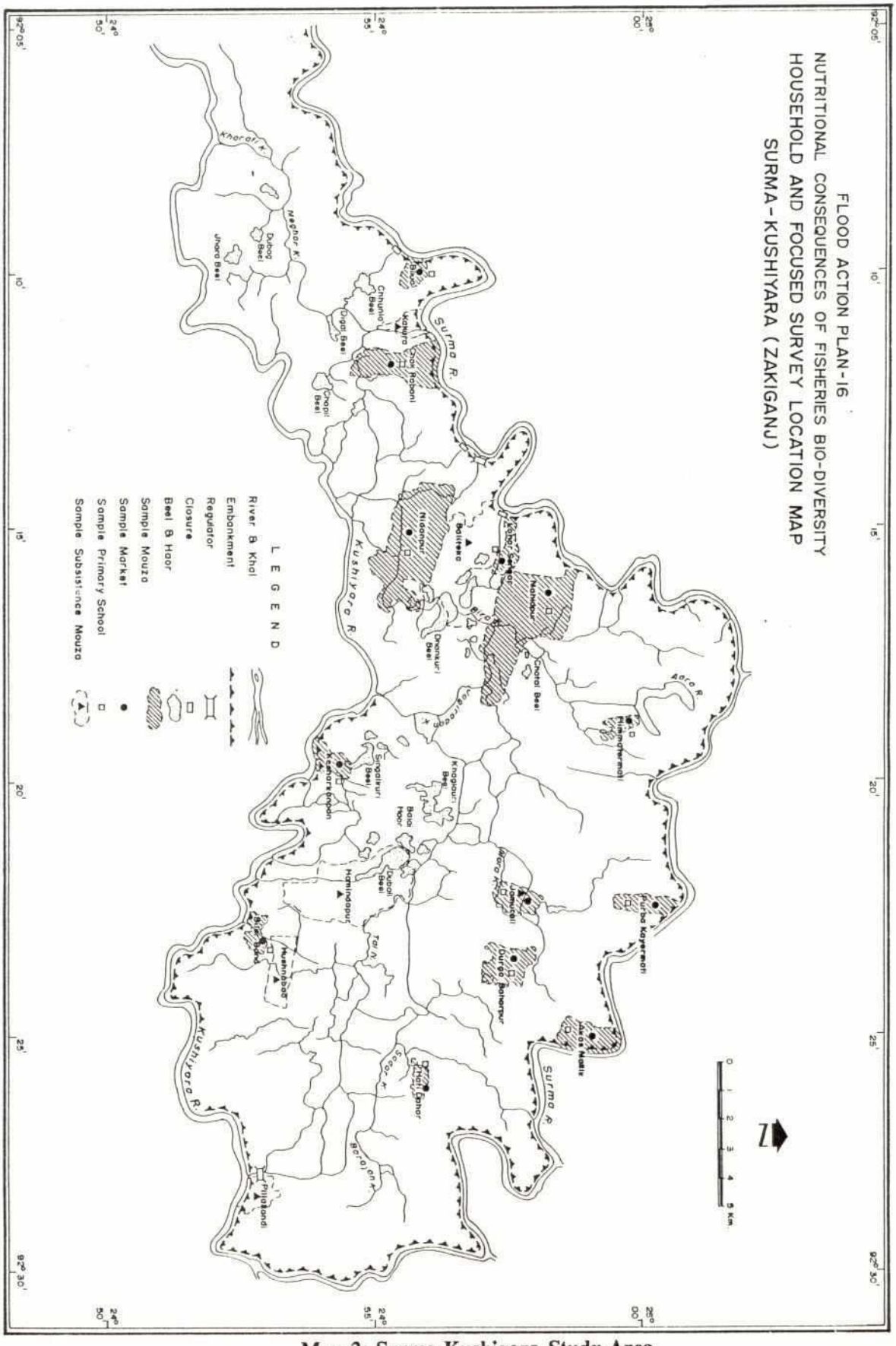
Based on the findings of this study, the following is recommended:

- The preservation of capture fishery resources should be the highest priority of water resource allocation and planning.
- In most 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.

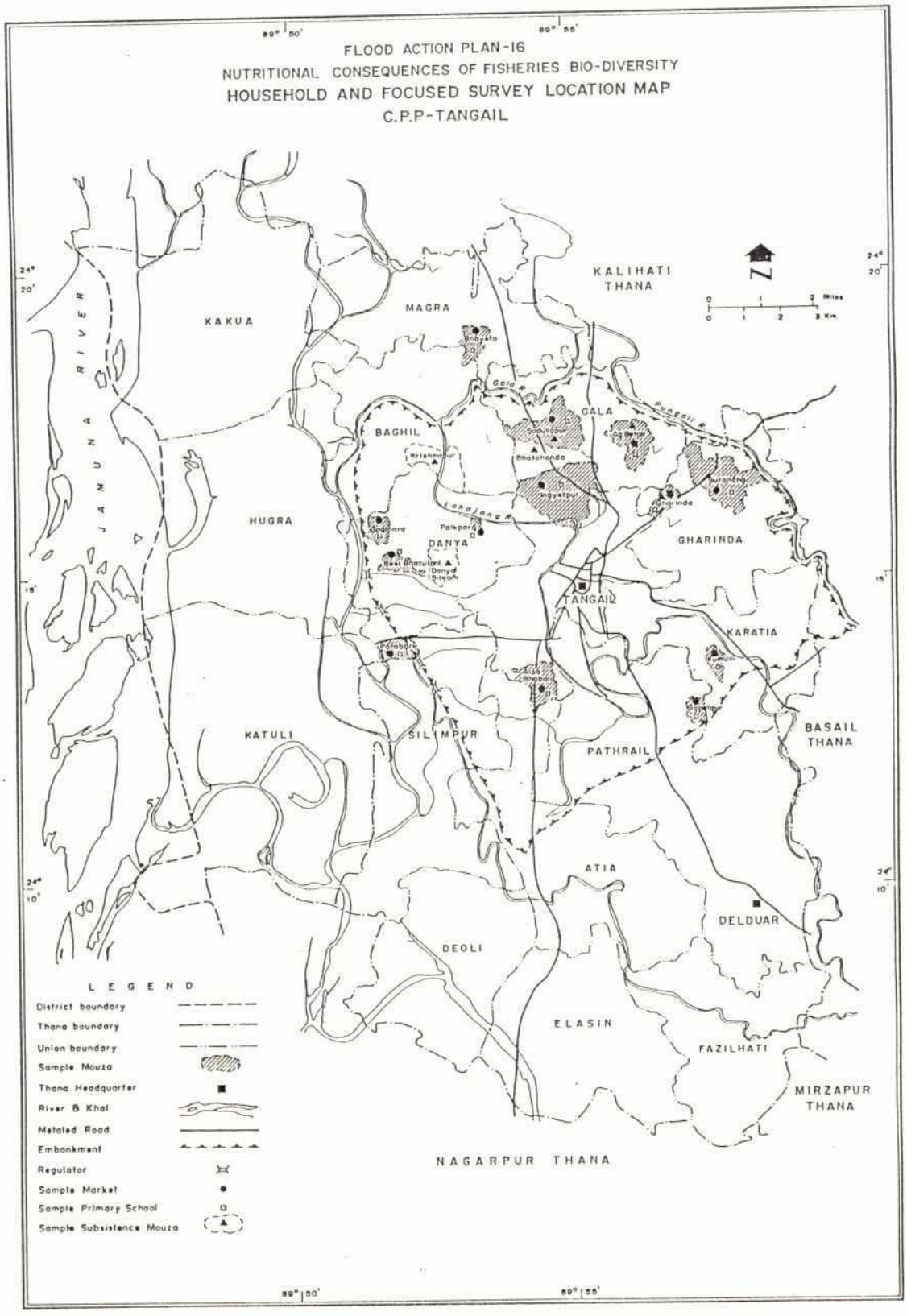
In addition, too little is known about the biology of most of the floodplain species of Bangladesh. Consequently, impact assessments of FCD/I projects inadequately quantify fisheries losses and incompletely estimate the affects of mitigation measures. To correct this problem, more detailed study of the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



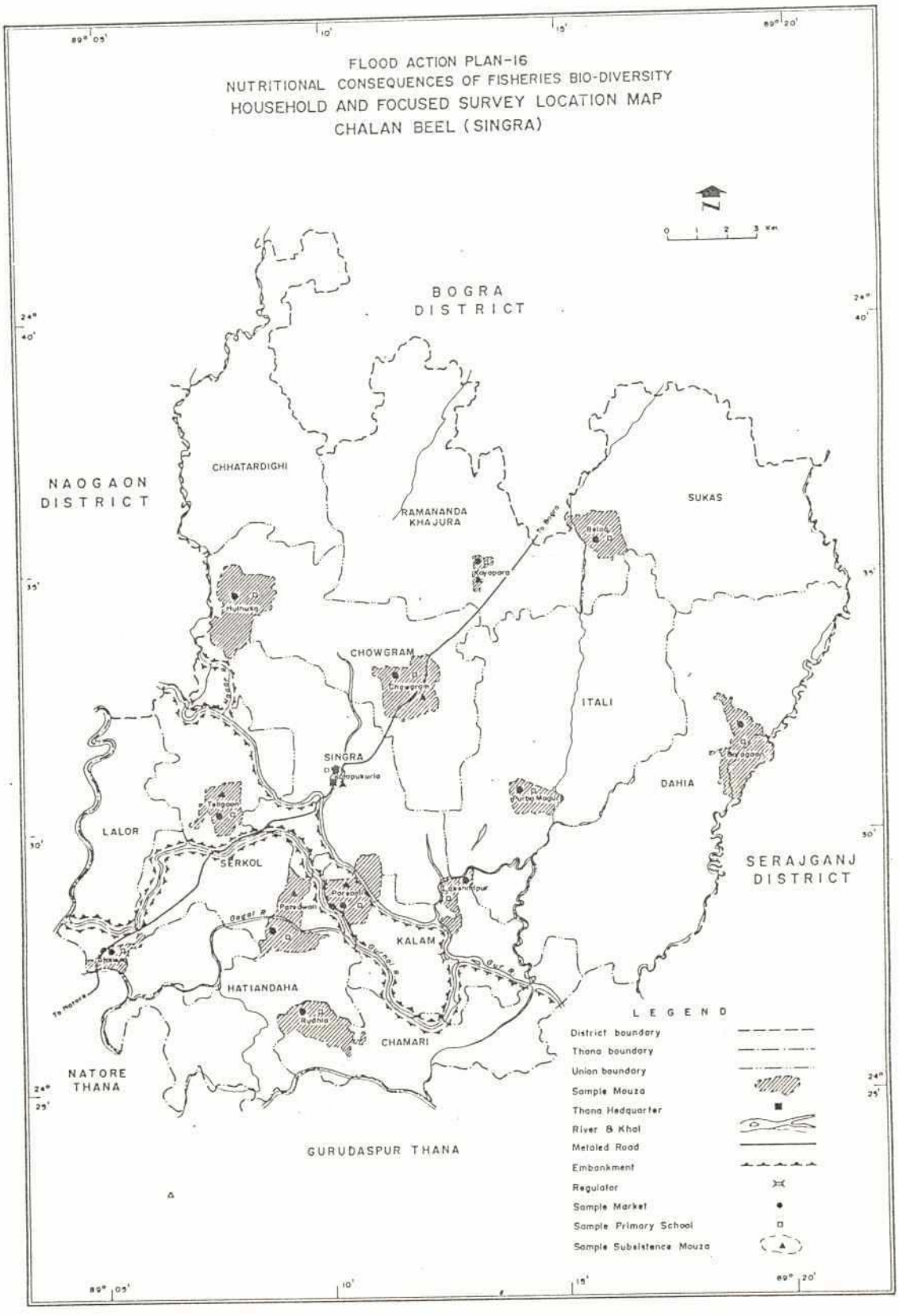
Map 1: Study Area Location



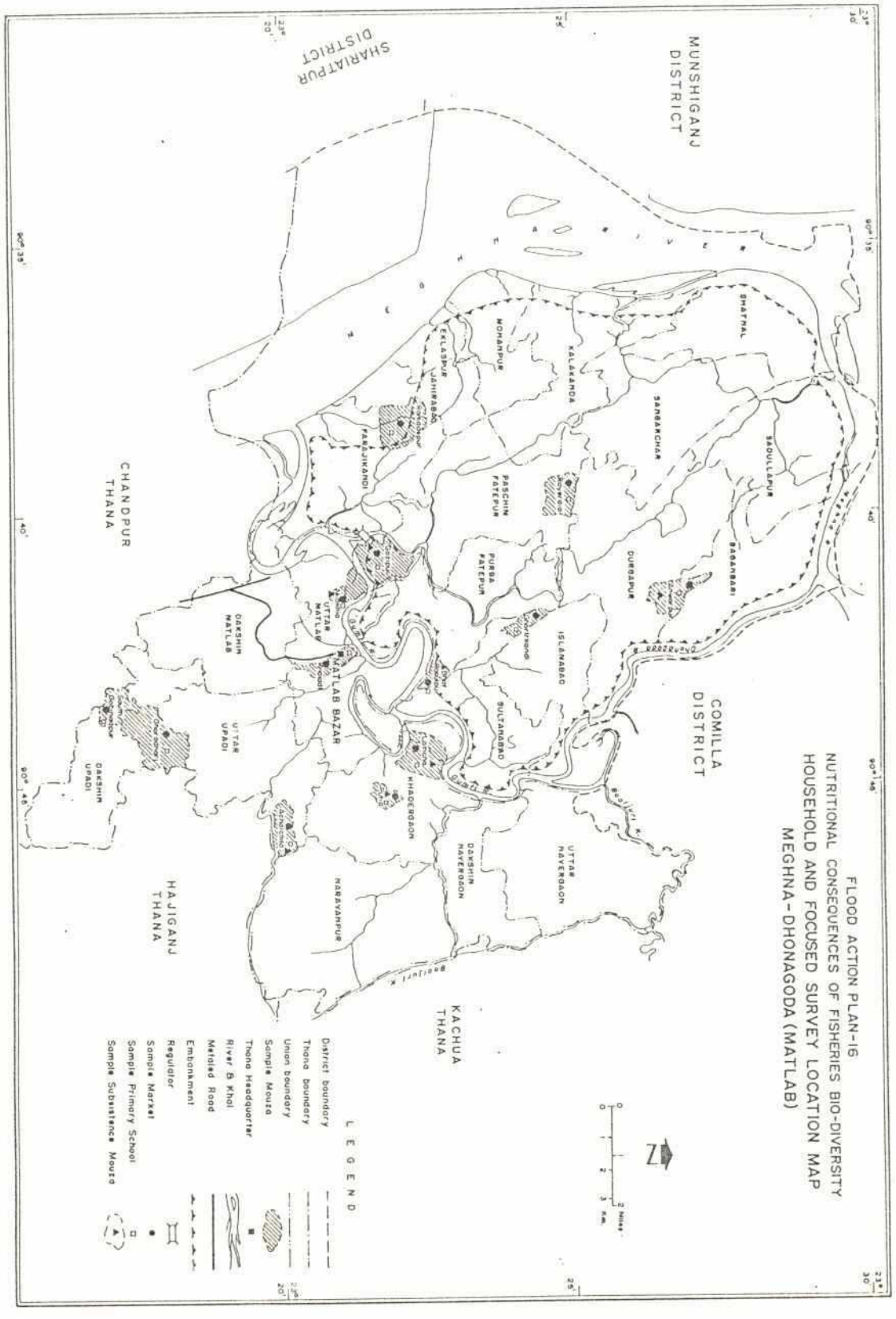
Map 2: Surma-Kushiyara Study Area



Map 3: Tangail CPP Study Area



Map 4: Singra, Chalan Beel Study Area



Map 5: Matlab, Meghna-Dhonagoda Study Area

Chapter 1

INTRODUCTION

1.1 Nutrition and Bio-diversity

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 end up 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 92) leaving most of the fish produced and consumed in Bangladesh with no implicit value. In fact, lower-priced fish, the daily food of tens of millions, play a major role in the nation's economy as well as in the nutrition of its people.

Substantial numbers of people in Bangladesh engage in subsistence fishing. Their numbers in fact constitute a hidden economy. During the bio-diversity study, fisheries researchers found that interviewed families often said that members engaged in subsistence fishing were unemployed *(bekar)*. Large numbers, perhaps millions of such "unemployed" people enter a wageless labor system and produce food for their families by catching fish. This activity effectively subsidizes grain production by allowing laboring families to obtain necessary levels of nutrients despite low and intermittent wages. Free and inexpensive fish also sustain agricultural laborers when agricultural work is not available.

Although the words "nutrition" and "bio-diversity" are seldom linked, species diversity is an important component of the nutritional profile of the Bangladeshi people. The 1980-81 Nutritional Survey of Bangladesh found that of 28 grams of animal protein consumed per capita, 80 percent, 22 grams, came from fish. As this study will show, landless people rely on a wide variety of species to meet their protein needs. The fact is, subsistence fishing provides agricultural laborers and their families with their principal source of animal protein. Nonetheless, during the past 22 years, fish consumption fell at an annual rate of 4.66 percent, while the population annually grew at about 2.5 percent (Minkin 1989).

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

Historically, government and donor agency sup-

port for fisheries has tended to concentrate attention on a mere handful of species. This has led to some ill-advised piscicultural practices. Carp stocking and production, for example, which can lead to restricted species 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 natural 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 this practice, those people often lose traditional fishing rights that enable them to provide affordable fish for household consumption.

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 bio-diversity and fisheries yields largely have been ignored.

1.2 The Economic Value of Fisheries

The people of Bangladesh depend heavily on natural wild aquatic resources for their food and livelihood. In addition to making up a large part of people's protein consumption, fish constitutes nearly 6% of the gross domestic product and more than 12% 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. 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)

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.

Open-water capture fisheries contribute prodigiously to fish production in Bangladesh. Hundreds of thousands of metric tons of fish are produced this way annually (Table 1). According to BBS data, however, inland fish catches, which once accounted for nearly 90 percent of all fish production

Table 1
Quantity of Fish Caught
(thousands of metric tons)

Year	Inland	Marine	Total
1972-73	729	95	818
1973-74	723	88	820
1974-75	733	89	822
1975-76	545	95	640
1976-77	541	100	646
1980-81	525	125	724
1983-84	589	165	754
1984-85	586	188	774
1985-86	587	207	794
1986-87	597	217	814
1987-88	599	228	827
1988-89	607	233	840
1989-90	613	234	847
1990-91	654	239	893

(BBS 1987), have declined in both absolute and relative terms. The data show that production has been falling rapidly, and that recent numbers are well below levels reported during the 1970s (BBS 1987).

Despite the size of the country's fishing industry, press reports in Bangladesh now indicate that fish is being imported from India—a partial reversal of the traditional trade relationship between the two nations *(Daily Ittefaque* 1992). Ironically, the country's fish exports also are growing, but declining yields could force the importation of more fish, thereby creating a negative balance of payments in this sector.

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 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.

Figure 1, adapted from the Master Plan Organization (MPO), shows projected relationships between demand and production through 2005. The demand lines are based on constant and increasing per capita availability and a five percent growth in gross national product (GNP).[1] The MPO, in 1986, 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. Clearly, fish stocks will decline in the absence of a radical rethinking of the role of fisheries in the sustainable development of Bangladesh.

The Interim Report of the Tangail Compartmental-

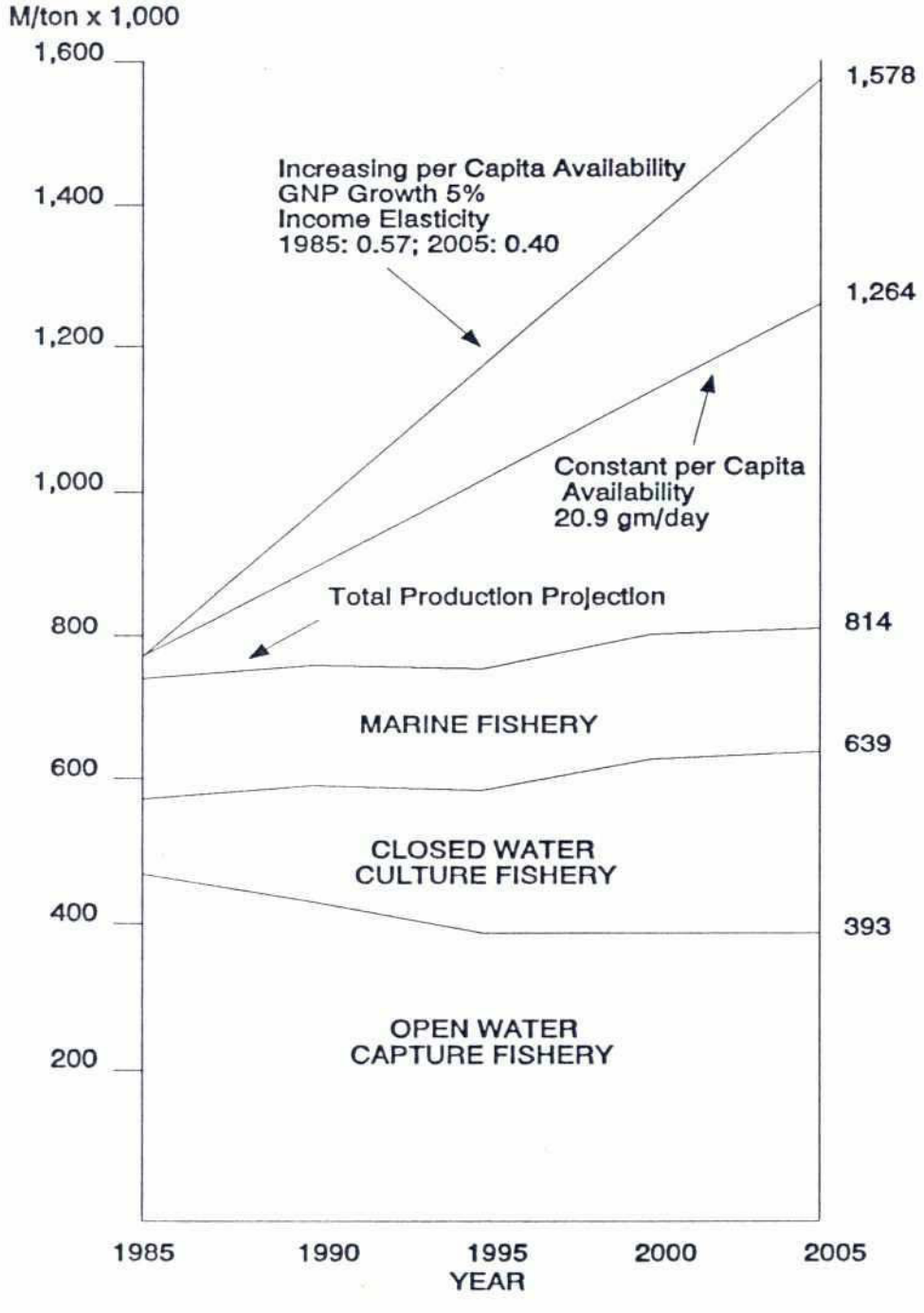


Figure 1: Fish Demand and Production (1985-2005)

Table 2
Value of Fish, Tangail CPP

Species	Tk./kg
Major Carp	60
Minor Carp	50
Catfish	90
Hilsa	100
Macrobrachium	120
Small shrimp	40
Miscellaneous	40

Source: FPCO, Compartmentalization Pilot Project (FAP 20), Tangail CPP Interim Report, Annex 3: Fisheries and Aquaculture, September 1992.

ization 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 2. 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 is a vast improvement over what was done by MPO, or in previous FCD feasibility studies. 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 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 to agree 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).

1.3 Flood Control and Fish Losses

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's aquatic fauna reportedly comprises more than 260 fish species (Rahman 1989)[2]—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.

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 as follows:

> *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. It must be understood that the open water fishery (i.e., capture fishery) has been estimated to give 80 percent of the country's total inland fish 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 be fully 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 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. 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 incalculable costs 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.[3]

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 267). In most areas, recruitment takes place from the rivers with the onset of the rains. During monsoon, fish movement increases throughout the floodplain and from rivers into canals. 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 canals 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 flood waters 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 approaches zero and the only remaining fish are in large beels such as those in parts of Sylhet.

Beels continue to yield fish during the dry season in some areas, but discussions with fishermen and empirical observations suggest that many beels either completely dry up or become unproductive. Other beels do support populations of reproducers. Evidence from our migrations studies, however, suggest that even these water bodies are partly dependent on recruitment from rivers in order to maintain their reproductive potential. In a sense, fish in the rivers are "fish in the bank," which become available to an exhausted floodplain every year. In the absence of this perennial source, fish populations cannot be maintained in the hostile environment of the dry season.

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 economic 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 foolish 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.

1.4 Flood Control Project Appraisal

The Flood Action Plan as originally outlined proposed to give due consideration to 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 on a commitment to ensuring that social, environmental, and nutritional issues are considered before projects are funded or implemented.

1.4.1 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.[4]

Multi-criteria analysis, as described for the Flood Action Plan, 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). Both the prices of those fish and their labor cost are low, often approaching zero. Yet, while the taka price of commonly consumed fish species may be low, those fish are highly useful to rural families. Data on the species diversity, seasonal abundance of fish, and consumption and market information are necessary 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.

1.4.2 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, requires some form of scarcity premium to reflect the dimension of fish population (Shahabuddin & Rahman 1992). Moreover, those fisheries are a source of protein for poor households, which may not otherwise 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.

In order 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 a project assessment not only should consider actual losses to fish production but also losses of opportunities to enhance production. The elasticity of fish popula-

tions, 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 in section 1.1 suggest that it will become increasingly difficult for the natural process of replenishment to occur. Therefore, facilitating fish production by increasing access to the floodplain should be viewed as a planning priority. Eliminating drainage congestion, by reopening and dredging 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, pervades 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 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 do this. Furthermore, projections of the long-term impact on fisheries require detailed baseline information on productivity of the various fish species caught and consumed in Bangladesh. But sacrificing environmental impact assessment to expediency can have severe implications for the future economic development of Bangladesh.

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. Women and children, for example, are sometimes among those involved in fishing activities. This study quantifies their involvement in fishing, as well as in related agricultural sectors. The analysis of collected data will also 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 unleashing the reproductive and growth potential of hundreds of natural species whose habitats are continuously being eroded. ■

NOTES

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

2. Rainboth has suggested that the number of species exceeds 400.

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

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

Chapter 2

METHODOLOGY

The fisheries 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 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 bio-diversity and related household nutrition.
- Assess the migration patterns of floodplain species.
- Ascertain seasonal variation of fish species and their market price.

2.1 Study Areas

The sample areas 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 names of the household head and his/her father), 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 the following 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.

Each of the selected households was surveyed for one year in three cycles. Each cycle covered a period of 17.33 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 survey 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 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.

2.3 Focused Surveys

To better understand the dynamics of fisheries and nutrition, additional resources 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 information 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 specific 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 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, slightly differing methods were used.

In Surma-Kushiyara, where the beels are fished once a year by leaseholders who drain the beels 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 ditches, which are called *kuas*. The captured fish are then harvested between December and April. Monitoring of this catch was done by selecting sample *kuas* in each of four beel areas in Singra, Teligram, Balubhara, Noorpur, and Chakly. The catch was observed and recorded during fishing months 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, totalled, 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.

2.3.4 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, canals originating in rivers adjacent to the project area[6] were used as sampling sites. Canals were selected for study based on observation and on interviews with local fishermen.

After the canals 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.

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 a fine-mesh bag net 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 the fishermen used.

2.3.5 Subsistence Fisheries Survey

The Subsistence Fisheries Survey examined subsistence fishing in six sample mouzas of each study area. The sample villages each had average fishing intensity and fish availability, and therefore were representative of their area. The selected villages were also near rivers, canals, 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, that 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 flood water during the previous 15-day period. Field observations of subsistence fishermen were also conducted during these visits. Data gathered about captured fish species and quantity 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 Professional Fishermen Survey

The Professional Fishermen Survey identified 100 professional fishermen in each study area. These fishermen, interviewed once during the study period, were asked questions about their perceptions of the status of fisheries resources and their opinions about ways to improve those resources. The information gathered was not compiled in time for this draft report.

2.3.7 Socioeconomic Survey

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

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-Dhonagodha 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

FINDINGS OF THE HOUSEHOLD SURVEY

3.1 Introduction

Unfortunately for this study, and even more so for families that depend on fishing for food and livelihood, river flows and floodplain inundation were abnormally low in 1992. The highest flow of the Jamuna at Sirajganj was 13.25 m[1]; 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 from 60 surveyed households in six villages was only 75 kg during the first half of December 1992. In the second half of December 1991, the fish catch by the same households was 119 kg.

Field enumerators working on this study reported that when they went to set up nets to study fish migration, there was no flow in many of the channels considered normal migration routes. Because of lack of water, few fishermen were found in traditional fishing spots.

The abnormally low inundation had no impact on the results of the first two cycles of this study, but the third cycle catch was far below normal. As a result, prices during that period were abnormally high.

This chapter presents the findings of the Household Survey on three major subjects: fish consumption, fishing employment, and the economic value of fisheries.

3.2 Fish Consumption

In this section, consumption is discussed: a) for all households (excluding large farmers and urban households) in the four survey areas, b) by households grouped into land ownership classes, c) by fisheries ecological zones, d) in terms of species diversity, e) by source of catch, and f) whether caught or bought. The results of a special survey of school children are presented at the end of the section.

3.2.1 Quantity Consumed

Total fish consumption is summarized in Table 3. Total annual fish consumption in the four study areas was 8,188 tons. Consumption peaked at 43 percent of the total in Cycle 3, and it was lowest during Cycle 2 at 24 percent of the total. Surma-Kushiyara, located in the Sylhet haor area, has a different seasonal pattern than the other study areas. Consumption was highest there during Cycle 1, probably reflecting the longer time required to drain the haors. This likely resulted in peak fishing during Cycle 1 rather than in Cycle 3

Table 3
Total Household Fish Consumption by Fish Type* (metric tons)

Area	Small Fish	Cat-fish	Snake Head	Carp	Shrimp	Hilsa	Eels & Other	Total
				Full Year				
Tangail CPP	223	65	56	37	51	107	39	577
Surma-Kushiyara	534	233	152	139	96	77	16	1,247
Singra	433	287	117	351	147	73	148	1,555
Meghna-Dhonagoda	2,301	487	285	543	413	472	308	4,809
Total	3,491	1,072	610	1,070	707	728	511	8,188
Percent	43	13	7	13	9	9	6	
				Cycle 1				
Tangail CPP	56	30	27	17	36	0	15	181
Surma-Kushiyara	179	113	70	88	33	1	4	487
Singra	110	124	66	170	79	0	67	616
Meghna-Dhonagoda	869	158	82	168	95	28	34	1,435
Total	1,214	425	245	443	244	29	120	2,720
Percent	45	16	9	16	9	1	4	
				Cycle 2				
Tangail CPP	26	18	17	10	4	13	7	94
Surma-Kushiyara	219	79	36	22	34	24	4	419
Singra	55	57	5	93	24	16	16	266
Meghna-Dhonagoda	480	54	48	156	139	266	4	1,148
Total	780	209	106	281	201	318	31	1,926
Percent	41	11	6	15	10	17	2	
				Cycle 3				
Tangail CPP	141	17	12	10	11	94	17	302
Surma-Kushiyara	135	41	47	29	29	52	8	341
Singra	268	105	46	88	44	57	65	673
Meghna-Dhonagoda	952	275	154	219	178	178	270	2,226
Total	1,496	438	259	346	262	381	360	3,542
Percent	42	12	7	10	7	11	10	

Source: Household Survey
*Excludes dry fish.

as in the other areas.

The relative importance of small fish, catfish, snake head, and shrimp in terms of their contribution to total consumption is about the same in all seasons. Except for a small quantity in Meghna-Dhonagoda, hilsha are caught only during the last two cycles, which coincided with the onset and recession of floods. More carp are consumed during Cycle 3, but as a percentage of total consumption, carp are relatively more important during the first and second cycles.

Overall, small fish accounted for 42.6 percent of the fish consumed; followed by catfish and carp (both 13.1 percent), hilsa (8.9 percent), shrimp (8.6 percent), snake head (7.4 percent), and eels and other fish (6.2 percent). Consumption per household is shown in Table 4. The average consumption per household for the full year was 52 kg. This amounts to 1,003 grams per household per week, or 143 grams per day. The average daily per capita consumption rate of 25 grams/day (5.8 people/family) is slightly above the 1991 national average of 22 grams.

Of the four areas studied, consumption was lowest in Tangail. Daily consumption per person was only 11 grams in Cycle 1, six grams in Cycle 2, 18 grams in Cycle 3, and an average 12 grams for the year. In contrast, the highest consumption was in the Meghna-Dhonagoda area, 47 grams daily per capita in Cycle 3, and an average of 34 grams for the year. Consumption in Singra drops off sharply from 27 grams daily per capita in Cycle 1, to only 11 grams in Cycle 2, a consequence of beel drainage, drying up of rivers, and late monsoon.

Table 4
Daily Per Capita Fish Consumption

Area	Total (kg)	Weekly (gm)	Daily (gm)	Daily/ Capita (gm)
Full Year				
Tangail CPP	22	428	61	12
Surma-Kushiyara	41	796	114	18
Singra	44	847	121	22
Meghna-Dhonagoda	73	1,409	201	34
Average	52	1,003	143	25
Cycle 1				
Tangail CPP	7	403	58	11
Surma-Kushiyara	16	934	133	21
Singra	17	1,007	144	27
Meghna-Dhonagoda	22	1,262	180	31
Average	17	1,000	143	25
Cycle 2				
Tangail CPP	4	209	30	6
Surma-Kushiyara	14	802	115	18
Singra	8	435	62	11
Meghna-Dhonagoda	18	1,009	144	24
Average	12	708	101	17
Cycle 3				
Tangail CPP	12	672	96	18
Surma-Kushiyara	11	653	93	15
Singra	19	1,100	157	29
Meghna-Dhonagoda	34	1,957	280	47
Average	23	1,302	186	32

Source: Household Survey

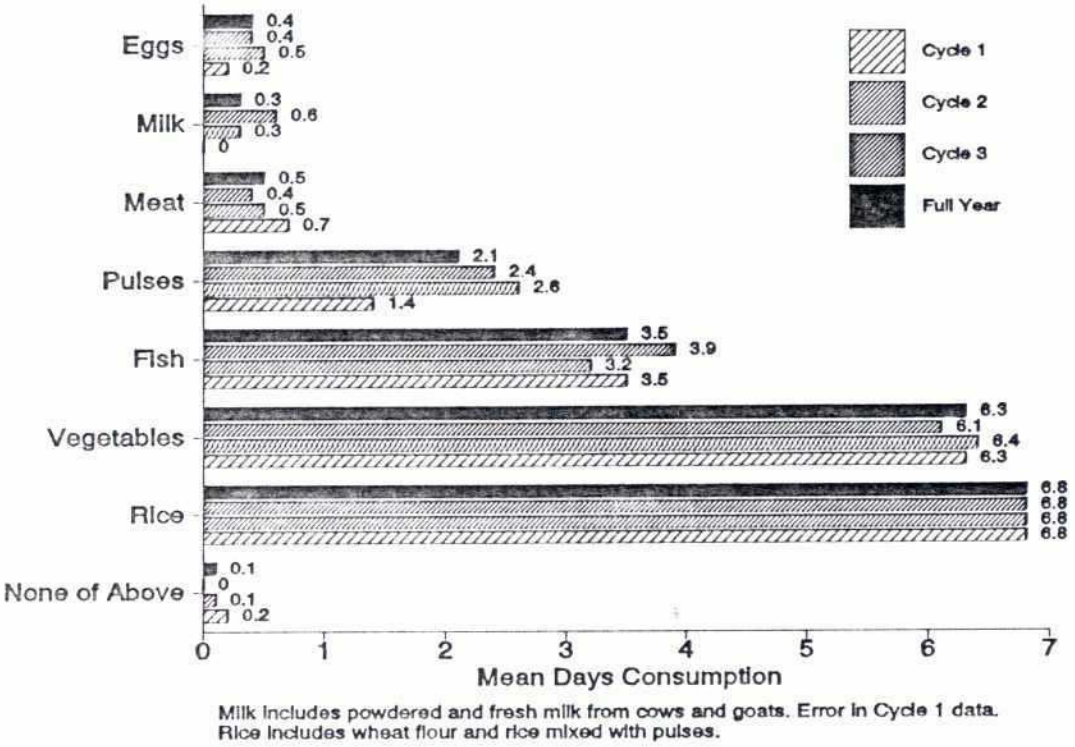


Figure 2: Comparison of Food Item Consumption

Data on dried fish consumption were gathered during study Cycles 2 and 3. Significant quantities were consumed in Surma-Kushiyara and Meghna-Dhonagoda. On average, 1.25 kg of dried fish were 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 it occurred during the third cycle.

3.2.2 Other Foods

The importance of fish in the diet compared to other food items is illustrated in Figure 2. On average, households consumed fish 3.5 days per week, compared to 2.1 for pulses, and 0.5 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 Cycle 1 to 2.6 in Cycle 2, and remained near that level during the third cycle.

The seasonality of household nutrition is reflected

Table 5
Weekly Food Consumption for Vulnerable Groups

	Cycle 1		Cycle 2		Cycle 3		Full Year	
Food Item	%	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.

in the figures. During flood recession, only 1.2 percent of households reported that they did not consume 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.

Nearly all of the households consumed rice every day of the week, while the percentage consuming only rice averaged five percent for the year and dropped as low as one percent during Cycle 3.

Considering the frequent consumption of vegetables, fish, and pulses, there is diversity in the diet, although it is not luxurious. There seems no justification, therefore, to increase the monotony of the diet further by subsidizing rice production at the expense of other foods.

3.2.3 Vulnerable People

A well-balanced diet is especially critical for nursing mothers, pregnant women, and young children. Consumption patterns of these vulnerable people were separately studied in the Household Survey and the results are shown in Table 5.

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 consumed 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.

The survey found fish to be the most important source of protein for nursing mothers, pregnant women, and children over two. Pulses were next in importance. Fish was second in importance only to mother's milk as a protein source for children under two years old.

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.

Per capita consumption for landless and marginal farmers is compared with the same data for small and medium farmers in Table 6. Surprisingly, there is no difference in consumption levels between the two groups in the Meghna-Dhonagoda area. This result may reflect the relative abundance of fish in the area.

In the other three areas, consumption by small and

Table 6
Daily Per Capita Fish Consumption by Land Ownership (grams)

Area	Cycle 1	Cycle 2	Cycle 3	Mean
Landless and Marginal				
Tangail CPP	8	5	17	11
Surma-Kushiyara	21	15	11	15
Singra	19	7	23	17
Meghna-Dhonagoda	33	24	48	34
Small and Medium				
Tangail CPP	14	8	21	14
Surma-Kushiyara	28	29	27	28
Singra	29	17	42	30
Meghna-Dhonagoda	29	27	50	35

Source: Household Survey

Table 7
Household Fish Consumption by FEZ (kg)

Area	FEZ 1	FEZ 2	FEZ 3	Avg.
	Full Year			
Tangail	22	26	18	23
Surma-Kushiyara	43	42	36	41
Singra	59	28	31	42
	Cycle 1			
Tangail	8	8	5	7
Surma-Kushiyara	17	17	11	16
Singra	23	10	12	16
	Cycle 2			
Tangail	3	5	2	4
Surma-Kushiyara	13	14	19	14
Singra	11	2	6	7
	Cycle 3			
Tangail	11	13	11	12
Surma-Kushiyara	13	11	6	11
Singra	25	16	13	19

Source: Household Survey

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 during the period of lowest availability of capture fish, small and medium farmers have sufficient income to maintain higher consumption levels by purchasing fish from the market, whereas the poorer households simply do without.

The survey found that landless and marginal farmers (82 percent of the households) consumed an average of 47.8 kg of fish, of which 5.5 kg (12 percent) were carp and 42.3 kg (88 percent) were capture fish. The small and medium farm households consumed 69.1 kg of fish per household, of which 12.5 kg (18 percent) were carp and 56.6 kg (82 percent) were capture fish. Thus, both groups depend preponderantly 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 are provided by the capture fishery.[2]

In terms of Fisheries Ecological Zones (FEZ), there doesn't seem to be a consistent pattern in all areas for all cycles. In Tangail, consumption was highest in the riverside (FEZ 2) areas and about the same in the beel (FEZ 1) and upland (FEZ 3) areas, as shown in Table 7. In Surma-Kushiyara consumption was about the same in the beel and riverside areas. The upland areas

Table 8
Meghna-Dhonagoda Fish Consumption
(kg/household)

Area	Cycle 1	Cycle 2	Cycle 3	Full Year
Inside Project	14	15	27	56
Outside Project	32	22	43	97
Average	22	18	34	74

Source: Household Survey

Table 9
Household Species Consumption

Area	No. of Species	Consumption per Household: Amount (kg)	Consumption per Household: No. of Days/wk	Consumption per Household: No. of Meals/wk
Tangail	56	173	2.2	3.1
Surma-Kushiyara	56	297	3.3	5.8
Singra	73	305	3.2	5.4
Meghna-Dhonagoda	64	561	4.4	9.4

Source: Household Survey

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 beel area and lowest in the riverside area. Overall, the classification of households by FEZ proved not to be very informative.

Households surveyed in the Meghna-Dhonagoda area were stratified according to location inside and outside the project. The results of this stratification are shown in Table 8. Fish consumption was much lower inside the project area than outside during all three cycles.

Table 9 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 56 in Tangail to 73 in Singra.[3]

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. Table 10 shows the 10 species consumed in greatest quantity for each cycle and the entire year. Of the listed species, 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, which started in Cycle 2 and ended in Cycle 3. Capture fish also ranked high on the basis of number of days it was eaten, number of meals it was eaten, and the number of households eating them (Annex 5). This is probably because rural people can either catch these fish

Table 10
Species Ranking by Quantity Consumed

Cycle 1	Cycle 2	Cycle 3	Year
Pooti	Ilish	Pooti	Pooti
Shrimp	Pooti	Ilish	Ilish
Taki	Silver-carp	Taki	Taki
Shing	Shrimp	Shrimp	Shrimp
Koi	Taki	Chanda	Shing
Telapia	Ruhi	Koi	Koi
Tengra	Shing	Ruhi	Ruhi
Silver carp	Tengra	Boal	Silver carp
Shoil	Telapia	Kholisha	Tengra
Foli	Kachki	Goochi baim	Telapia

Table 11
Number of Species by Source of Catch

Source	Small Fish	Cat-fish	Snake Head	Eels & Others	Carp	Hilsa	Shrimp	Total
River	20	9	3	4	5	1	4	46
Canal	18	11	2	4	2	2	3	40
Beel	18	11	2	4	5	0	3	43
Floodplain	18	8	2	4	7	0	3	42
Pond	14	8	3	5	8	0	4	44
Ditch/pit	17	8	3	3	3	0	4	38

Source: Household Survey

or purchase them in the small quantities they need and can afford from the market.

3.2.4 Source of Catch

The importance of species diversity is also evident in Table 11, which details catch according to source. The most species were caught from ponds, followed by rivers and beels. Although the pond catch includes the most carp species, they also have 12 species of small fish, four species each of catfish and shrimp, three species of snake head, and five species of eels and other fish. This shows that ponds are not used primarily for fish culture. Rather, they also depend on annual inundation for replenishment in order to provide the diversity of species for household consumption.

Table 12 summarizes the source of catch for major species groups in percentages based on weight (see also Annex 6). Except for hilsa, which are caught only in rivers and canals, every species group is

Table 12
Source of Catch by Species Group (percent)

Species Group	River	Canal*	Beel	Floodplain†	Borrow Pit	Pond
Small fish	7	12	13	31	11	26
Shrimp	23	9	31	23	5	9
Catfish	7	5	33	11	6	39
Snake head	4	17	19	25	10	24
Eels & Other	19	18	32	8	5	17
Carp	2	3	13	5	2	75
Hilsa	95	5	0	0	0	0
Total	10	11	22	21	8	29

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

Table 13
Source of Catch by Area (percent)

Area	River	Canal*	Beel	Floodplain†	Borrow Pit	Pond
Tangail	3	15	33	6	22	10
Surma-Kushiyara	4	13	9	40	10	23
Singra	7	3	43	9	5	34
Meghna-Dhonagoda	18	18	<1	27	9	27
Total	10	11	22	21	8	29

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

caught from 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. Carp are caught from all sources but mostly from ponds (75 percent). Most catfish are caught in beels and ponds. Snake head are pretty evenly distributed over all sources, but rivers are of least importance.

The source of total fish catch in each of the four areas is summarized in Table 13. In the Tangail area, most of the household catch is from the beels (34 percent) and the group consisting of canals, drains, and borrow pits (38 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, 22 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.

Table 14
Fish Caught, Sold, and Bought (tons)

Area	Caught	Sold	Caught & Consumed	Bought	Total Consumed
Tangail	157	27	131	355	486
Surma-Kushiyara	837	323	515	469	984
Singra	1,973	1,576	397	559	956
Meghna-Dhonagoda	1,302	386	917	2,736	3,653
Total	4,270	2,311	1,959	4,119	6,078

Source: Household Survey

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

Assuming all carp were raised as 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 is, of course, much greater than the amount caught for human consumption because small fish are the food supply of catfish.

Table 15
Annual Household Income from Subsistence Fishing

Category	Caught (t)	Sold (t)	Value per Household (Tk.) Consumed	Sold	Total
Landless	2,171	1,113	482	484	966
Marginal	1,278	642	866	835	1,700
Small	534	345	591	1,033	1,624
Medium	505	210	919	624	1,543
Total	4,487	2,310	610	618	1,228

Source: Household Survey

3.2.5 Caught and Bought

A large amount of the fish catch is sold instead of consumed directly as indicated in Table 14. In Singra, 80 percent of the catch is sold, and in Surma-Kushiyara 39 percent is sold. Thus, in addition to its importance in family nutrition, fishing is a major source of household income in these areas (Table 15). The average value of fish consumed by households was Tk. 610, and the average value sold was Tk. 618. Landless households averaged an income of 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).

The social group that seems to benefit most by participation in subsistence fishery is the marginal farmers. On average for the four areas, the value

Table 16
Fish Caught, Sold, and Bought by Social Group

	Caught (kg)	Sold (kg)	Caught & Consumed (kg)	Bought (kg)	Total Consumed (kg)
Landless	23	12	11	28	39
Marginal farmer	40	20	20	38	58
Small farmer	38	25	13	31	45
Medium farmer	36	15	21	53	74
Total	29	15	14	32	46

Source: Household Survey

Table 17
Fish Caught and Bought for Household Consumption (percent)

Species Group	Caught	Bought
Small fish	33	67
Catfish	26	74
Snake head	62	38
Carp	20	80
Shrimp	34	66
Total	32	68

Source: Household Survey

of subsistence fishery to this group was Tk. 1,700 per household. There is considerable variation between the survey areas: In Surma-Kushiyara the value per household for marginal farmers was Tk. 1,838, and in the Singra area the highest value per household was Tk. 3,597 for small farmers (Annex 8).

The quantity of fish caught and bought for consumption by socioeconomic category is shown in Table 16. 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 would be 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 a greater quantity than the small farm households.

Except for carp and snake head, about two-thirds of the fish consumed are purchased, and one-third are caught (Table 17). The relationship is reversed for snake head: 62 percent of the amount consumed is caught directly. 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 Annex 7.

3.2.6 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 on the day the classes were surveyed during Cycle 1, almost equally divided between boys and girls. The major occupations of the children's guardians were: landowner, six percent; owner/cultivator or sharecropper, 40 percent; laborer, 15 percent; service/business, 24 percent; fishing, three percent; and rickshaw puller, three 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.

3.3 Employment

Employment during the three cycles is compared

Table 18
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
No. Not Working	561,348	3.58	537,250	3.42	566,521	3.61
No. Working	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.

in Table 18 (details are in Annex 9). The number of people engaged in work during the seven day period their household was 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 persons over the age of four in Cycle 1 was 5.03, and the number not engaged in income-generating activities as defined by the survey was 3.58.[4]

Data on the distribution of work cannot be fairly compared between Cycle 1 and the other two cycles because of improvement in the survey questionnaire following review of the Cycle 1 results.[5] Of the 228,022 people engaged in some 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 other income-generating activities.

Income-generating activities increased somewhat during the second cycle. Of the people reporting work for one or more days during the week, 52 percent reported work in agriculture, 26 percent in fisheries, and 43 percent in other work. Eleven

percent of those working reported multiple income-generating activities during at least one day of the week.

The number of people engaged solely in fishing increased from Cycle 2 to Cycle 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 activity increases during the third cycle because that is when fish are most abundant. 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.

The importance of fishing as a household activity is shown in Table 19. Overall, during Cycle 1, one or more members of 24 percent of the survey households were involved in fishing at least once during the week. The participation rate increased to 33 percent during Cycle 2, then fell to 29 percent during Cycle 3. For comparison, the percent of households involved in agriculture during the same periods was 49, 52, and 40 percent, respectively.

Table 19
Household Involvement in Fishing and Agriculture (percent)

Area	Fishing	Farming	Neither
Cycle 1			
Tangail	18	51	32
Surma-Kushiyara	23	43	33
Singra	32	55	13
Meghna-Dhonagoda	23	48	29
Total	24	49	27
Cycle 2			
Tangail	10	49	42
Surma-Kushiyara	45	53	2
Singra	27	54	19
Meghna-Dhonagoda	39	52	9
Total	33	52	15
Cycle 3			
Tangail	3	35	62
Surma-Kushiyara	35	48	17
Singra	35	49	16
Meghna-Dhonagoda	34	35	32
Total	29	40	30

Source: Household Survey

As mentioned earlier, fishing was expected to be highest during the flood recession, Cycle 3. This is the pattern reported in Singra, where the households involved in fishing increased from 27 percent during Cycle 2 to 35 percent in Cycle 3. However, fishing activity decreased during Cycle 3 in all other areas. This is probably a consequence of the low level of river flows in 1992, but another survey in a year of more normal flow would be necessary to see whether this is true.

Although agricultural participation rates are fairly

Table 20
Days of Agriculture and Fishing Work Per Week

Area	Agriculture		Fishing		Other		Total
	Mean	%	Mean	%	Mean	%	Mean
Tangail	2.6	33	0.1	1	5.2	67	7.8
Surma-Kushiyara	3.9	41	1.2	13	4.9	52	9.5
Singra	4.3	49	1.2	14	3.4	39	8.8
Meghna-Dhonagoda	3.6	44	1.5	18	3.1	38	8.2
Average	3.6	43	1.2	14	3.9	46	8.4

Source: Household Survey

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 20. The total days worked is less than the sum of the days reported for agriculture, fishing, and other work because some people engage in more than one activity in a day. For example, in Surma-Kushiyara, the sum of the days worked per household reported by activity is 10, while the total days any activity was reported is 9.5. Therefore, more than one activity was reported for 0.5 days per week for the average household.

Of the four study areas, Meghna-Dhonagoda had the highest percent of people engaged in fishing, and Tangail had the lowest. For all four areas, out of 8.4 days in which work was reported, 14.3 percent of the working

Table 21
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

*Reported fishing or agriculture one or more days per week.
†No. of households equals 157,006.
Source: Household Survey

days went to fishing and 42.9 percent went to agriculture.

Employment in fisheries and agriculture by age and sex is reported in Table 21. The average number of people engaged in fishing per household for all areas is .40 compared to .73 in agriculture. Young children are much more involved in fishing than in agriculture. Of 11,805 children aged five to 10, an average of .08 per household participated in fishing, compared to an average of only 3,057, or an average of .03 in agriculture. In the 11 to 17 age group, about the same number engage in the two activities, while those over age 17 tend to work more in agriculture.

Fisheries also provide greater employment than agriculture to female children. The number of female children aged 5 to 17 employed in fishing was 6,958 compared to 3,086 in agriculture. Overall, 15 percent of females are involved in fishing, and 40 percent of those are 5-10 years old.

3.4 Value of Fisheries

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.

3.4.1 Market Prices

The monthly average prices from December 1991 through December 1992 reported by markets in the four survey areas for groups of species are listed in Table 22. Small fish, which account for 43 percent of consumption, 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. The average price starts at Tk. 18.4/kg in December 1991, and peaks at Tk. 55.3/kg in April. Catfish are the highest priced fish of those listed,

Table 22
Monthly Average Prices of Species Groups
(Tk./kg, 1991-92 prices)*

Month	Small fish	Shrimp	Cat-fish	Snake head	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.

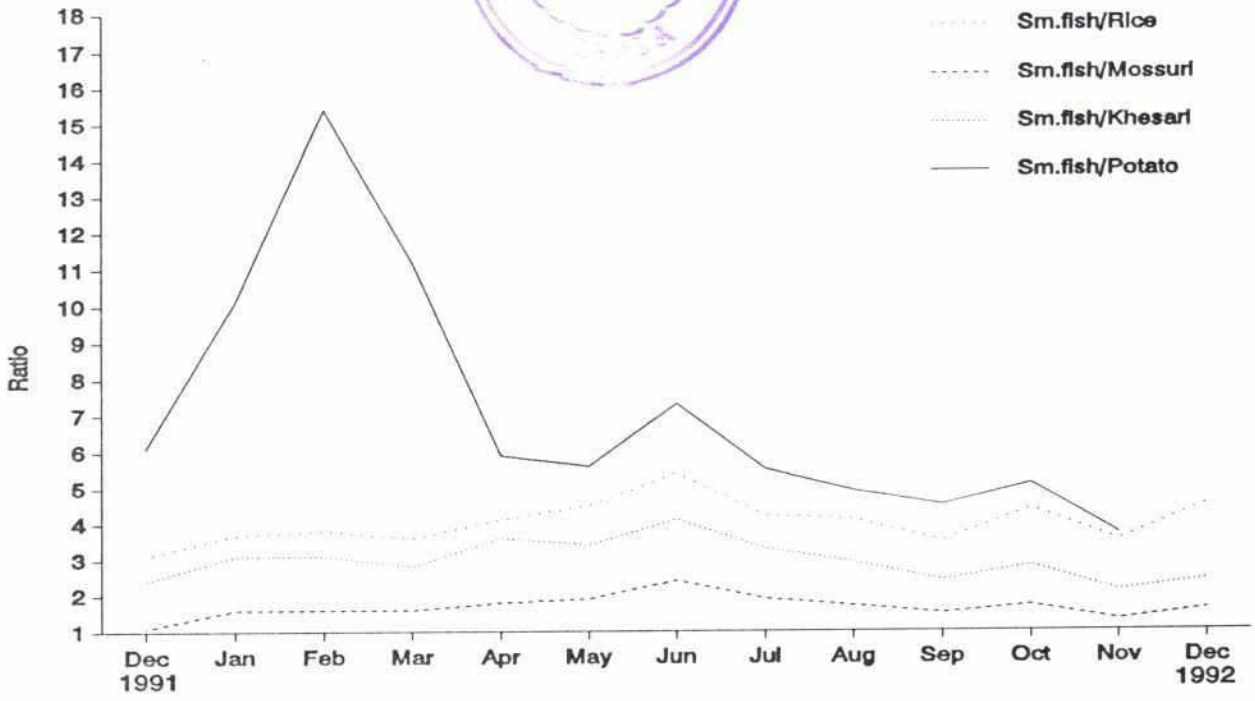


Figure 3: Small Fish/Commodity Price Ratio

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 were in November.

The effect of scarcity on prices during the flood recession of 1992 is apparent in the comparison of 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 snake head 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 3. 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/potato price ratio is highest in January, February, and March because potatoes

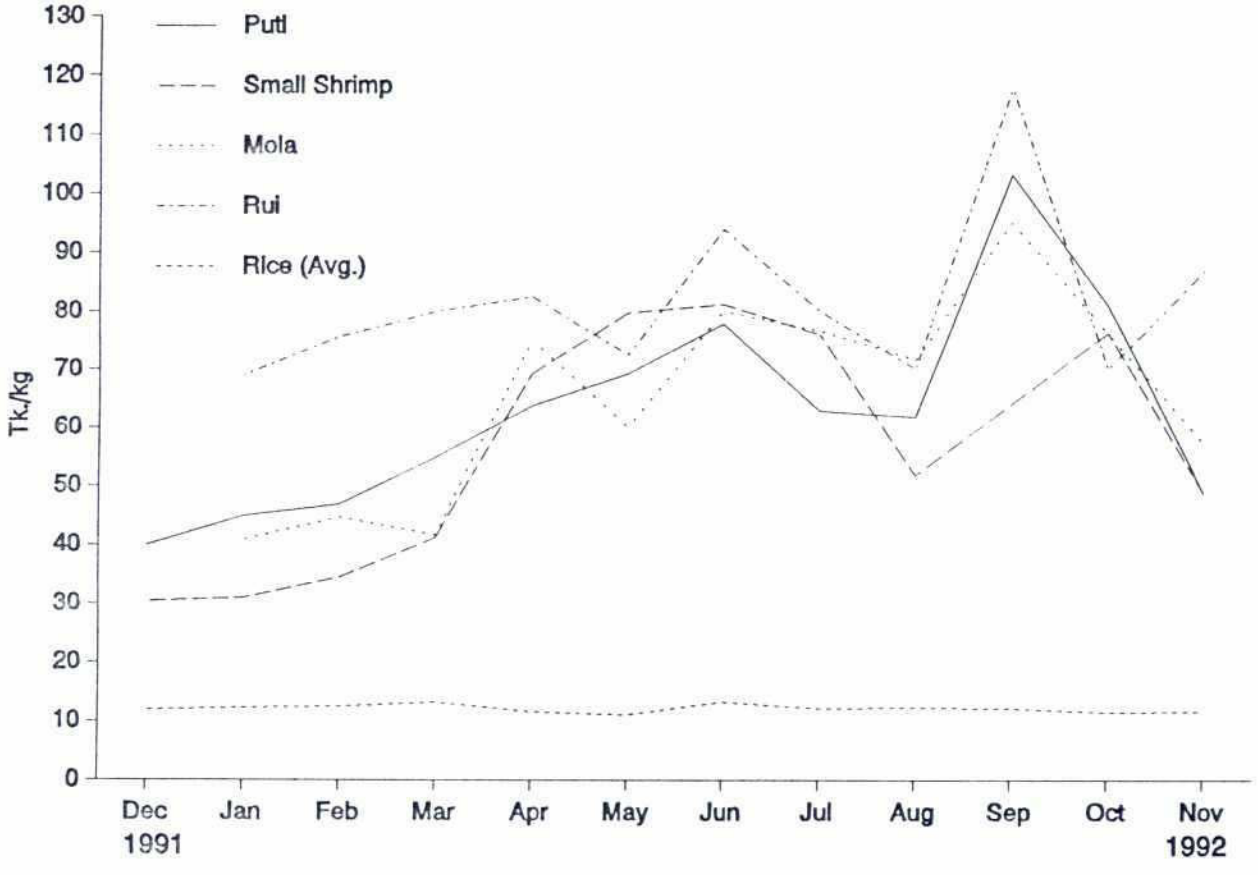


Figure 4: Price of Fish in Tangail CPP Area

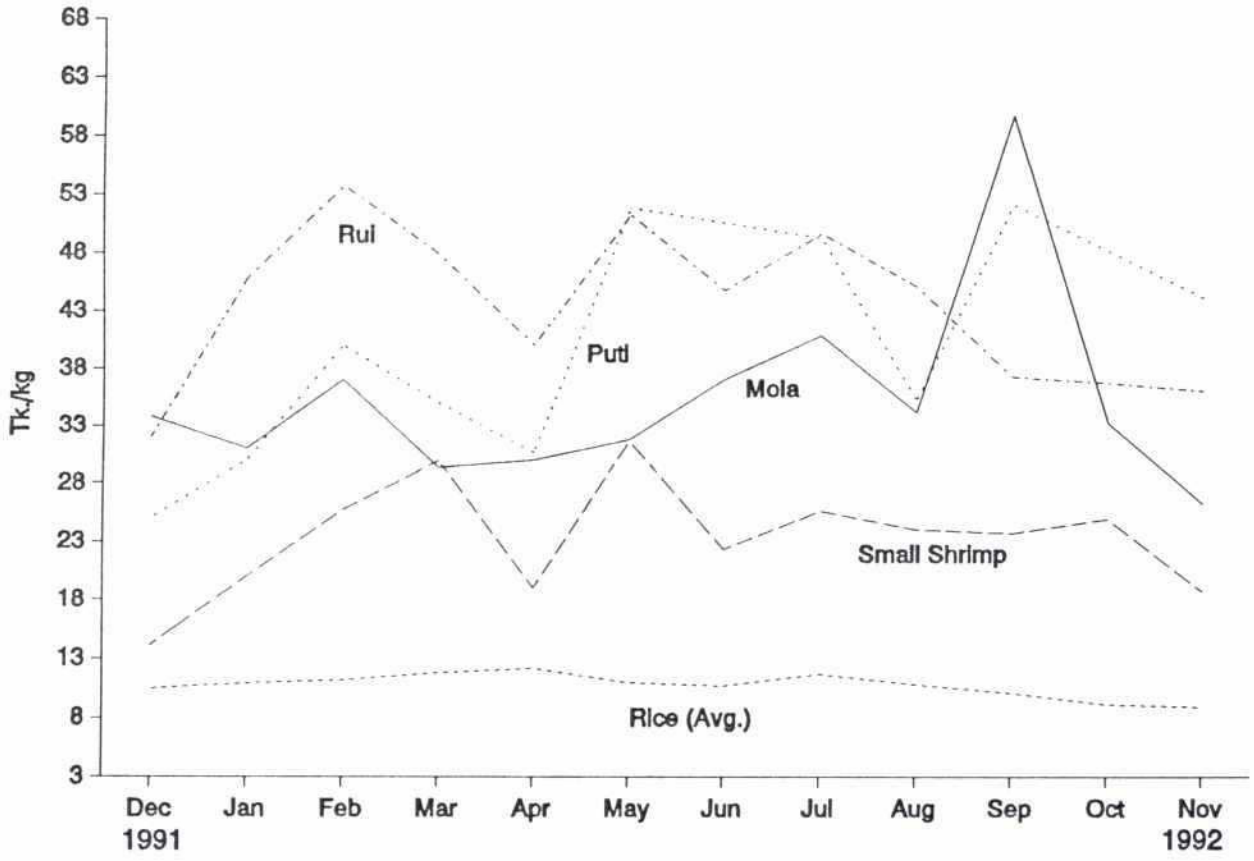


Figure 5: Price of Fish in Chalan Beel Area

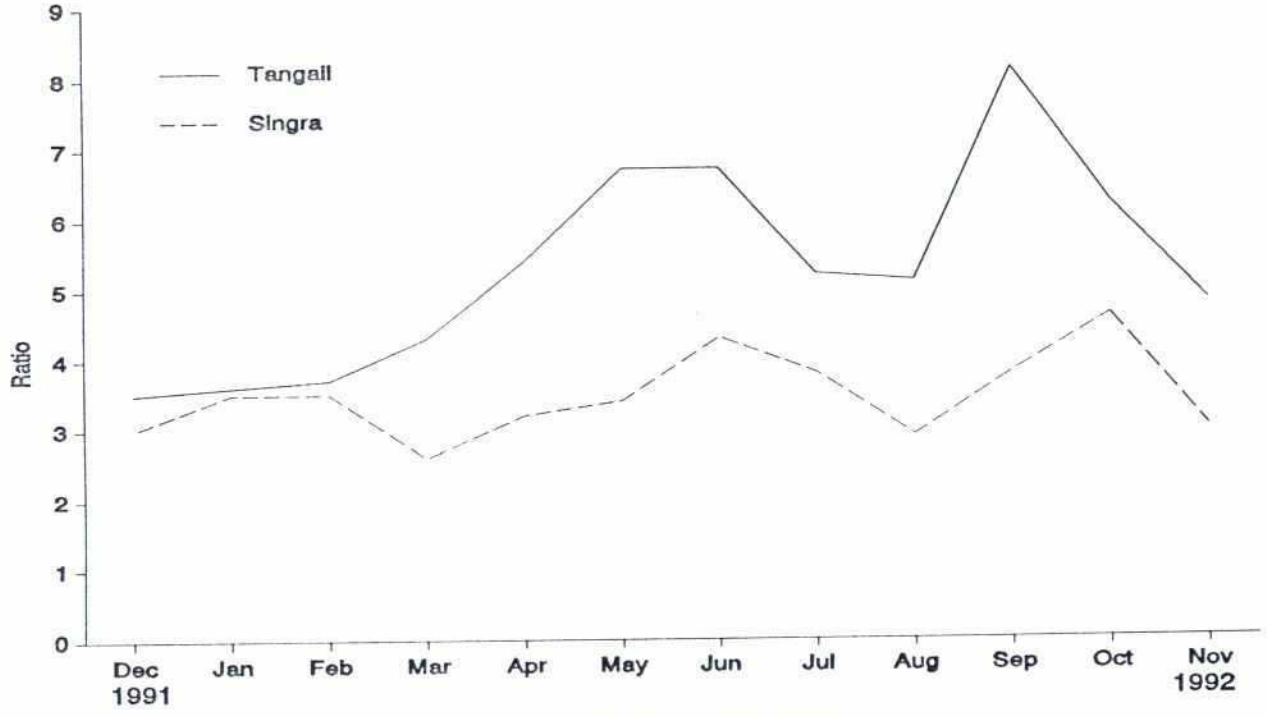


Figure 6: Small Fish to Rice Ratio

are abundant at that time. Potatoes are about twice as expensive the rest of the year, when they are marketed out of cold storage.

3.4.2 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 and Figure 5. 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 differences in prices between the two areas probably reflects:

- Local abundance of supply in Chalan Beel, and perishability, distance, and cost of transport to Dhaka.
- Low production in Tangail, and proximity to the Dhaka market. The urban demand influences local prices.

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 1.6 taka lower in Singra than in Tangail.

Table 23
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
Snake Head	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.

The combination of the above factors results in much different fish/rice price ratios for the two survey areas as shown in Figure 6. The price ratio of small fish to average quality rice is about the same (3:3.7) in the first three months, December, January, and February. The ratios begin to diverge sharply in March. By May, the ratio is 6.7 in Tangail compared to 3.4 in Singra, while the average ratio for the year is 5.0 for Tangail and 3.6 for Singra.

Monthly prices by species group, and for other commodities for the four study areas are in Annex 10, and price to commodity ratios are contained in Annex 11.

The average annual prices for the four areas covered in this study are summarized by major species groups in Table 23.[6] These market prices are converted to economic prices in Table 24 using the scarcity premium of 1.25, and the standard conversion factor of .87. Of course, the scarcity premium has no empirical basis, but it does represent acknowledgement of the argument that real prices of fish are likely to be higher in the future.

3.4.3 Replacement Value

Resources are often valued on the basis of what it would cost to replace them. A rough estimate of

Table 24
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
Snake Head	71.3	49.3	44.1	44.7	49.4
Carp	84.3	67.0	41.4	58.9	57.7

*Prices from Table 21 multiplied by scarcity premium of 1.25 and standard conversion factor of 0.87.

Table 25
Estimated Cost of Fish Stocking, 2,000 Ha (Tk., 1991/92 prices)

Item	Rate	Price	Cost
Fingerlings	25 kg/ha	110 Tk./kg	5,500,000
Facilities*			35,000
Staff (2 months)	4 months	12,000 Tk./mo.	
senior (2)	4 months	10,000 Tk./mo.	48,000
mid-level (2)	4 months	5,000 Tk./mo.	40,000
junior (2)			20,000
Administration and Overhead (20%)			21,600
Total Cost			5,643,000
Expected Yield†	450 tons		
Cost/kg			12.54

Source: Personal interview with Keith Thompson, Third Fisheries Project, December 15, 1992.
*Facilities cost Tk. 50,000 in the first year, Tk. 20,000 in the second, averaging Tk. 35,000 per year.
†Estimated yield to fingerling ratio 9:1.

Table 26
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.

the cost of increasing fish production through a stocking program that is being developed under the Third Fisheries Project is shown in Table 25. The estimated cost per kilogram of fish production under this program is Tk. 12.5, assuming a yield to input ratio of 9:1 (Thompson 1992). This is a preliminary estimate, just to illustrate the approximate magnitude of cost for the project. If output is only half of what is expected, the cost will still be about half of the economic price of carp.

Stocking programs increase production of the stocked species at the expense of other species. For example, the size of stocked fingerlings are too large to serve as a food source for many predator fish who 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 an economically promising method of boosting fish 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 for local household consumption.

Another possibility for estimating the replacement value of capture fish is to use the cost of culture fishery. An estimated cost of raising cultivated fish using semi-intensive technology is Tk. 22/kg as shown in Table 26. Although culture fishing is profitable, the social effects of the displacement of capture fishery production from natural ponds should be considered when calculating the estimated cost.

As in the case of the stocking program, the poor do not receive any benefit of fish culture, partly because they do not have ponds or land on which to dig tanks for culture fish. Moreover, when a pond is converted to culture fishery, traditional natural fish production is lost as is public access to the pond.

3.4.4 Nutritional Value

Fish also can be valued in terms of what it would cost to replace the nutrients they provide in the diet by other sources. The results of a collaborative analysis of the nutritional value of fish and possible substitutes were not available for this draft report, but they should be for the final report. Nevertheless, assuming fish, beef, and chicken are roughly equivalent in their nutritive value, the cost of beef was about Tk. 48/kg and poultry about Tk. 65/kg in 1991 (Khalil 1991). Applying the standard conversion factor, the equivalent economic prices are Tk. 42 for beef and Tk. 57 for chicken. Except for Singra, the beef value is less than the economic price for small fish, and the poultry value is less than the economic prices for carp and catfish listed in Table 22.

In terms of distribution, a viable scheme has not been suggested that would compensate those who lose the nutritional value of capture fishery with beef or chicken. ■

NOTES

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

2. Consumption by category for the four areas is presented in Annex 3.

3. The species-by-species detail of the catch by source is in Annex 4.

4. Household work was not on the list of income-generating activities, therefore, most women fell into the not working category.

5. 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.

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

Chapter 4

FISH MIGRATION

Bangladesh has one of the world's richest and most diverse aquatic environments. More than 260 species of fin fish have been identified, along with 20 species of prawns (Rahman 1989). The inland freshwater water fish community of Bangladesh is dependent on and strongly influenced by the seasonal variations of hydrologic cycle in the rivers and floodplain systems.

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 a specific habitat, and the fish migrate accordingly. 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 7).

4.1 Migration

4.1.1 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 channel, some newly inundated floodplain, and some stagnant pools. Spawning is

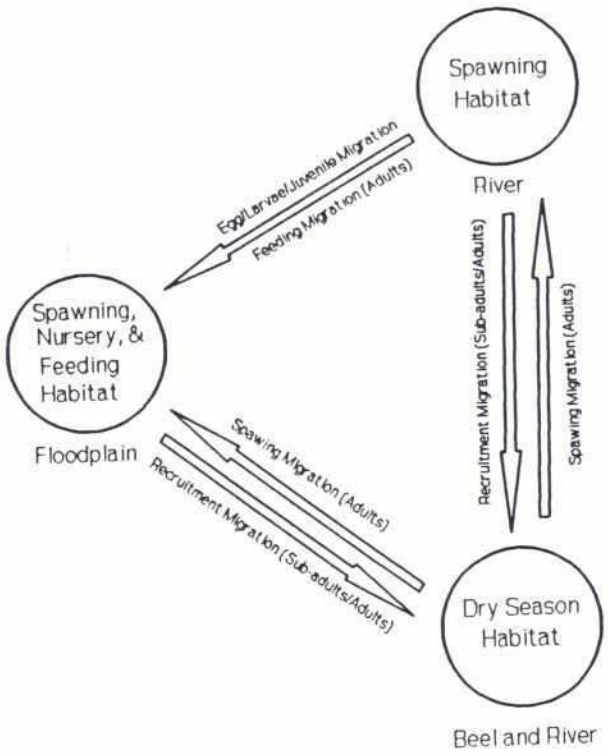


Figure 7: Migration Pattern of Floodplain Species

timed with temperature rises, rainfall, and 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 lower reaches of rivers to upstream areas of the Ganges and Brahmaputra where they spawn from May to August. Of all 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)*, tengra *(Mystus spp.)*, and rita *(Rita rita)*, migrate from river to floodplain for spawning in early monsoon. In the Surma-Kushiyara area (Map 6) 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 27).

Species that remain in beels throughout the dry season, such as koi, singh, magur, puti, gutum, guchi, and snake head, 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.

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.

The highest level of lateral spawning migration from river to floodplain occurs during the first few days of the influx of early monsoon waters. Annex 11 lists the fish species found migrating through canals *(khals)* in all four study areas.

Table 27
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
Ruhi	8	23	2.9

4.1.2 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 byproducts of dry season agricultural activities 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 *khals* onto the floodplains for early growth and feeding.

For this study, larvae migrating from river to

floodplain were monitored in the Tangail area (Map 7). Larvae were trapped in Sadullahpur and Gaizabari *khals* from July 1 through September 7, 1992, but monitoring was done only on days when the water flowed toward the project area. Annex 12 details the number of larvae trapped on each sampling date. Among the larvae trapped were major carp, eels, bailla, aair, boal, chanda, and chela.

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 *khals* connecting the project area to the Dhaleswari were blocked by dykes or closed regulators. Figure 8 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.

In addition to larvae, numerous fish eggs also were trapped in 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 *khals* to the floodplain along with the larvae.

During early monsoon, young aair also were found in the *khals*, 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.

4.1.3 Migration to Dry Season Habitat

After spending three to six months in the flood-

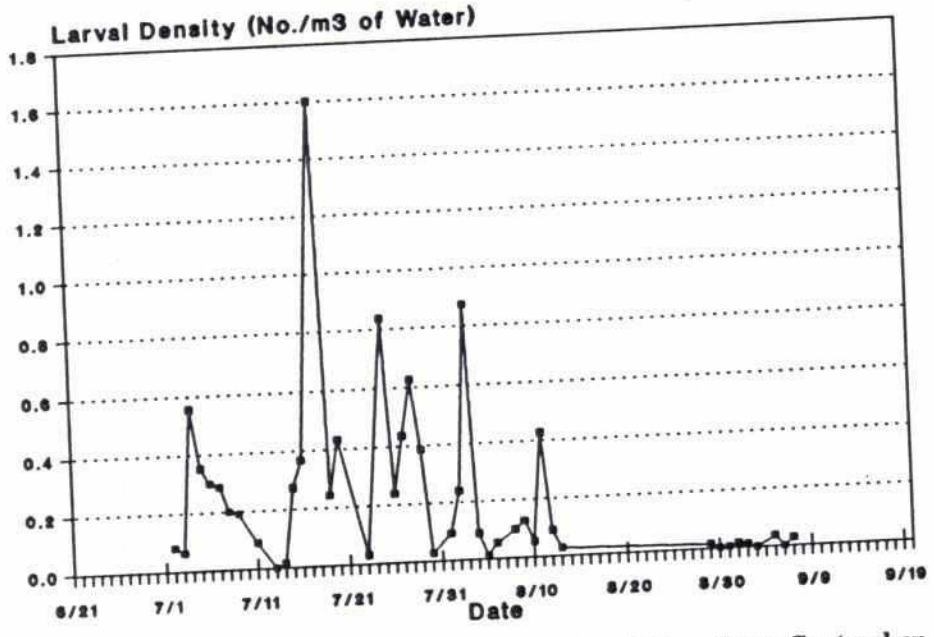


Figure 8: Density of Fish Larvae in Lohajong River (July-September 1992)

plain, all fish species (young, subadults, and adults) migrate back through the *khals* to the river along with the receding flood water. The only exception to this is that the adults of riverain fish (carp and some catfish) may start migrating back to the river earlier than other species. When the flood water 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.

4.1.4 The Role of *Khals* in Migration

Khals are crucial in providing access for fish migration during early and late monsoon. The study revealed that immigration begins with the initial influx of river water during the first few days/weeks of early monsoon. Emigration back coincides with the peak recession of water from floodplain to rivers during the last few days/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 river banks overspill. But because this overspill normally occurs during peak monsoon (mid-July to mid-August), which is after and before the major migration periods, overspill migration is an insignificant factor in the overall picture.

During the study year Bangladesh experrienced less flooding than usual, and none of the four study areas had any incidence of riverbank overspill. Fish were observed migrating only through *khals* and public cuts in embankments (particularly in Polder C in Singra; Map 8). This leads to the conclusion that *khals* and embankment breaches are the only reliable routes for the lateral migration of fish.

4.2 Migration Obstruction

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

4.2.1 FCD and FCD/I Projects

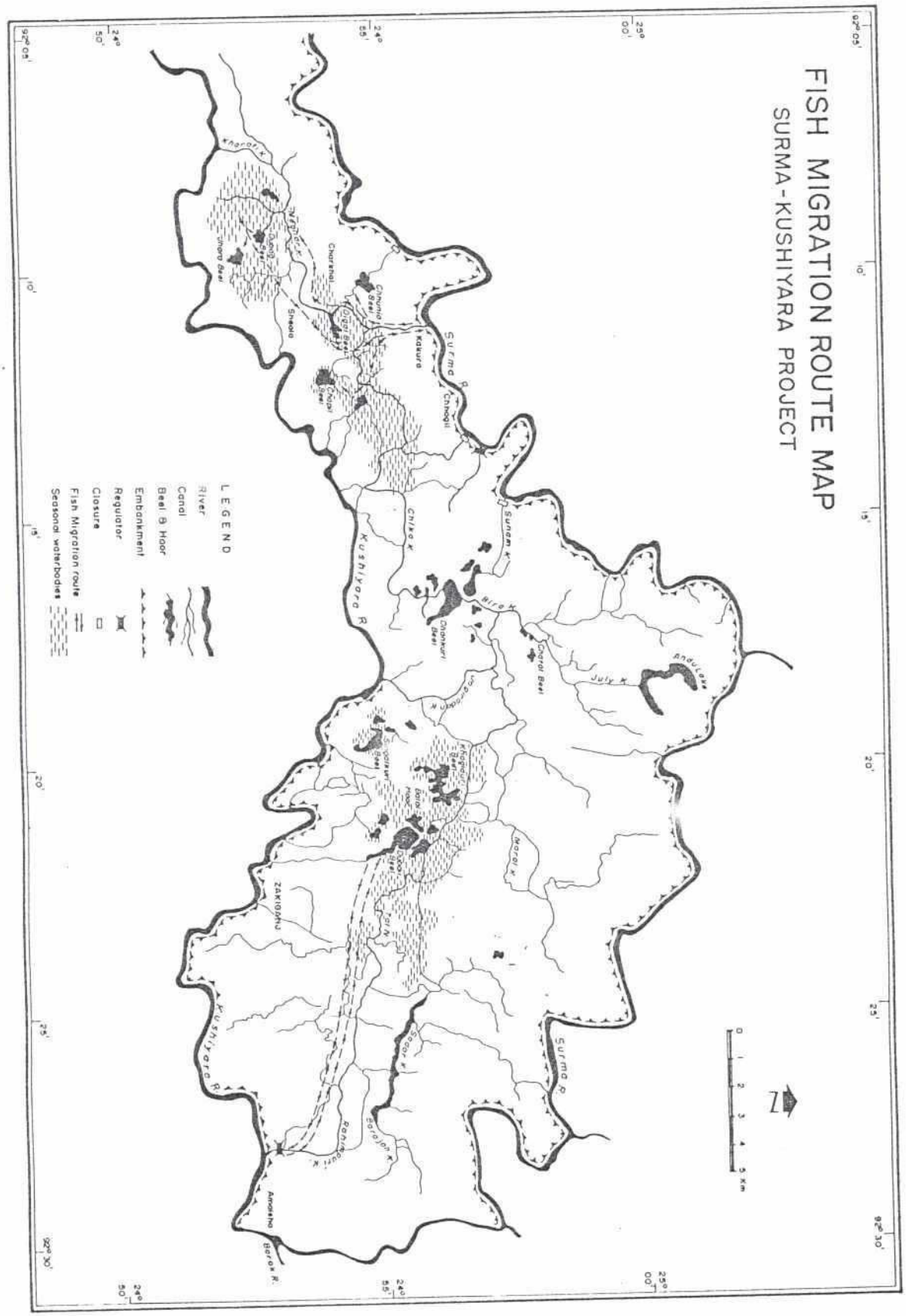
FCD and FCD/I projects are designed to protect an area from river flooding, improve drainage and irrigation, and increase cropping intensity. Typical projects have three major components:

- Embankment construction to control overbank spills.
- *Khal* closures to control entry of river flood water.
- Construction of *khal* regulators to control entry and drainage of flood water.

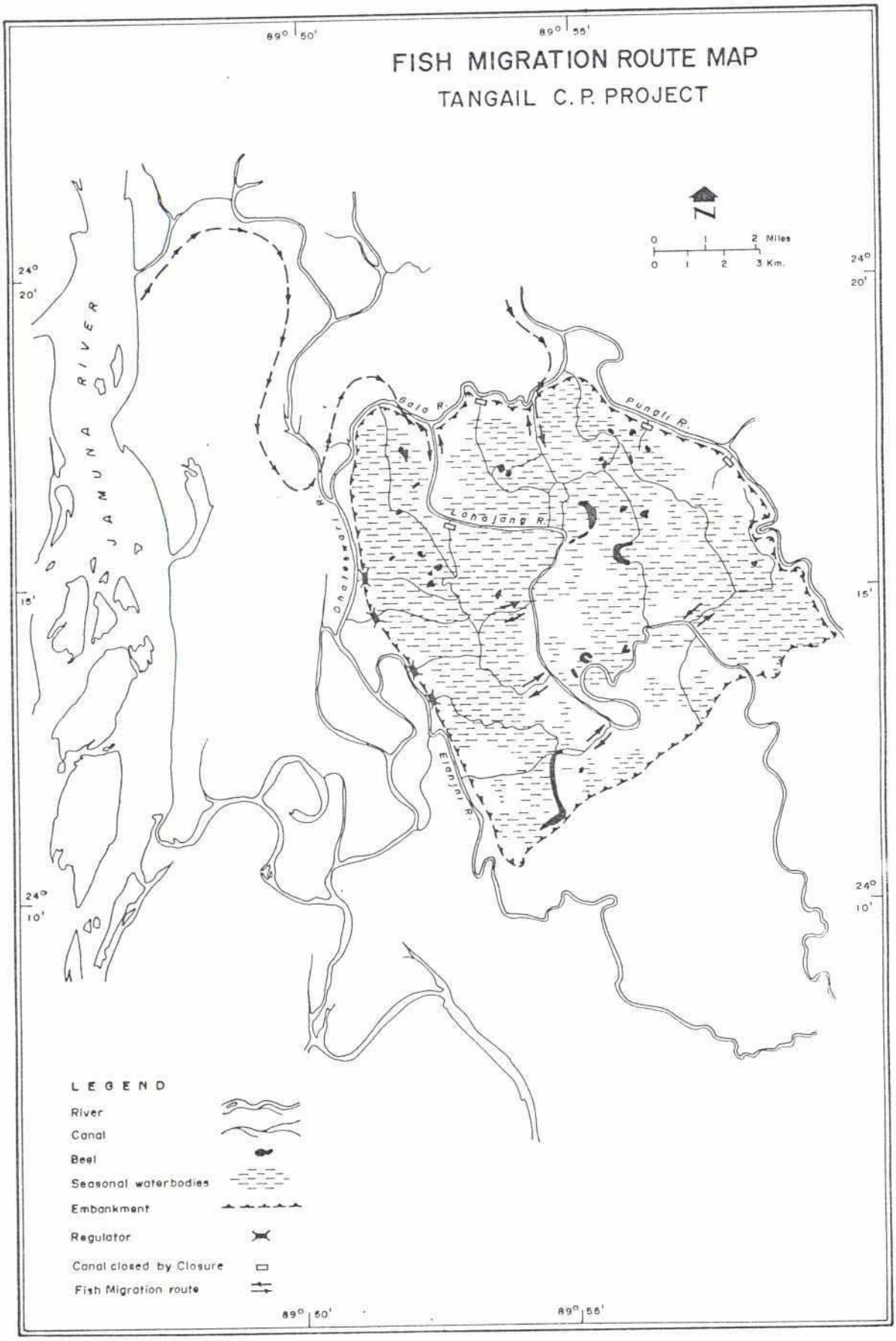
All of these components negatively effect fish migration.

In Tangail CPP area, Baruha, Kalibari, Barta, Suruj, and other areas *khals* have been closed by embankment projects along the Dhaleswari, Pungli, Lohajong, and Elanjani rivers. In addition, water flow in the Darjipara, Fatepur, Indro Belta, and Baro Belta *khals* 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.

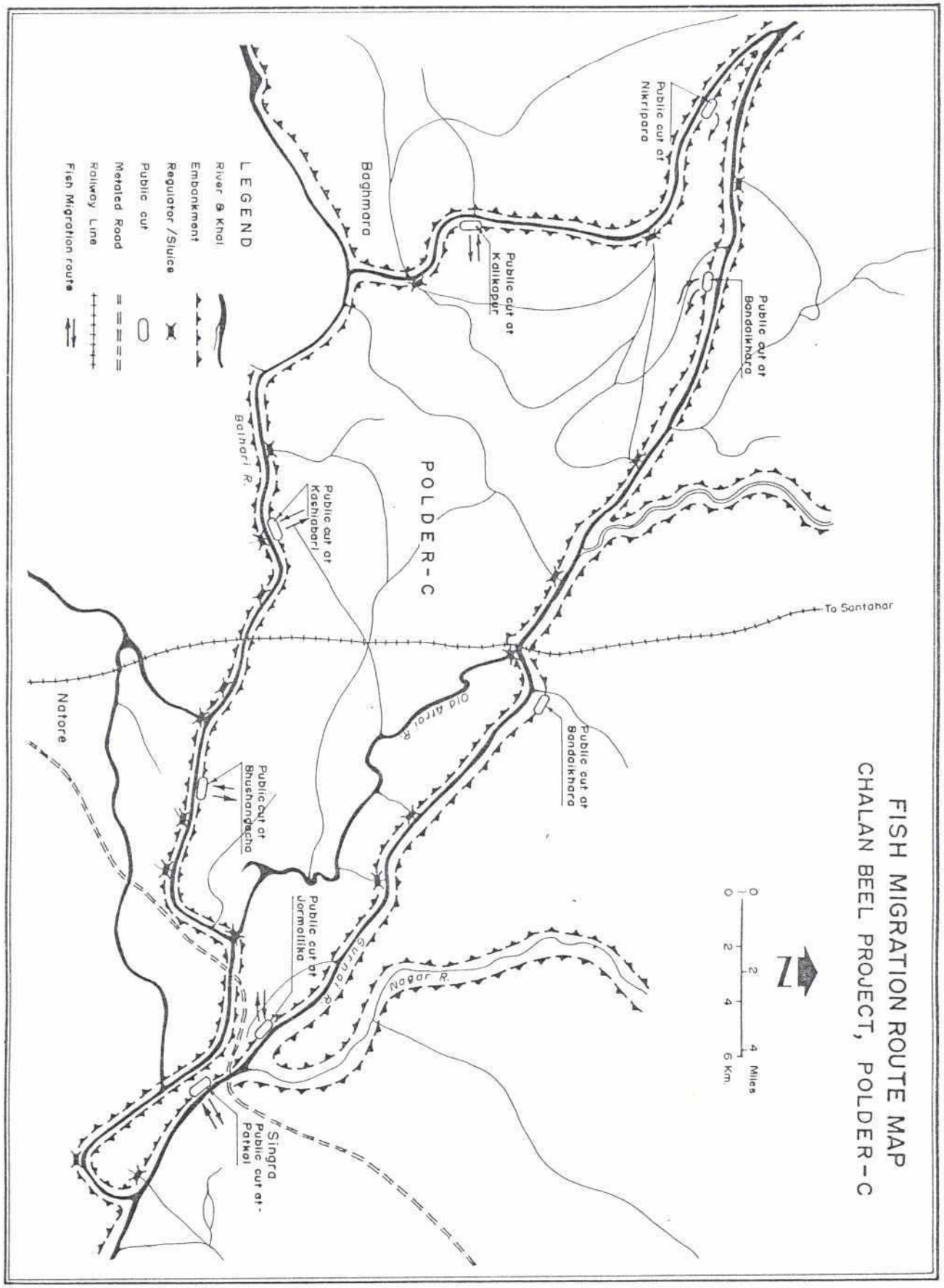
In Surma-Kushiyara area, the Babur and Chagli *khals*, along with many others, have been closed by the embankment along the right bank of the Surma River. Moreover, water flow is regulated in



Map 6: Fish Migration Route—Surma-Kushiyara Project



Map 7: Fish Migration Route—Tangail CPP Project



Map 8: Chalan Beel Project, Polder C

Chapter 5

SUBSISTENCE FISHING SURVEY

5.1 Introduction

The economic and nutritional benefits of fishing are not limited to professional fishermen and their families. As Chapter 3 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 the professional fishermen, the open water capture fisheries of the Bangladesh floodplain are a vital natural resource. The annual renewal of this resource 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, floodplain, and borrow pits, are particularly valuable common-property resources for the rural poor. To understand better the role of the capture fishery, this study was undertaken to examine rural household participation in subsistence fishing.

For this study, 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

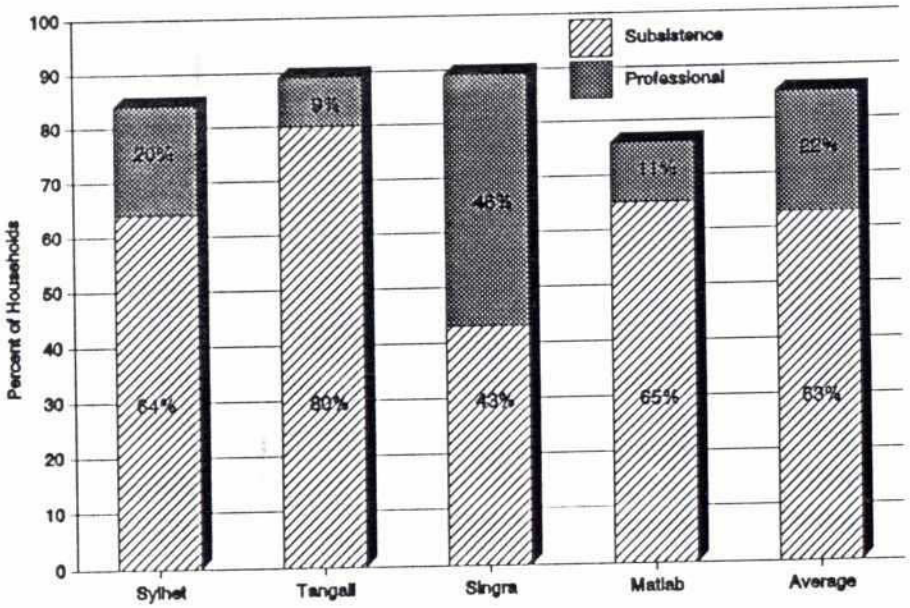


Figure 9: Subsistence and Professional Fishing Households

Table 28
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

months, in three cycles, starting December 15, 1991, and running through December 14, 1992.

5.2 Household Participation

The survey found that 85 percent of the households fished during the year (Figure 9). 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. 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, and it therefore offers considerable commercial 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 (Table 28). The highest level of individual participation was found 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 2 members of each household engaged in fishing. Although the Subsistence Fishing Survey did not determine the

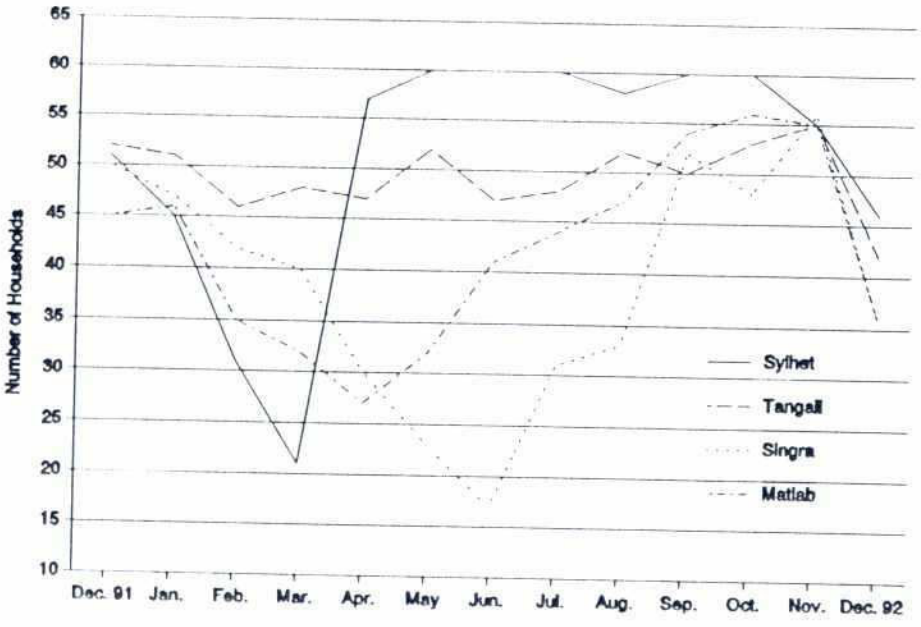


Figure 10: Seasonal Participation in Subsistence Fishing

percentage of women involved in fishing, according to the Household Survey, about 15 percent of women, including female children, fished (Chapter 3, Table 20). The Subsistence Fishing Survey found that 35 percent of those fishing were children.

5.3 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 likewise varies from season to season.

5.3.1 Fishing Intensity

Figure 10 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 3 or 4 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.

5.3.2 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 by flood inundation.

Table 29
Fishing Grounds

	Sylhet		Tangail		Singra		Matlab		Average	
Location	HH (%)	Days	HH (%)	Days	HH (%)	Days	HH (%)	Days	HH (%)	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

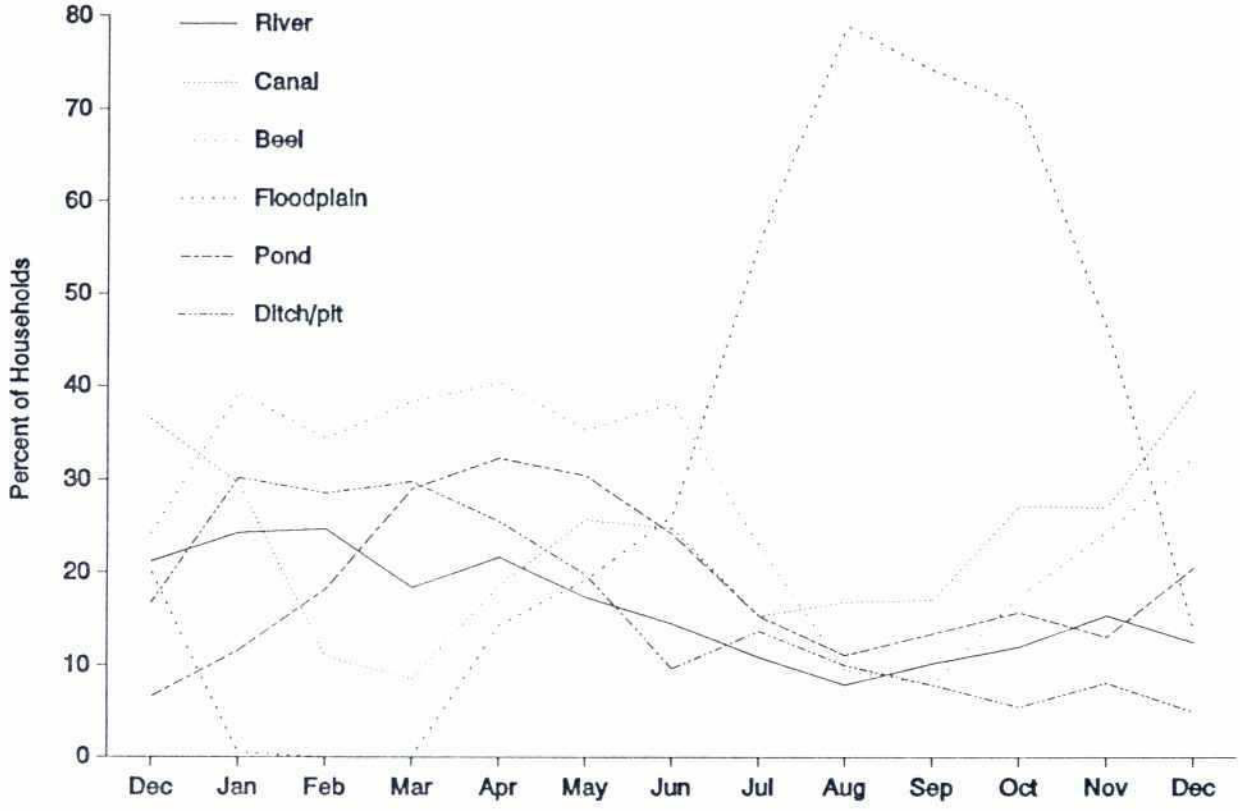


Figure 11: Seasonal Patterns in Fishing Location

Table 29 shows that most fishing was done in the floodplain and beels, but this is not consistent. In Matlab, for example, beel fishing was insubstantial, while in Tangail it was the principle source of catch. The reason there is so little river fishing in Tangail is that most of the Lohajong River remains dry for four to five months of the year. Moreover, the sample mouzas are closer to beels, *khals*, and floodplains than to rivers.

Figure 11 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.

5.4 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

Table 30
Quantity of Fish Caught by Subsistence Fishing

	Singra		Sylhet		Matlab		Tangail		Total	
Source	kg	%	kg	%	kg	%	kg	%	kg	%
Floodplain	368	45	221	33	168	36	64	16	821	35
Beel	80	10	71	11	2	1	217	55	370	16
Khal	83	10	168	25	71	15	30	8	351	15
Pond	62	8	89	13	157	34	19	5	328	14
River	147	18	63	10	43	9	3	1	256	11
Ditch/pit	84	10	54	8	22	5	61	15	220	9
Total	824		666		463		393		2347	

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 30 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 the area floodplains provided the most fish.

Table 31
Types of Fish Caught by Subsistence Fishing

	Singra		Sylhet		Matlab		Tangail		Average	
Species Group	kg	%	kg	%	kg	%	kg	%	kg	%
Small Fish	243	30	328	49	213	47	157	40	235	41
Catfish	230	28	135	20	65	14	65	17	124	20
Snake Head	115	14	82	12	52	11	56	14	76	13
Eels	74	9	38	6	46	10	49	13	52	9
Carp	81	10	49	7	37	8	16	4	46	7
Small Shrimp	82	10	30	5	5	1	50	13	42	7
Large Shrimp	0	0	4	1	38	9	0	0	11	2
Total	824		666		455		393		585	

Table 32
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

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 31 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.

5.5 Fishing Gear Used

Field observations found that about 30 types of fishing gear was used for subsistence fishing. They were grouped into 11 categories based on similarities in shape, size, and fishing technique (Table 32). Hand-picking of fish and the draining of water bodies, particularly ditches and borrow pits, were also observed in the study areas. Most common among the fishing gear used were the low-cost cast net, push net, and gill net. 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.

5.6 Fishing Rights

Figure 12 shows the number of days when fishing occurred under particular property rights systems. Nine systems of property rights were covered in the survey:

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. Sub-lease: 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 clandes-

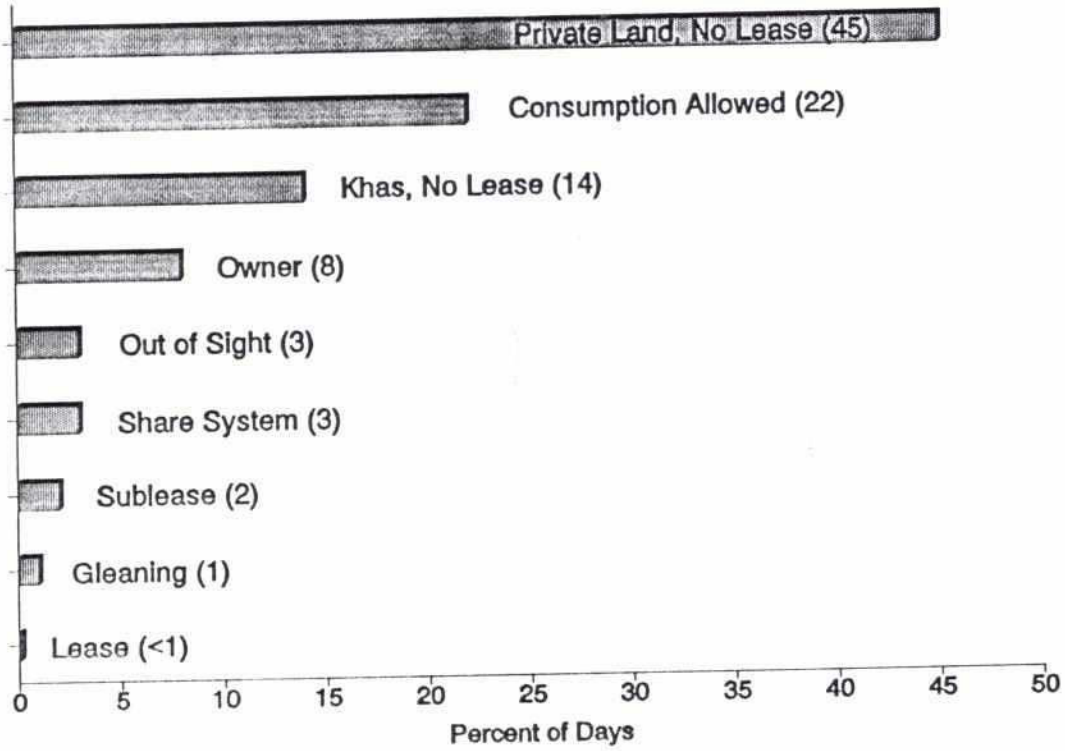


Figure 12: Source of Catch by Fishing Rights

tinely. Sometimes the lessor/owner overlooks consumption fishing by locals.

5. Consumption fishing: Local people have the right to fish openly for their own 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.

Little 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-Dhonagodha 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 *(Khartic)* 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. ■

Chapter 6

FISH CATCH ASSESSMENT

6.1 Introduction

The floodplains and beels of Bangladesh are key components of the country's open water capture fisheries resource. In 1989 the Department of Fisheries reported that the floodplain alone 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 the current levels of fish yield and species diversity in the floodplains and beels. The survey was conducted within proposed flood control project areas in Tangail, Singra, and Sylhet, and in Matlab, the floodplain catch was assessed outside the Meghna-Dhonagoda project.

6.2 Floodplain Catch Assessment

6.2.1 Fishing Season

The floodplain fishing season is usually four to six months long, starting with the onset of monsoon in June and continuing until November or December. In 1992, floodplain fishing started earliest in Sylhet, where it commenced in mid-June and continued until the middle of November. Fishing in Tangail started in early July, and it 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.

6.2.2 Fish Yield

The annual yield of fish for floodplain areas averaged 75 kg/ha (Table 33), 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 the Tangail floodplain is due to the fact that it had the latest and least flooding in 1992.

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

Table 33
Floodplain Fish Yield

	Yield (kg)	Area (ha)	kg/ha
Singra			
Teligram	15,862	230	69
Beel Chalan	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

In Sylhet, the difference in yield between Gastala and Hamindapur floodplains may be due to differences in flood depth between the two areas. Gastala was flooded to more than one meter and is near the Sada and Kakura *khals*, 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. In this case, the Belta Raxit is near Santosh *khal*, one of the major *khals* 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 for a longer period of time. 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.

6.2.3 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. There was considerable variation between areas on some other species, which reflects some of the ecological characteristics of the areas surveyed. As Table 34 shows, catfish occupied the second position in Sylhet and third in Tangail, which showed 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 species' abundance in the Meghna River.

6.3 Beel Catch Assessment

6.3.1 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

Table 34
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
Snake Head	14	6	5	10	7
Large Shrimp	1	0	0	23	2

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 fishing went on almost all year long, depending on the leasing agreements for those beels.

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 in the beel 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 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 flood waters recede, many small bodies of water remain. These *kuas*, as the

Table 35
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			
Garaildaha	2,862	7	409
Jugnidaha	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 36
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
Chakly	5	483	97
Total	131	32,965	252

bodies are called locally, are ditches that have been excavated by landowners, and as the flood waters 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.

6.3.2 Fish Yield

The overall annual yield of fish from the Sylhet and Tangail beels averaged 322 kg/ha (Table 35). The data for Tangail indicates that the leased beels, 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 36 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*.

Table 37
Diversity of Beel Species (percent)

Species Group	Sylhet	Tangail	Singra	Total
Catfish	49	12	52	47
Small Fish	24	30	20	24
Carp	14	30	7	13
Shrimp	7	10	7	7
Snake Head	4	12	8	7
Eels	1	5	6	3

6.3.3 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 37). 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 7

CONCLUSIONS

7.1 Summary of Findings

7.1.1 Consumption

The average per capita consumption rate for the study period ranged from 12 gm/day in Tangail to 34 gm/day in Meghna-Dhonagoda. The overall average 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.

Nearly all of the households consumed rice every day of the week, while the percentage consuming only rice averaged five percent for the year and dropped as low as one 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 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, 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: in Tangail they consumed 27 percent more, in Surma-Kushiyara, 87 percent more, and in Singra, 76 percent more.

7.1.2 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.

7.1.3 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. 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.

7.1.4 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; snake head, 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; snake head, 49; and carp, 58.

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

Although preliminary figures indicate that fish stocking may be an economically promising method of boosting fish production, most of the benefits of the increased productivity are going to relatively wealthy landowners, leaseholders, and middlemen. They 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, lose access to the ponds, to an important source of protein, and to an income-generating activity.

If mitigating this loss is considered, the nutritional and economic value of other protein sources, beef and chicken, should be viewed. The equivalent economic price for beef is Tk. 42 and for chicken, Tk. 57. Except for Singra, the beef value is less than the economic price for small fish, and the poultry value is less than the economic prices for carp and catfish.

7.1.5 Fish Migration

Almost every inland freshwater fish species in Ganges-Brahmaputra floodplain rivers migrates for spawning and growth. *Khals* (canals) are the most important routes of those migrating fish. The major movements take place during the early monsoon and late monsoon. Migration patterns, particularly those associated with spawning, are highly time-specific and synchronized with such environmental stimuli as temperature rise, rainfall, and water flow.

The early monsoon 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 to reach the floodplain.

Their migration is blocked by FCD/I embankments and regulators, siltation, and traps and fences. In Tangail, for example, regulators were closed for no beneficial purpose 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.

In Tangail, heavy siltation of the Jugni Khal hampered fish migration because it blocked canal access to the floodplain during the monsoon.

In some *khals*, 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.

7.1.6 Subsistence Fishing

Eighty-five percent of the surveyed floodplain households were occupied at least part time in 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 flood for replenishing and sustaining 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 monsoon and just following it.

Little subsistence fishing takes place on water bodies that are leased from the government. The main sources for subsistence fishing are unleased private land, lands under lease that permit local consumption fishing, and public water bodies with no fishing lease.

7.1.7 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 are routinely 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 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 availability of fish and the diversity of species in both floodplains and beels are dependent on regular seasonal flooding by river water. The affects of typical FCD and FCD/I projects, which block fish migration routes, reduce the size of beels and floodplain, and change the length of time those areas are flooded, will bring about irreversible loss to these fisheries.

7.2 Recommendations

The preceding findings lead to the following recommendations:

- Preservation of capture fishery resources should be the highest priority of water resource allocation and planning.
- In most 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 are not a substitute for the natural capture fishery.

In addition, too little is known about the biology 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. 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 are 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 Bangladesh continues to disrupt the fishery environment, fish diversity will plummet, and people, particularly the poorest and most vulnerable, will 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.

Indeed, further FCD investment may be unjustifiable, particularly when a high level of investment produces inadequate flood control. A post-project review of FCD projects under the National Water Plan finds:

> *There is widespread failure of project (FCD) structures to operate as intended, such as damaged flap gates, reduced drainage capacity due to inadequate maintenance of channels, and breaching of embankments both through erosion and public cuts. The poor condition of structures observed at every FCD and FCD/I project, and the inability of Government to prevent public breaches of embankments suggests that caution should be exercised before investing in new projects until solutions can be found to these problems.* (MPO 1991)

Not only do many projects suffer poor performance, the rationale for their existence—reducing property damage and increasing food grain production—is faulty. Only two percent of the officially

estimated damages from the 1988 flood were agricultural, and FCD projects are not designed to withstand such floods in the future anyway.

Bangladesh also has seen the end of food grain deficiency. The result for farmers is low prices, and returns that are below production costs (*Holiday* 1992). The government is now promoting rice exports, including sale to Saudi Arabia for famine relief in Somalia (*Telegraph* 1992). If food grain production is to continue increasing, as it must to accommodate future population growth, there are more efficient ways to do so than through flood control projects. The National Water Plan concluded that groundwater irrigation provided about six times the increased production of FCD projects (MPO 1992). Furthermore, groundwater irrigation can be done through private development with no cost to the government, while the construction, operation, and maintenance of FCD is 100 percent government subsidized.

Therefore, the imperative of water resource planning should not be how to mitigate fish losses in order to get more rice production through FCD/I projects, but rather, to restore the habitat that has already been destroyed, and to optimize conditions for the maximum survival and sustainability of the capture fishery.

Making minimal improvements in the access fish have to the floodplain can return a large increase in fish productivity. Project planners should search first for solutions that benefit multiple resources, such as drainage, and second for measures that generate the least conflict between beneficiaries, as is usually the case with irrigation.

When formulating FCD/I projects, rather than lumping together flood control, drainage, and irrigation, the benefits and costs of each solution should be broken down. The adverse effects of the project, such as the value of lost fisheries, should be charged against that component of the project that is causing harm. Each feature of the project must be justified separately by comparing its incremental benefits to incremental costs. Incremental costs in the case of flood control include loss of fisheries, loss of navigation, and increased flooding outside the project, as well as the more traditionally included costs of land acquisition, construction, and maintenance.

Stocking programs and culture fishery will continue where they are profitable. However, they should be additions to, not substitutes for, the natural fishery. Stocking and cultivating fish requires investment, and the fish it produces are vulnerable to diseases. Furthermore, although those projects may be taken up in the name of the poor fishermen, it is those same poor fishermen who lose their fishing rights because the project strengthens and extends the government leasing system. Under this system, fisheries program profits are skimmed off by nonfishing middlemen who are able to obtain the government leases.

The scarcity premium applied to the economic value of fisheries in FAP cost/benefit analysis is significant because it acknowledges the principle that such a value is justified. However, it must be acknowledged that there is no empirical basis for the particular value 1.25. Acceptance of the concept is commendable, but, research into the projected future supply of capture fisheries, and the willingness to pay for fisheries under future conditions of supply and demand is necessary for a proper estimate of the scarcity value. ■

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ANNEXES

Annex 1

Reports Comparing Flood Control and Fisheries (Partial List)

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Annex 2

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 1).[1]

2. Family Size and Composition

For the purpose of this study, a family consists o

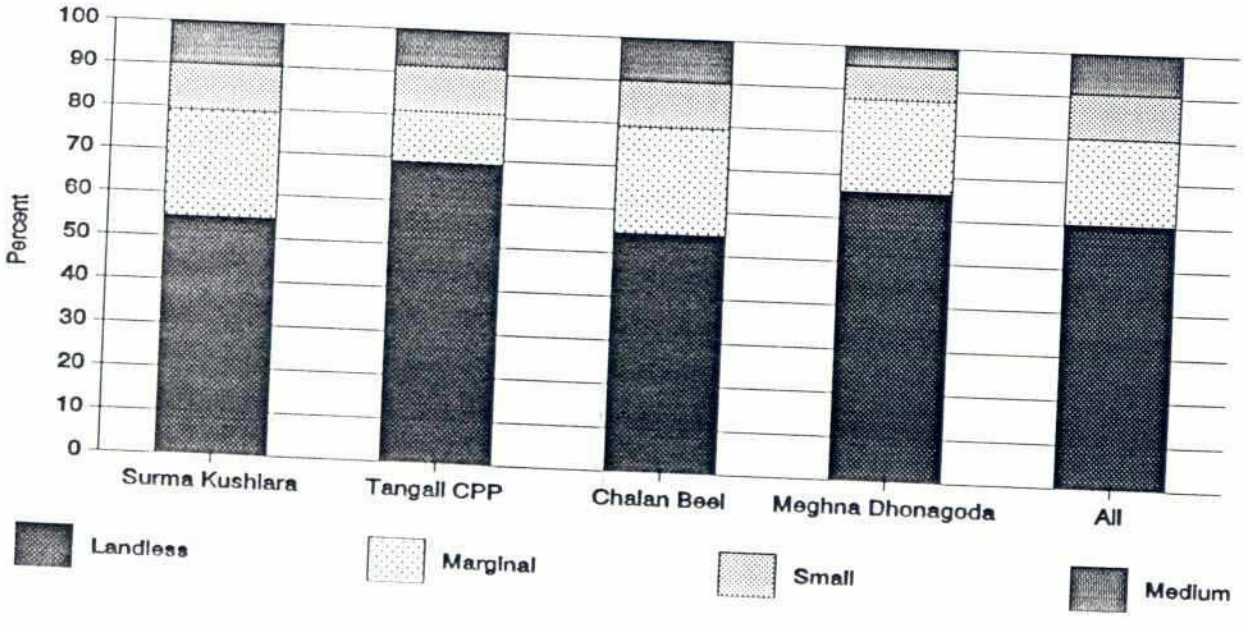

Figure 1: Households in Each Social Stratum

Table 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

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 Sociological 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, those with marginal farms consisted of 6.1 people, small farm families had 6.9, and medium farm

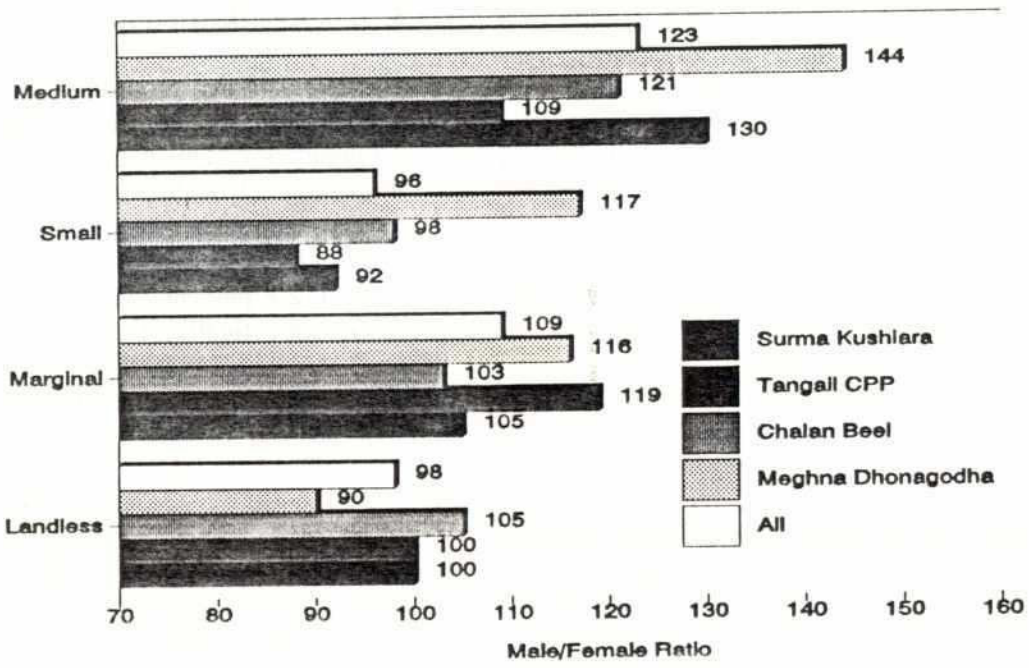

Figure 2: Male/Female Ratio in the Study Area

Table 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

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

3. Sex Ratio

Figure 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 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 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

Table 3
Literacy Rates in the Survey Areas (percent)

Category	Surma-Kushiyara	Meghna-Dhona-goda	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 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

Table 5
Main Occupation of Adult Household Members (percent)

Category	Farming	Agricultur-al labor	Fishing	Artisan	Nonagricul-tural labor	Transporta-tion	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

level. Among the landless, only 25.4 percent met the criteria, but among medium farm families, 53.4 percent were literate (Table 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. 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 4). Among household heads, the figure is even higher, 48.3 percent (Table 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. ■

NOTES

1. See Chapter 2 for an explanation of the categories.

Annex 3
Consumption of Culture and Capture Fish by Socioeconomic Category

Category	No. of Households	Total Consumption (mt)			Consumption/Household (kg)		
		Carp	Other	Total	Carp	Other	Total
All Areas							
Landless/Marginal	128,847	707	5,456	6,163	5.5	42.3	47.8
Small/Medium	28,158	352	1,595	1,947	12.5	56.6	69.1
Total	157,005	1,059	7,051	8,110	6.7	44.9	51.7
Tangail							
Landless/Marginal	21,044	24	355	379	1.1	16.9	18.0
Small/Medium	4,905	14	185	199	2.9	37.7	40.6
Total	25,949	38	540	578	1.5	20.8	22.3
Surma-Kushiyara							
Landless/Marginal	23,936	69	734	803	2.9	30.7	33.5
Small/Medium	6,194	76	369	445	12.3	59.6	71.8
Total	30,130	145	1,103	1,248	4.8	36.6	41.4
Singra							
Landless/Marginal	26,676	186	639	825	7.0	24.0	30.9
Small/Medium	8,628	148	501	649	17.2	58.1	75.2
Total	35,304	334	1,140	1,474	9.5	32.3	41.8
Meghna-Dhonagoda							
Landless/Marginal	57,191	429	3,726	4,155	7.5	65.2	72.7
Small/Medium	8,431	114	539	653	13.5	63.9	77.5
Total	65,622	543	4,265	4,808	8.3	65.0	73.3

Source: Household Survey

Annex 4
Species Source of Catch (tons)

Species	River	Canal	Drain	Beel	Haor	Ox-bow	Flood-plain	Pond	Borrow pit	Total
					Small Fish					
Bailla	18.2	10.9	1.7	2.9	2.0	0.0	30.3	1.3	1.6	68.9
Betrongi/Botia	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
Bheda	0.0	3.6	0.2	2.9	12.2	0.0	4.8	2.4	0.1	26.2
Bhetki	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	1.1
Chanda	8.8	5.5	6.4	17.3	3.1	0.1	6.2	9.3	29.9	86.5
Chapila	0.1	0.0	0.0	0.2	0.2	0.0	0.0	0.5	1.1	2.1
Cheaoa (red)	2.2	15.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	17.3
Cheaoa (white)	39.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.1
Chela	2.9	0.3	0.2	40.4	0.1	0.0	0.2	0.1	0.2	44.5
Cheng	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Chital	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2
Dankina	0.1	5.7	8.1	4.2	0.0	0.0	14.6	0.7	5.7	39.1
Dhela	0.4	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.5
Faisha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.8	0.0	10.8
Foli	1.8	1.2	1.6	9.8	9.9	0.0	2.4	13.8	13.5	53.9
Frog	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
Gootoom	13.1	2.8	9.2	36.2	17.0	0.0	19.2	8.8	9.2	115.6
Kachki	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3
Kaika	0.8	3.7	0.1	2.3	0.0	0.0	0.7	0.7	0.4	8.5
Kholisha	0.1	12.6	1.8	21.6	16.9	0.0	11.9	25.0	38.3	128.0
Kholla	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4
Koi	2.0	8.4	8.5	31.5	2.3	0.0	25.0	74.0	32.9	184.7
Kotkoti Chaka	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.7
Mola	3.9	3.3	5.5	2.1	0.7	0.0	3.7	155.9	12.6	187.7
Naftani	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Nailotika	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Pooti	32.4	57.1	34.2	41.6	19.6	0.2	325.3	65.9	43.0	619.2
Potka Teapa	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2
Satronga	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Telapia	0.0	0.0	0.0	0.0	0.0	0.0	0.5	74.9	2.4	77.9
Thai Sarputi	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	2.3
Thotha	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Tora Walking Fish	0.1	0.0	0.6	5.2	0.0	0.0	4.9	0.8	0.7	12.3
Cooli Bailla	2.9	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
Total	130.3	136.3	78.3	221.0	84.0	0.3	450.8	444.8	193.0	1,738.6

continued

Annex 4 (cont.)

Species	River	Canal	Drain	Beel	Haor	Ox-bow	Flood-plain	Pond	Borrow pit	Total
Catfish										
Aair	6.4	1.2	0.0	1.1	0.0	0.0	15.6	222.5	0.5	247.3
Bagha Aair	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	2.4
Batashi	0.1	0.2	0.6	6.0	0.0	0.0	0.8	0.0	0.9	8.5
Boal	10.2	1.8	0.0	79.3	0.0	0.0	19.7	61.1	10.8	182.8
Boyori	0.0	0.5	0.0	2.0	0.0	0.0	0.0	0.0	0.0	2.6
Ghaora	0.7	0.7	0.0	1.5	0.0	0.0	0.0	0.0	0.0	2.9
Goolsha	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4
Gooyi Aair	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
Kayoli	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.5
Magur	1.2	3.7	1.1	3.6	0.0	0.0	1.2	4.5	5.9	21.1
Pabda	0.0	0.5	0.8	2.0	1.1	0.0	0.2	2.5	3.9	11.0
Ritha	10.6	0.0	0.0	5.3	0.7	0.0	0.0	0.3	0.0	17.0
Shilong	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9
Shing	11.5	4.2	17.5	135.9	13.7	0.0	11.1	52.2	23.3	269.5
Tengra	28.6	11.6	1.7	70.2	2.4	0.0	34.5	21.9	8.1	179.0
Total	69.4	28.4	21.7	309.2	17.9	0.0	83.0	365.6	53.8	949.0
Snake Head										
Goyar	4.8	0.0	0.0	0.0	0.0	0.0	0.0	24.5	0.7	30.0
Shoil	7.3	31.6	2.5	60.3	0.0	0.0	0.7	37.8	1.2	141.4
Taki	8.6	36.2	12.6	30.6	40.6	0.1	77.1	51.5	46.2	303.5
Total	20.7	67.7	15.2	90.9	40.6	0.1	77.8	113.9	48.1	474.8
Carp										
Baush	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
Flat Fish	0.0	0.0	0.0	0.0	0.0	0.0	2.7	31.9	2.5	37.1
Goinnabatka	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5
Kali Baosh	0.2	0.0	0.0	0.8	0.0	0.0	2.9	19.2	0.0	23.0
Karpio	0.6	0.0	0.0	33.6	0.0	0.0	0.0	38.9	0.0	73.1
Mohashoil	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3
Mrigel	4.4	0.0	0.1	0.2	0.0	0.0	1.1	34.9	2.3	42.9
Ruhi	1.0	8.9	0.0	1.3	0.0	0.0	7.6	63.1	0.0	81.9
Silver Carp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.3	0.0	56.3
Tatkeri Along	0.8	0.0	0.0	7.7	0.0	0.0	0.2	0.3	0.7	9.7
Total	7.0	9.0	0.1	43.5	0.0	0.0	15.3	244.5	5.5	324.9

continued

Annex 4 (cont.)

Species	River	Canal	Drain	Beel	Haor	Ox-bow	Flood-plain	Pond	Borrow pit	Total
					Hilsha					
Ilish	28.2	0.7	0.9	0.0	0.0	0.0	0.0	0.0	0.0	29.8
Total	28.2	0.7	0.9	0.0	0.0	0.0	0.0	0.0	0.0	29.8
					Shrimp					
Black Shrimp	4.5	1.2	0.0	0.4	0.0	0.0	0.6	1.2	0.2	8.2
Shrimp	80.4	28.8	11.9	158.0	0.0	0.3	91.5	37.6	22.7	431.3
Sotka Shrimp	0.3	4.0	1.6	7.1	20.3	0.0	6.9	6.9	5.6	52.6
Large Shrimp (Golda)	37.5	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.1	39.1
Total	122.7	34.0	13.5	165.6	20.3	0.3	99.0	47.3	28.6	531.1

Annex 5
Species Ranked by Key Indicators

Amount Eaten	Number of Meals	Number of Days	Number of Households
Pooti	Pooti	Pooti	Pooti
Ilish	Shrimp	Shrimp	Shrimp
Taki	Taki	Taki	Taki
Shrimp	Dried fish	Dried fish	Tengra
Shing	Tengra	Tengra	Dried fish
Koi	Shing	Shing	Chandra
Ruhi	Ilish	Ilish	Mola
Silver carp	Chandra	Chandra	Shing
Tengra	Koi	Koi	Ilish
Telapia	Mola	Mola	Kholisha
Mola	Goochi baim	Goochi baim	Goochi baim
Goochi baim	Kholisha	Kholisha	Koi
Boal	Gotoom	Gotoom	Gotoom
Chandra	Chatka shrimp	Bailla	Bailla
Kholisha	Bailla	Chatka shrimp	Chatka shrimp
Shoil	Chapila	Ruhi	Chapila
Mrigel	Telapia	Chapila	Foli
Foli	Foli	Telapia	Ruhi
Chapila	Ruhi	Foli	Telapia
Bailla	Dankina	Dankina	Dankina
Chatka shrimp	Boal	Boal	Boal
Flat fish	Silver carp	Silver carp	Silver carp
Kachki	Mrigel	Mrigel	Mrigel
Chital	Kachki	Kachki	Chela
Gotoom	Magur	Magur	Magur
Cheaoa (red)	Shoil	Pabda	Kachki
Kalibaos	Pabda	Shoil	Pabda
Magur	Chela	Chela	Batashi
Aair	Bojari	Cheaoa (red)	Bajori
Baro baim	Cheaoa (red)	Batashi	Shoil

Annex 6
Source of Fish Caught (tons)

Species Group	River	Canal*	Beel	Floodplain†	Pond	Borrow pit	Total
All Areas							
Small Fish	133	215	228	535	445	194	1,751
Catfish	69	50	309	101	366	54	949
Shrimp	21	83	91	118	114	48	475
Snake Head	78	77	128	34	73	21	411
Eels & Others	7	9	44	15	245	6	325
Carp	28	2	0	0	0	0	30
Hilsa	123	47	165	120	47	29	531
Total	459	484	964	924	1,290	351	4,471
Percent	10	11	22	21	29	8	100
Tangail							
Small Fish	13	18	33	8	11	19	101
Catfish	3	1	3	0	3	6	15
Shrimp	1	3	8	0	1	4	17
Snake Head	2	0	3	0	0	3	8
Eels & Others	2	3	6	1	1	1	13
Carp	1	0	0	0	1	4	6
Hilsha	0	0	0	0	0	0	0
Total	21	24	53	9	16	35	159
Percent	13	15	33	6	10	22	100
Surma-Kushiyara							
Small Fish	11	59	35	201	57	55	418
Catfish	7	19	13	33	38	11	120
Shrimp	0	13	7	29	14	3	66
Snake Head	4	35	17	74	44	13	187
Eels & Others	0	1	0	6	1	1	8
Carp	5	0	1	0	41	0	46
Hilsha	12	1	0	0	0	0	12
Total	38	128	73	342	194	83	858
Percent	4	15	9	40	23	10	100

continued

Annex 6 (cont.)

Species Group	River	Canal*	Beel	Floodplain†	Pond	Borrow pit	Total
			Singra				
Small Fish	29	31	159	12	151	44	425
Catfish	35	8	293	59	307	19	720
Shrimp	16	11	150	70	11	13	271
Snake Head	2	4	69	13	31	4	122
Eels & Others	47	6	118	11	11	15	209
Carp	1	0	42	2	159	2	206
Hilsha	0	0	0	0	0	0	0
Total	130	59	831	167	669	97	1,953
Percent	7	3	43	9	34	5	100
			Meghna-Dhonagoda				
Small Fish	80	108	1	315	226	76	806
Catfish	25	22	0	9	19	18	93
Shrimp	105	21	0	20	21	9	177
Snake Head	13	44	2	32	39	29	158
Eels & Others	29	67	4	16	61	4	181
Carp	1	9	0	13	44	0	67
Hilsha	17	1	0	0	0	0	17
Total	269	272	7	406	411	136	1,501
Percent	18	18	0	27	27	9	100

*Includes canals and drains.
†Includes floodplains and haors.

Annex 7
Fish Caught, Sold, and Bought (tons)

Species Group	Caught	Sold	Caught & Consumed	Bought	Total Consumed
All Areas					
Small fish	1,784	768	1,016	2,098	3,114
Catfish	1,050	806	244	684	928
Snake Head	505	194	311	192	503
Carp	340	155	185	744	930
Shrimp	591	388	203	401	604
Total	4,270	2,311	1,959	4,119	6,078
Percent	-	-	32	68	100
Tangail CPP					
Small fish	108	19	89	159	248
Catfish	15	4	11	78	89
Snake Head	9	0	8	41	49
Carp	6	1	5	36	41
Shrimp	20	3	18	40	58
Total	157	27	131	355	486
Percent	-	-	27	73	100
Surma-Kushiyara					
Small fish	418	141	277	154	431
Catfish	120	39	81	97	178
Snake Head	187	73	114	24	138
Carp	46	29	17	147	164
Shrimp	66	40	26	48	74
Total	837	323	515	469	984
Percent	-	-	52	48	100

continued

Annex 7 (cont.)

Species Group	Caught	Sold	Caught & Consumed	Bought	Total Consumed
			Singra		
Small fish	452	314	137	200	337
Catfish	821	747	75	139	214
Snake Head	151	106	45	50	95
Carp	221	125	97	123	219
Shrimp	328	284	44	46	90
Total	1,973	1,576	397	559	956
Percent	-	-	42	58	100
			Meghna-Dhonagoda		
Small fish	806	294	513	1,586	2,099
Catfish	93	16	78	369	447
Snake Head	159	14	144	76	220
Carp	67	1	67	439	505
Shrimp	177	61	115	266	381
Total	1,302	386	917	2,736	3,653
Percent	-	-	25	75	100

Annex 8
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

Annex 9
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	0.8	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

Annex 10
Monthly Average Prices (Tk./kg, 1991-92 prices)

Month	Tangail	Surma-Kushiyara	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

Annex 10 (cont.)

Month	Tangail	Surma-Kushiyara	Singra	Meghna-Dhonagoda	Mean*
Snake Head					
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

Annex 10 (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

Annex 10 (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

Annex 10 (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.

Annex 11
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

Annex 11 (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

Annex 12
Fish Species Captured Migrating through *Khals*

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

Annex 13
Estimated Number of Fish Larvae Entering the Tangail Floodplain through *Khals*

Date	Sadullahpur Khal		Gaizabari Khal		Darjipara Khal	
	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

Annex 14
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