SEASONAL VARIATION OF FISH MIGRATION IN SARIAKANDHI FISH PASS

A thesis by

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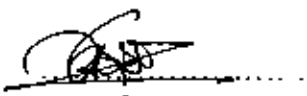

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ABBREVIATIONS

BBS	Bangladesh Bureau of Statistics
BETS	Bangladesh Engineering and Technological Services Ltd.
BWDB	Bangladesh Water Development Board
BRE	Brahmaputra Right Embankment
CEGIS	Centre for Environmental and Geographic Information Services
CPP	Compartmentalization Pilot Project
CAS	Catch Assessment Survey
CPUA	Catch Per Unit Area
DoF	Department of Fisheries
D/S	Down Stream
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCDI	Flood Control Drainage and Irrigation
GoB	Government of Bangladesh
IWFM	Institute of Water and Flood Management
IUCN	Internation Union for Conservation of Nature and Natural Resources
JRE	Jamuna Right Embankment
MPO	Master Plan Organization
MSY	Maximum Sustainable Yield
NWP	National Water Plan
NWMP	National Water Master Plan
NGO	Non Government Organization
PRA	Participatory Rural Appraisal
SSI	Semi-Structured Interview
UP	Union Parshad
UFO	Upazila Fisheries Officer
WARPO	Water Resources Planning Organization

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ABSTRACT

The importance of open water fish in our socio-ecouomic regime has recently drawu the attention of the policy makers of the country. FCD/FCDI projects mainly serve the agricultural interests, but it interfere fish migration. This inevitably affects the open water fisheries sector as migratory routes. Nursing grounds of many species of fish are hampered and disturbed for these projects also.

In order to permit fish migration in rivers, it is necessary to maintain conditions that help migrants reach their spawning grounds. To overcome obstacles, such as hydraulic structures, placed in the path of migrating fish, structures must be designed to assist the fish to pass them. The periodic and directed travel of fish mainly for feeding, breeding and over coming adverse climatic conditions is called migration Fish passes are constructed to allow normal breeding migration and to ensure natural route of fish movement.

The concept of a fish passes is relatively new in Bangladesh. At present, two Fish passes and two fish friendly structures are constructed These are Fish Pass in Jamuna to Bangali River at Sariakandi in Bogra, fish Pass in Kawadighi Haor of Monu river in Moulovibazar, fish friendly structure in Lohajong river of Tangail and fish friendly structure at Morichardanra in Chapainawabganj.

Fish fry, spawning and hatchling movement from Jamuna to Bangali River was the main objective of Sariakandi Fish Pass Project. The Fish Pass Project of Sariakandi is necessary for the development of the dominant fishes like catfish and small fishes. The structures will also aid in efficient development of the carp fishes. Spawning migration, mainly in carp fish, in the study area was found to begin at the 2nd week of May and continue up to the 3rd week of July. Catfish migrations began at the last week of March and continue up to the 2nd week of June.

Seasonal variation was found in four periods of fish migration; firstly over-wiutering or dry season migration, in this period the large size carps and small catfish especially Magur and Shing showed peak migration. Secondly spawning migration season, small size catfishes showed peak migration. Thirdly nursery/ grow out migration season, carps, catfishes and other fishes showed peak migration during this season. And fourthly flood recession migration season, large size carps and catfishes also showed peak migration.

CHAPTER ONE
INTRODUCTION

1.1 Background

Bangladesh is a flood prone country and thus there is a necessity of flood management. Presently, most of the flood management projects are aimed to support agriculture sector. Several important river system and floodplain areas have already been brought under coverage of flood control and drainage (FCD) facilities for this purpose. Irrigation has also been introduced in FCD projects .The traditional way of flood protection has been in the form of construction of embankments, regulators, sluices and pumps and its history is very old. Major water resources development projects in the form of FCD projects started in early sixties in the coastal area in the name of Coastal Embankment Project. As the time advanced more and more such projects came into existence. Many of the new projects were smaller in size but their technical characteristics were the same.

These flood control, drainage and irrigation (FCDI) projects interfere with the environment and ecosystem of the floodplain and the connected rivers. This inevitably affects the open water fisheries sector as migratory routes and nursing grounds of many species of fish are hampered and disturbed (FAP-12 1993) In recent years, majority of fresh water fish have declined both in abundance and biodiversity; researchers have identified barriers to migration as a major contributing factor (Lioyed et al. 1991). It is necessary to maintain conditions which help migrants reach their destination. As a mitigation measure, fish pass and fish friendly regulators are to be constructed in FCDI projects to support the natural migration pattern of fishes as far as possible (FAP-12 1993; FAP-17 1994).

There has been substantial growth in rice production in flood protected areas in short run, but its environmental costs has been heavy (MPO 1991, FAP-17 1994). Environmental issues had largely been overlooked in apprising water management projects in the past. Flood management schemes in Bangladesh, prior to initiation of studies under the Flood Action Plan (FAP) in 1989, did not consider nor proposed mitigation against the negative impacts only floodplain fishery. The FAP studies have pointed out the importance of fishery resources and created awareness for its

protection and preservation. Despite importance of fisheries in terms of nutritional value and rural employment and access to the common property, these resource are gradually decreasing. Bangladesh is a nation where there is too much water during rainy monsoon season, usually from May to September. The low-lying, deltaic, alluvial land becomes submerged every year with rivers over-flowing their banks and natural depressions (haors, baors) and flat areas (paddy fields) virtually becoming broadly interconnected. This situation has enriched the fisheries of Bangladesh. The capture fisheries is decreased due to

- the deterioration of the environment on account of riverine water pollution,
- excessively high fishing pressure; and
- large scale agricultural development programs, focused primarily on rice production that have been undertaken by the government for over a decade in order to ensure food security for the rapidly increasing population.

A major element of these programs is water management for flood control and irrigation. For this, a number of FCD and FCDI schemes have been implemented.

Migration is an important feature of the biology of many fish species, and the flood control measures reduction of water extent and duration in the floodplain in the recent years has affected migration adversely (FAP, 17 1994) In order to permit fish migration in rivers it is necessary to maintain conditions that help migrants reach their spawning grounds. To overcome obstacles, such as hydraulic structures, placed in the path of migrating fish, structures must be designed to assist the fish to pass them The efficiency of such fish-passing structures depends to a large degree upon the ability of engineers to utilize knowledge of physiology, ecology and behavior of the migrating species (Pavlov, 1989). The task of minimizing the effects of FCD/FCDI on fish stocks is complex and requires close co-operation of planners, biologists, engineers and decision makers (FAP 12, 1992).

The concept of a fish passes is of recent introduction to our country. Till to date four fish passes have been constructed. They are, fish pass in Kawadighi Haor of Manu River Project in Moulvi Bazar, fish pass in Jamuna to Bangali River Project in Sariakandi, Bogra Jugini Inlet of Compartmentalization Project, Tangail and Marichar Danra Regulator of Marichar Danra Sub Project in Nawabganj district (Draft Feasibility Report, August 2001).

The periodic and directed travel of fish mainly for feeding, breeding and over coming adverse climatic conditions is called migration (FAP 17, 1994). Upstream migration of adult major carps in the Jamuna river starts in March, coinciding with the gradual rise of water level. Spawning starts in May, with the onset of the Southwest monsoon, and continues till the end of July (Tsai and Ali, 1986). Hydraulic factor influences the total process of fish migration. The migration of fish for breeding, grazing and recruitment are rearranged along with the hydraulic changes (EGIS, 1997).

Fish passes are constructed to allow normal breeding migration and to ensure natural route of fish movement (FAP-6, 1998). This structure is designed, constructed and operated in such a way that the adult carps migrate upstream at the beginning of May and the hatchling can enter the floodplain in June/July.

Fish specially spawn generally move from deep water to shallow water during monsoon season. During the flood receding period, fish move to deepwater areas for overwintering. During dry season, fish are aggregated in the deep-water and start breeding at the onset of the next monsoon season (Chufa, Tsai and Ali, 1997). Seasonal variation is also important for fish migration. Because different migratory species are dominant in different season. One research project under the main frame of BUET-DUT Linkage Project has been undertaken to develop an operational management system for Shariakandi fish pass ensuring stakeholders participation and interagency coordination (BUET-DUT, 2006).

In this research a list of migratory species, species diversity, migration pattern and seasonal variation of dominant species of Sariakandhi fish pass has been studied. That information will assist in the development of an appropriate management strategies for the Sariakandhi fish pass.

1.2 Fish Resource and Its Importance in National Economy

The Fishery is one of the major aspects of economic development in Bangladesh and is strongly linked to advancement of target groups, poverty alleviation, nutrition and employment generation. The fisheries sector is reported to account for about 10% of agricultural gross domestic product (GDP), 3% of total GDP, 8% of total export

earnings. 60% of animal protein intake and 7% of total protein intake. It employs almost 2 million fulltime fishermen and 12 million part-time fishermen every year (Draft NWMP, 1999).

Fisheries sector is playing a very vital role regarding employment generation, animal protein supply, and foreign currency earning and poverty alleviation. According to the report of Draft NWMP, 1999, fisheries sector is contributing 5.71% of the total export earning and 4.92 % to the GDP. About 12 million people are directly or indirectly involved in this sector. Labor employment in this sector has been increasing approximately by 3 5 % annually. Fish production in ponds, lakes, borrowpits, floodplain, oxbow lakes, and semi-closed water bodies are increasing day-by day through transfer of modern technology. Fish production has been increased to 21.02 lakhs Mt in 2003-04, which was 17.81 lakhs Mt in 2000-2001. During 1980's about 95 % fish spawn used to be collected from natural sources. Currently more than 98 % spawn is produced in the hatcheries. More than 4 lakhs beneficiaries (Unemployed youth, landless people, farmers, fishermen, and destitute women) have been provided training in the year 2003-04. Last four years, 256,000 farmers received 56.24 cores Taka as micro credit from various projects as well as revenue budgets of Department of Fisheries (DoF, 2005). Fish production in some floodplain increased from 150 Kg/ ha to 2000-3000 Kg/ha in recent years. In 2004-2005 the highest ever export earning of Taka 2572 core was earned through export of 633378 MT shrimp and fish products. Appropriate steps have been undertaken by the department of Fisheries and other public and private institutions for the alleviation of poverty, employment generation, and export earning through boosting fish and shrimp production, management of inland fisheries through community participation, infrastructure development, human resource development, sanctuary establishment and need based technology dissemination.

Bangladesh is endowed with extensive river system, ponds, beels, haor, baors, ox-bow lakes, reservoirs, etc. which are habitat of open water fisheries. During the rainy season the entire flood plain (with Haors and Beels), rivers and khals become a single block of water. Fishes are widely dispersed and access is freely open to public. In the dry season individual beels emerge and are over-wintering refuge/habitat for brood stock of many commercial and subsistence fish species. Over the past decades annual

yield in closed water culture fisheries and in marine fisheries gradually increased but annual yields decreased in open water capture fisheries to the same extent. Potentials of the open water fisheries is being reduced every year as more and more fish habitats are removed and / or altered for crop production. The direct loss to the fishery of a FCD project will come from the land from which flooding is eliminated. Direct fish harvest loss from every hectare of flood plain removed has been estimated to vary between 37 kg to 110 kg (MPO, 1989). Loss of biodiversity is another impact of FCD development.

1.3 Fish Production in Bangladesh

Inland fisheries and aquaculture are the major contributors of fish production covering 50% and 22% of the total production respectively (DoF, 2002). Though the average annual growth rate of fish production during the year 1995-2001 was around 7% it is not enough to meet the demand of additional people. Moreover, different types of native fish species are declining day by day due to the construction of different water control structures under water development projects.

Fisheries can broadly be divided into two types, namely, capture fisheries and culture fisheries. In capture fisheries human intervention comes in the stage of harvesting only, whereas in culture fisheries it is involved in all stages, starting from rearing the stock to harvesting. Till the recent past, capture fisheries have been the main source of inland fish production. The total fish production in Bangladesh during 2001-2002 was 1.89 million MT of which 78.03% was obtained from inland waters (DoF, 2002). A total of Tk.16371 million was earned by exporting 41482 MT of fish and fisheries products in 2001-02, which contributed 4.76% of the total, export earning (DoF, 2002).

Average annual growth rate of fish production is around 7% Inland open water is the major source of fish production in the country. But production from closed water bodies is increasing very sharply due to dissemination of adaptive technologies and effective extension services rendered by DOF. Last 5 years fish production is shown in table 1 .1 and annual total catch and area productivity's by sector of fisheries for July 2003- June 2004 is shown in table 1.2.

Table 1 1: Major group-wise contribution in fish production (2004-05)

Year	Source-wise production (metric ton)			Total (metric ton)
	Open water	Closed water	Marine	
2000-01	689	713	379	1781
2001-02	689	787	410	1886
2002-03	709	857	432	1998
2003-04	732	915	455	2102
2004-05 (Projected)	822	940	496	2258

Source : Matshya Pakkha, in Bangla (DoF ,2005)

Table 1.2: Annual Total catch and Area Productivity's by sector of Fisheries for July 2003-June 2004.

Sector of Fisheries	Water Area, hectare (ha)	Total catch, Metrictone (Mt)	Catch/Area, Kg/ha
A. Inland Fisheries			
(i) Cupture			
1. River and Esturies	103563	137337	
2. Sundarbans	-	15242	
3. Beel	114161	74328	
4. Kaptai Lake	68800	7238	
5 Floodplain	2832792	497922	
Cupture Total	**4047316**	732067	**34.83 %**
(ii) Culture			
1. Ponds & Ditch	302025	795801	
2. Baor	5488	4282	
3. Coastal Shripm farm	203071	114660	
Culture Total	**513584**	**914752**	**43.52 %**
Inland Total	**4560900**	**1646819**	
B. Marine Fisheries			
(i) Industrial Fisheries (Trawl)	-	32606	
(ii) Artisanal Fisheries'	-	422601	
Marine Total	-	**455207**	**21.66 %**
Country Total		**2102026**	**100 %**

Source : Matshya Pakkha, in Bangla (DoF ,2005)

1.4 Concept of Fish Pass

BWDB has so far implemented about 544 Flood Control Drainage and Irrigation (FCDI) Projects in the country since 1954-55 and more are under the process of planning and construction. The main concept behind the formulation of the project was to increase agricultural food production. These projects have been implemented without a comprehensive assessment of their impact upon fisheries, which are often significant. The sequence of annual flooding and post-flood standing water in the floodplain fishery system are of particular importance to fishery and the floodplain in monsoon months play the primary role of re-population and increase of bio-mass in open water fishery production system. During Floods, fish move out into the flood plain for feeding, grazing, growth and reproduction. Interruption of natural cycle of flooding and recession of flood in channels by Flood Control Drainage & Irrigation (FCDI) work adversely affected the natural fisheries production system. It is believed that the important routes of fish migration and movement from one habitat to another had been blocked as a result of the implementation of the FCDI Projects of BWDB (Hassan, 2002).

To mitigate the adverse impact of the FCDI projects on fisheries, specifically to allow normal breeding migrations and to mitigate the natural route of fish movement and locomotion, the construction of fish pass and fish-friendly structures are necessary This will help to increase in fish bio-diversity, abundance and yield, and thus help to meet regional planning objectives of poverty alleviation, food self-sufficiency and economic development.

1.5 Objectives of Fishpass

The principal objectives of Fishpass are

- ❑ Maintain water velocity within swimming capacity of fish.
- ❑ Avoid rapid change in flow pattern.
- ❑ Operate without manual control.
- ❑ Discharge enough water to attract the fish and
- ❑ Have a well located fish entrance.

Fishpass structure Needs:

- ❑ Support and maintain the natural longitudinal and lateral migration;
- ❑ Reduce the hatchling mortality rate;
- ❑ Maintain connectivity between the river and beels for flushing and to maintain the condition for fish habitat;
- ❑ Reduce the turbulence; and
- ❑ Enough flow and depth to attract fish (specially) to use the structure;

1.6 Impact of FCD/FCDI projects

Embankment act as physical barriers to migration, tending to prevent access of fish to their usual breeding, rearing and feeding ground. It has been observed that in Haor areas where there is no embankment and control structure, the migrating fishes are able to swim freely in and out between rivers and Haors via the network of khals. But with embankment the natural fish migration is effectively blocked in both directions until embankments are over topped or breached. The denial of migration may result in reduction of fish stock ranging from the lowering the levels of abundance to complete depletion.

The following conditions prevail in open water flood plains before undertaking any project for flood management and drainage (MPO 1985):

- fish migration and movement into and out of floodplain occur freely;
- breeding and early growth of many species of fin fish and prawn occur in floodplains;
- spawning migration of many species of fish and prawn from rivers and beels takes place in the floodplains;
- with the recession of flood waters, fish population of the floodplains return to rivers, beels and other permanent water bodies; and
- fisherman harvest fish from floodplain for subsistence and income generation.

Under the post FCD project conditions the following changes usually occur in the floodplain ecosystem.

- open water fish production declines due to general reduction in the area of flood lands and beels (such as reducing the area of nurseries and feeding ground);
- regulators prevent movement, migration and recruitment of migratory species, specially major carp;
- small sized fish and prawn species replace large sized species,
- elimination of oxbows by canalization destroys prime carp spawning grounds;
- cross dam on rivers prevent migration upstream, and consequently the upstream fishery disappears;
- embankment cut of channels (khal) which connects beels to rivers thus preventing both water and fish stock replenishment of beel;
- embankment delay spawning migration, resulting in shortage of brood fish stock;
- impediment to breeding, feeding and early development of floodplain breeding fish;
- fish harvesting activity is reduced;
- reduction of fish biomass contribution to rivers and beels; and
- surface water abstraction for irrigation reduces the area of dry season habitat for fish.

The ecological changes brought about by FCDI projects adversely affect both migratory and non-migratory species of fish. Consequent to embankment construction, substantial morphological changes takes place in the original environment which include segmentation of ecological niche, blockade of water discharging channels, conversion of running water into a body of slow discharge characteristics (in case of a reservoir) and radical transformation of long established ties and interrelationship between organism. Other changes also occurs such as alteration of physico-chemical conditions of spawning ground, destruction/ shrinkage of rearing and feeding ground, change in turbidity and silting patterns which may result in failure of spawning or ineffective spawning of some species. Also when embankments are built around natural floodplain such as Haors, where fish spawn in shallow areas or when rivers are diverted from one system to another the natural genetic link in the life cycles of the fish is broken and some species might face

extinction. The impact of flood control projects on fish is shown in fig. 1.1 and summarized in table 1.3.

Table 1.3: Impact of flood control projects on fisheries with possible mitigation measures

Sl. no.	Issues/factors	Impact on migration movement	Mitigation suggestion	Example
1	Altered natural flooding process	Strong	Controlled Flooding	(CPP)
2	Restrict over bank spill and fish recruitment	Mild	Spill Gate	Had a plan in DWMP
3	Reduce fish migration and movement	Medium	Fish Pass	Fish pass at MIP, BRE
4	Reduce depth of beel/floodplain and internal river/canals	Low	Fish Friendly Structure	CPP
5	Reduce number of perennial beel. increase number of seasonal beel	Low	Excavation of beel and protecting kuas by sanctuary	Planned by 4th fisheries and DWMP
5	Reduce water fluctuations	Low	Fish Friendly Operation	Planned in DWMP
6	Reduce grazing area	Medium	Spill Gates	-
7	Transform perennial beel to seasonal beel	Medium	Ways	-
8	Reduce overwintering ground	Strong	Re-excavation /Water Retention	Planned by 4th fisheries and DWMP
9	Reduce inundation period	Medium	Control Flooding	CPP
10	Reduce flow of internal channels	Medium	Control Flooding	-
11	Deteriorate water quality	Medium	Control Flooding	-
12	Increase over fishing Increase Culture fisheries	Medium	Flood by Pass	SHP

Source. Draft Feasibility Report, August, 2001.

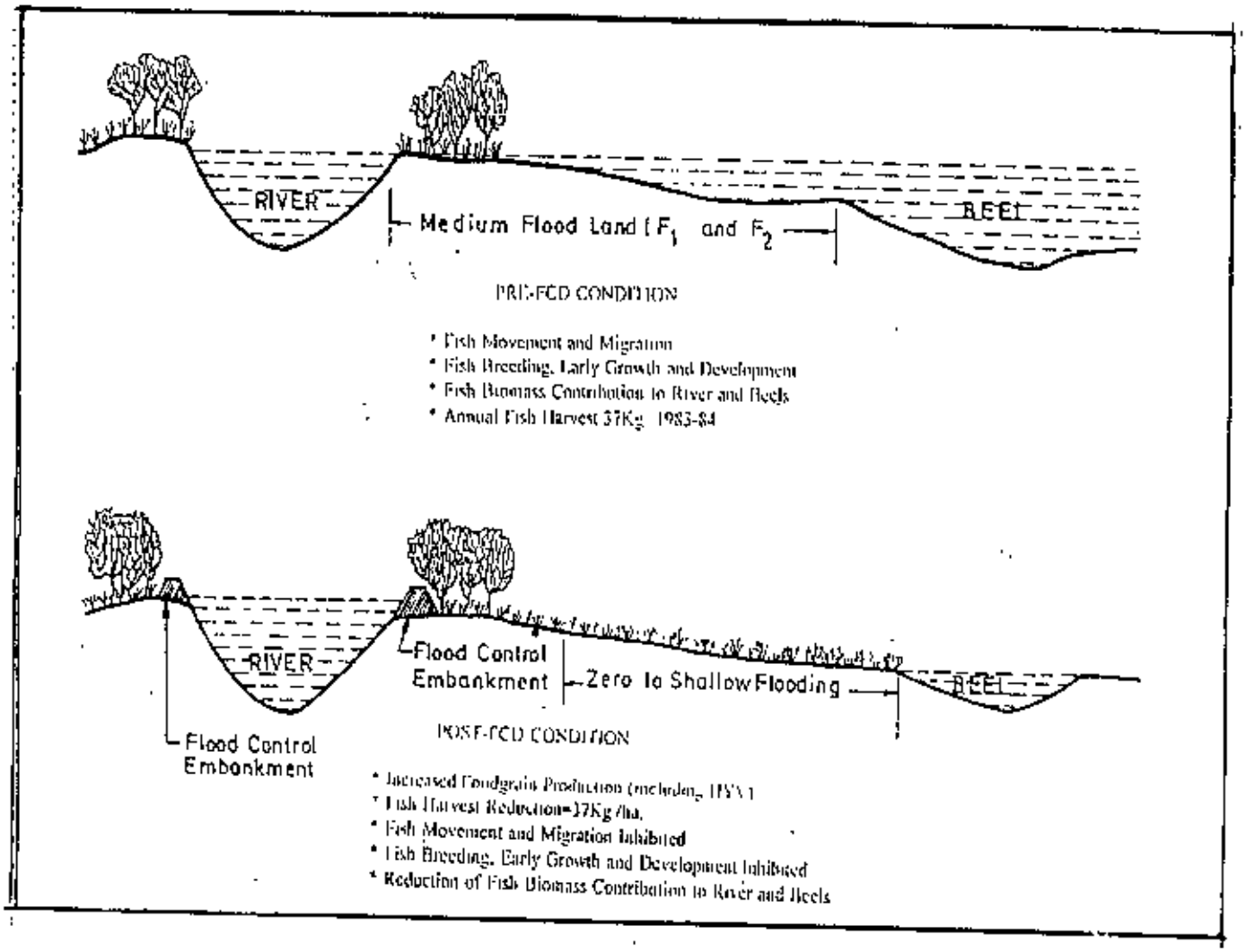


Fig. 1.1: Impact of flood control project on fisheries.

Source : BETS, 2002

1.7 Location of the study area

Sariakandi fish pass is located at the western part of the Bolai canal - a link canal between the Jamuna River and the Bangali River close to Pardevdanga village under Sariakandi Upazila of Bogra district. Bangladesh Water Development Board (BWDB) established the fish pass in the year 1999.

The site of the fish pass is located about 25 km from Bogra district town and 3 km from Sariakandi upazilla head quarters. More particularly, the site lies on the eastern bank of the Jamuna River and covers 7 villages of under Kutubpur and Paikpara union parishads (UP) of Sariakandi upazila. The construction work of embankment on eastern bank of Jamuna River started in 1996-97 and completed in 1998 while the construction work of the fish pass started in 1998 and completed in 1999. Location of study area is shown in fig. 1.2 and fishpass structure in the Jamuna to Bangali river at Sariakandhi is shown in photo 1.1.

1.8 Objective of the study

Specific objectives of the study are as follows.

a. To identify migratory species in the Fish-Pass.
b. To study migrational behaviours of different Fish species in the sariakandi Fish pass and
c. To find out the effect of seasonal variations of Fish migration.

1.9 Possible Outcome: The study will find out the migration pattern of different fish species with seasonal variation through the fish pass.

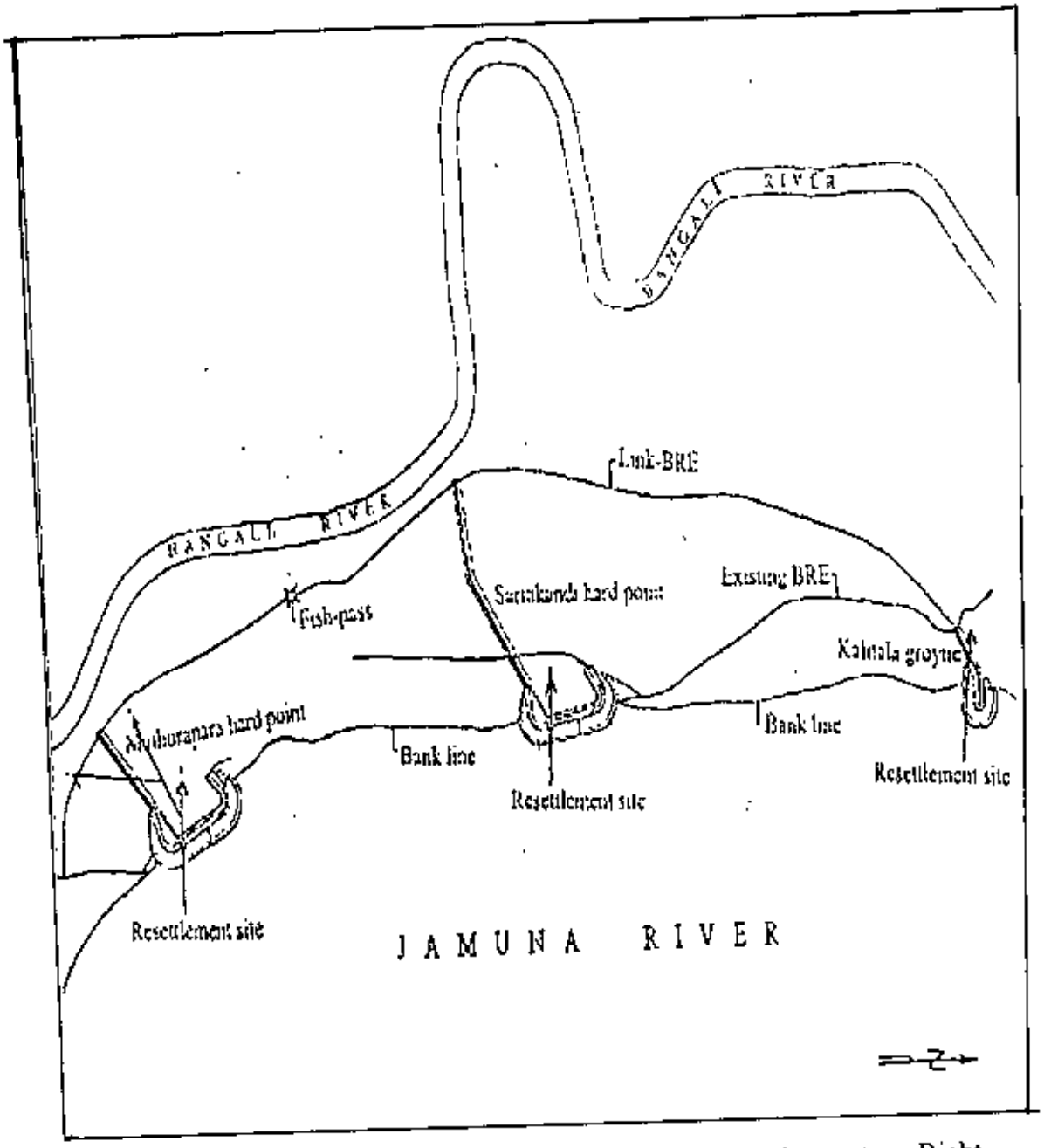


Figure 1.1 Location of Sariakandi Fishpass in Brahmaputra Right Embankment.

Source : (CNRS 2002)

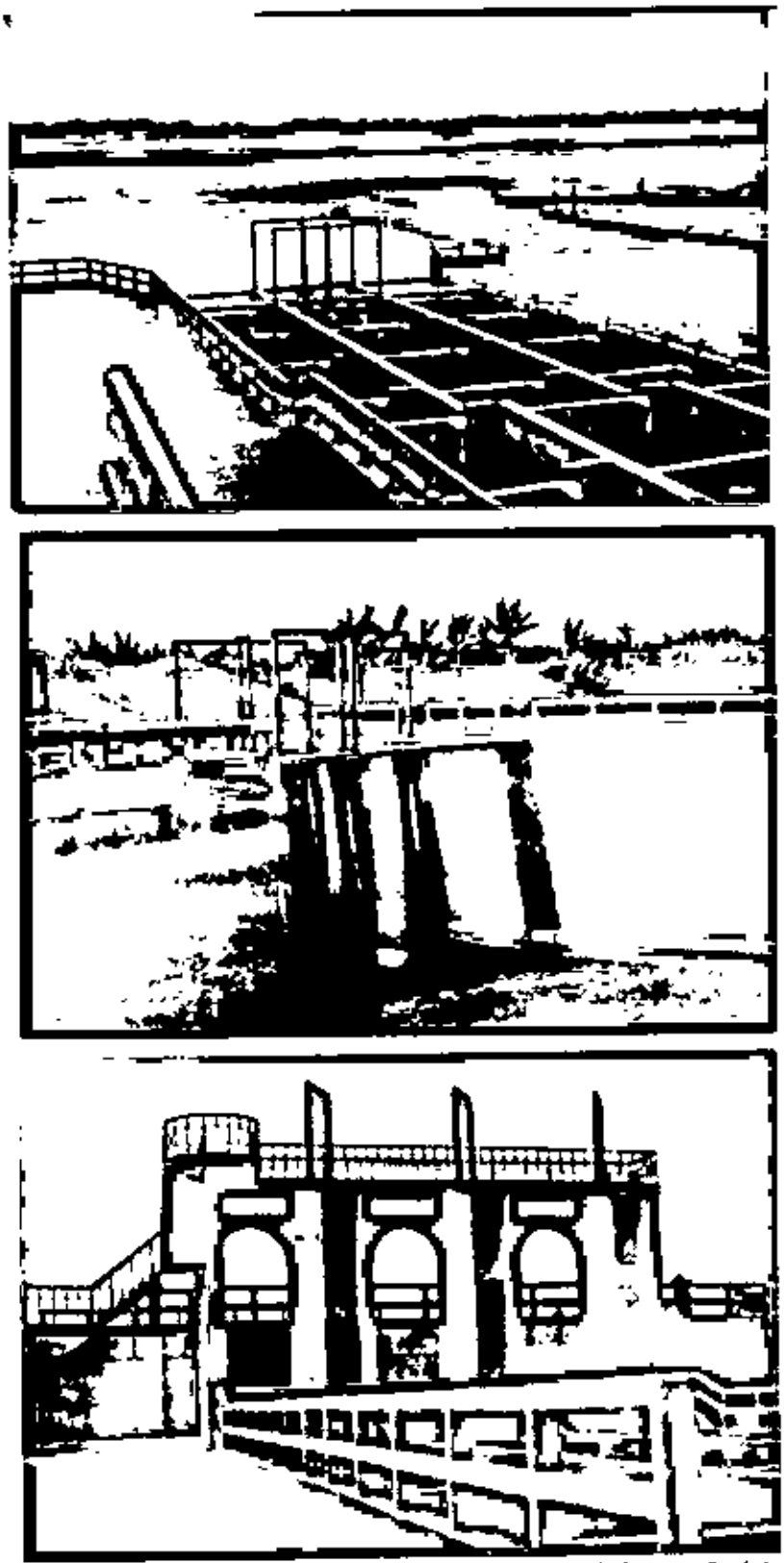


Photo 1.1: Fishpass structure in Jamuna to Bangli river at Sariakandhi.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The concept of a fish passes is of recent introduction to our country. Many works have been done on the fish migration and hydrological aspects in different water bodies in the world. However, in Bangladesh the number of such works is scanty. In Bangladesh very few of works have been done in this area. Among the study Kowadighi Fishpass pilot project study was carried out under FAP 6, 1998. In recent time there has been growing awareness amongst the research in our country to study open water fish migration and related hydrological and hydraulics aspects. Some of these aspects, collected from literature, have been discussed below.

2.2 Intervention and Fish Migration

Interventions in the form of embankments, sluices and regulators for FCDI schemes create obstacles in the path of migrating fish. To overcome the problem, structures may be designed so as to assist the fish to pass them. The efficiency of such fish friendly structures depends to a large degree upon the ability by designers to utilize knowledge of migratory behavior, spawning patterns and locations and swimming characteristics of the species. (FAP 6, 1998)

2.3 Migration Characteristics of Various Fish Species

Few open water fish are confined to one habitat throughout the year. The periodic and directed travel of fish mainly for feeding, breeding and overcoming adverse climatic conditions is called migration. From the point of view of migratory habits, fishes occurring in the rivers and flood plains are classified as (FAP 17, 1994):

- Resident species, which remain, confined within the local territories.
- Local migrants which perform seasonal migration within short distance for feeding, breeding etc. (20-30 km); and

- Long distant migrant, which perform regular annual migrations for feeding, spawning or both. They migrate substantial distances, up to several thousand kilometers, between widely different habitat.

The fish species has been divided into two categories viz. Black Fish and White Fish. The Black fish are essentially resident on floodplain. They would normally retreat into beels or other residual water bodies after the flood have receded. The include *testadineous, Heteropneustes* etc. The local Kai fish belongs to *testadineous* group and Shing fish belongs to *Heteropneustes* groups. During the dry period these fish move into the "Kua" or fish pits which are the last remnants of flood plain waters.

White fishes show some distinct migration within the river system, usually associated with spawning. The white fishes can be divided into three categories depending on the extent of migration:

(i) those with considerable longitudinal migration, which may be followed by lateral migration on to the floodplain e.g. Pangas, Maha Shoal;

(ii) those with limited longitudinal migration followed by lateral migration on to the floodplain (e.g. major carps such as Rue, Katla and Mrigel), and

(iii) those species which are truly "*Anadromus*" moving from sea into -the freshwater to breed e.g. *Hilsha (Anadromus* type of fish migration) .

Mainly carp and catfish, which over winter in the river to move into shallow areas within the Haor for breeding purposes. Other adult fish, which overwinter mainly within beels, migrate in the opposite direction (out migration) from Haor to the river area for spawning.

The migration pattern during the post-monsoon is a reversal condition at pre-monsoon. Older mature adult and young new adult fish move from breeding/rearing ground to over wintering areas.

Seasonal fish migration patterns divided into the following seasons as shown in Fig. 2.1 (FAP 6, 1998).

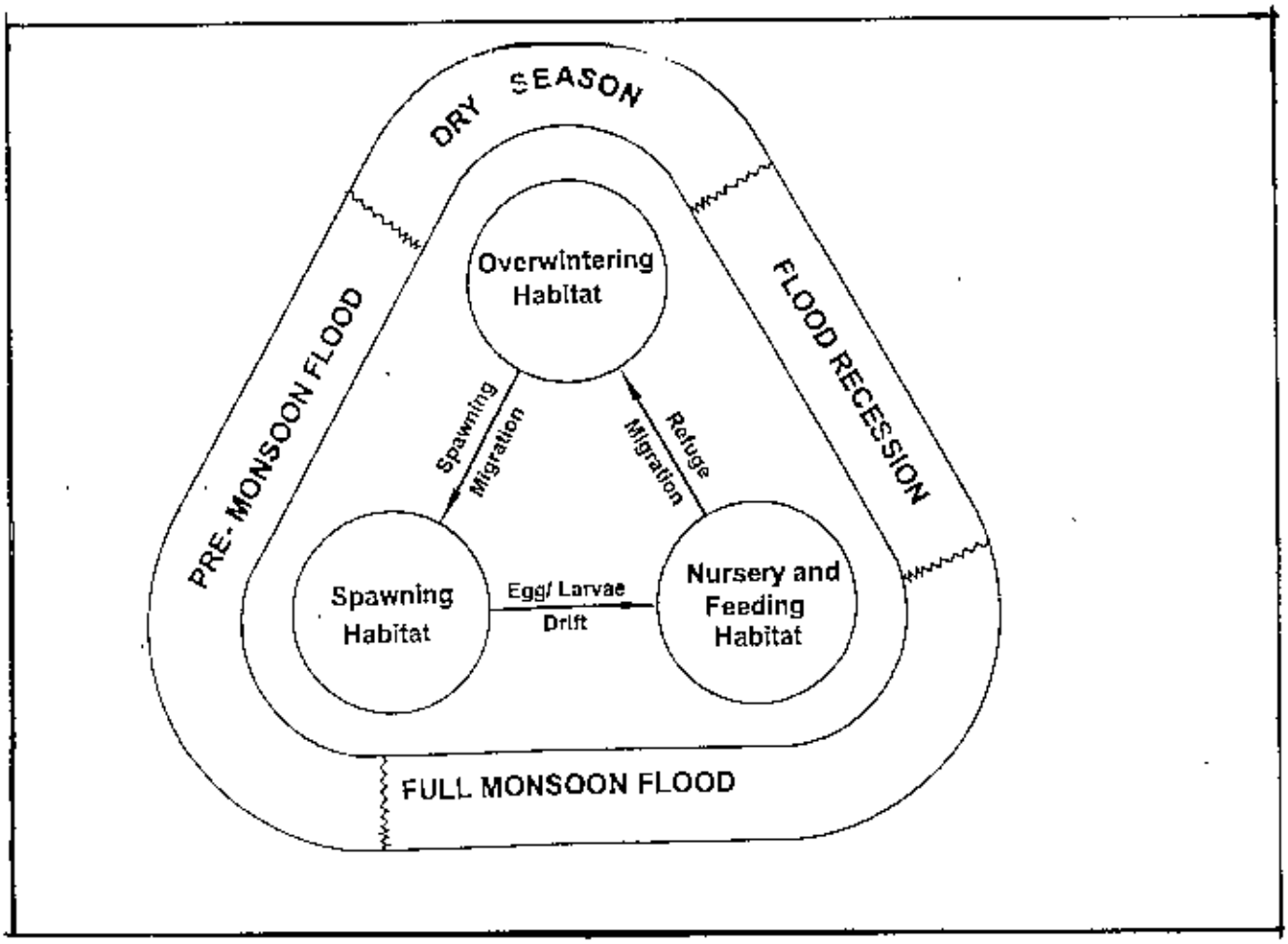


Figure 2.1: Seasonal fish migration patterns on floodplain in Bangladesh

Source : FAP-6

Overwintering dry season (December-March) - Broodstock and juveniles approaching recruitment size are concentrated in river duars and beels. No migratory movement takes place during this period.

Spawning migration season (April-June). This season usually begins during the pre-monsoon flood phase and continues into the first part of full monsoon flood phase. Fish generally move from deeper water to shallower water. Breeding takes place in shallower water.

Nursery/Grow-out season (June-Sept). This is the season of rapid fish growth. Fingerlings of those fish which bred on the floodplain are on the nursery ground so they do not have an access problem but the fingerlings hatched from the river breeding species need to get up to the floodplain.

Flood recession season (Sept-December). Floodwater starts receding. As water area shrinks fish move into deeper water navigating along khals and river channel, majority migrate to deeper water during flood recession except a few species. A fish moving from floodplain out in to river normally moves along khal.

To summarize for the majority of fish species the following principal fish migration takes place: active breeding migration of brood stock from over wintering grounds to breeding ground: passive hatchling/fingerlings migration from breeding ground to nursery/grazing grounds, active migration of juveniles and brood stock from breeding and or/grazing grounds to over wintering ground.

2.4 Migration Pattern

The fish migration and movement pattern in the floodplain areas through a 12-month cycle is basically the same; however, some differences are observed with the varying conditions associated with different hydrological regions namely: northeast, southwest and south-central regions etc (FAP 6, 1998).

During the life cycle of fish, spawning, feeding and over-wintering belong to a single migration. Almost every fish migrate and move to fulfill some biological needs like spawning, feeding, larval development etc. Fishes require migrating to fulfill each of

these activities. Fish migration and recruitment is responsible for maintaining a sustainable population balance, bio-diversity and fish production of different habitats. The factors that largely control the events in the fish's life cycle are rain, temperature, duration and extent of inundation, fluctuation in water level, water flow and velocity in the river. The extent of beels and haors along with their inter-connecting channels and the overwintering grounds are also important factors that influences the life cycle of fish.

Purpose of fish migration is to fulfill three objectives: spawning, nursing/feeding, and overwintering. Fishes that breed in the river are major carps, air, chital, baghaair and small species. On the other hand, floodplain resident small fishes eg. boal and ghonia breed in the floodplains. Fishes start spawning by migration in the pre-monsoon, rear the young in the floodplain during monsoon and return to the deeper areas (beels, rivers/duars) for shelter during post-monsoon Golda chingri breeds in the coastal areas and their post larvae and juveniles migrate up to the floodplain, juvenile *Hillsha* migrate to the sea and return to the floodplain after maturing, while pangas remain in the rivers (Draft Feasibility Report, 2001)

Fishes that take shelter in the rivers and *beels* start moving with the onset of monsoon into the spawning areas. The destination and time varies from species to species; some prefer rivers, some prefer channels, while others prefer river/channel confluences or the newly inundated floodplains

The species that go to the rivers from beels for spawning are katla, rui, calibaus, mrigel, catfish, guizza, rita, pabda, bacha, gharua, batashi, kajuli etc. Major carps migrate from the *beels* and duars against current in the rivers/channels longitudinally for spawning in March-May. In the NE region, they start migration for spawning early. This happens because rain and favorable conditions for migration start in this region earlier other areas. In the northwest and other regions, migration for spawning starts more than a month later (FAP 6, 1998).

After spawning in upstream locations, the adult carps migrate downstream and than move laterally in to the floodplain for feeding. The hatchlings in early stages migrate

or get swept downstream with the river current and gradually enter the inundated floodplain for feeding and growing.

Many mature boal, tengra, air, rita, ghonia, tatkini, rui, kalibaus and mrigel were observed ascending (migration for spawning) against heavy current through Kakura *Khal* in the Surma-Kushiyara area as they moved from the Surma river to the floodplain during mid-March to May (FAP 6, 1998)..

Fishes that start moving for spawning as soon as water inundates floodplains of the beel are koi, singh, magur, puti, gutum, guchi and snakeheads that remain in the beels throughout the dry season. These fish species migrate locally and laterally to the shallow floodplains, adjacent *beels* through connecting channels and inundated low lands for spawning, feeding and growth. Mature eels, many small fish species and small shrimps carrying eggs migrate to floodplain during early monsoon both against and in favor of current for spawning. It is estimated that about 30 species migrate actively or passively from the rivers to floodplains during this time (Draft Feasibility Report, 2001).

2.5 Riverine Fish Migration in Bangladesh.

On the basis of their behavior mainly related to migration and reproduction, the fish species of Bangladesh can be divided as Whitefish and Blackfish (Tsai and Ali, 1985). Blackfish species are able to tolerate the de-oxygenated water conditions of the dry season floodplain water bodies and may spend most of their lives in a single water body.

These include species such as snakeheads, catfish and climbing perch (*Anabas testudineus*). ''Whitefish" migrate upstream and laterally to the inundated floodplains adjacent to the river channel in the late dry season or early rainy season in order to spawn in the quiet nutrient-rich waters. The eggs and larvae of these species are drifting downstream and are entering the floodplain with the floodwater, where they feed on the developed plankton. At the end of the rainy season, the adults and young of the year escape/migrate to Main River channel in order to avoid the harsh conditions of the floodplain during the dry season. White fish or Riverine fish in

Bangladesh consist mainly of Rui, Cattla, Mrigal, Pangash, etc and they compose 5-10% of the total inland catch of Bangladesh (DoF, 1998) The fry migration route in Bangladesh is shown in Fig. 2.2.

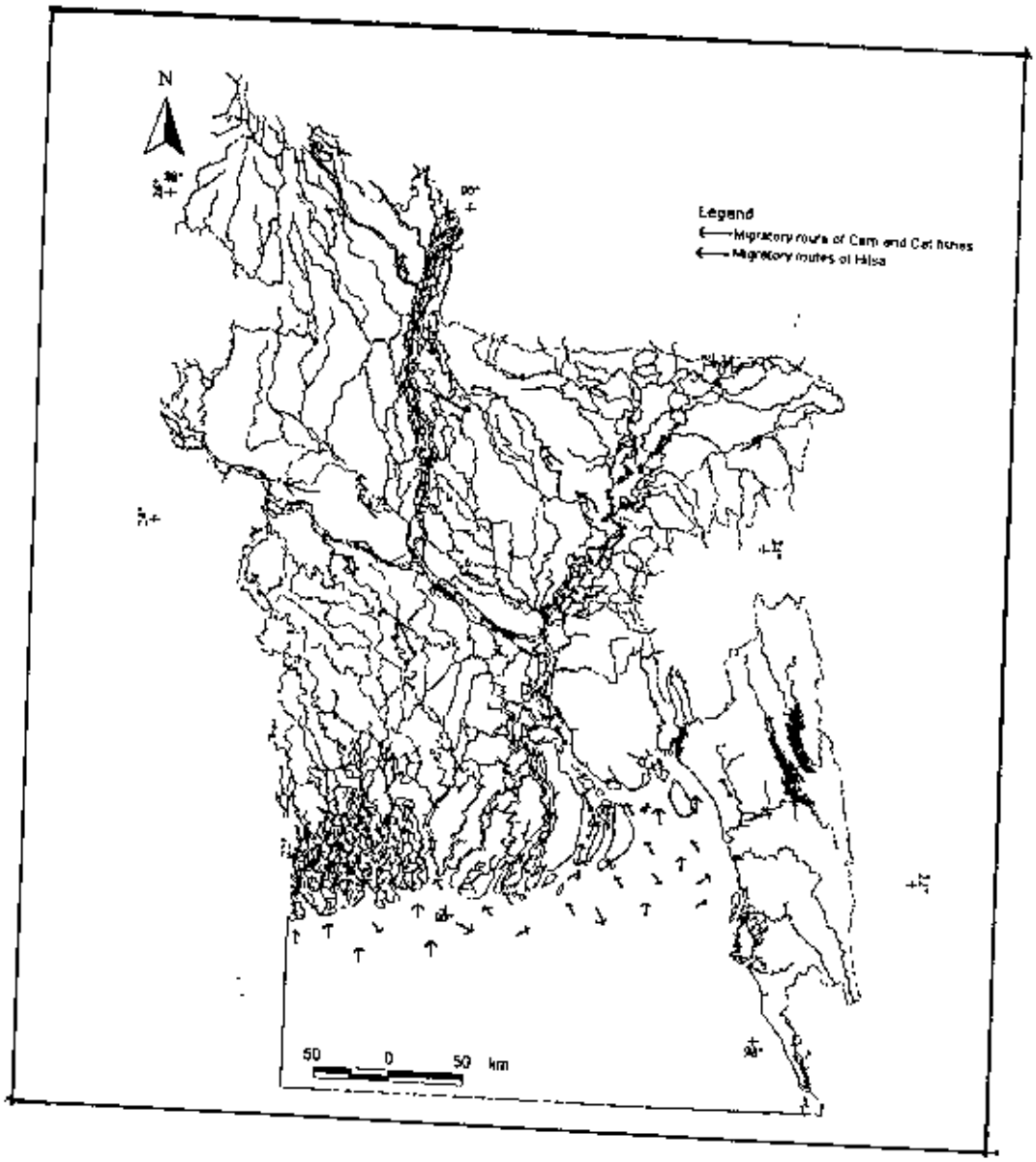


Fig. 2.2: Fry migration routes in Bangladesh.

Tsai and Ali (1985) first studied migration and spawning of the major carp in Bangladesh in 1983-85. They found that the major carp in Bangladesh were comprised of three stocks: the Brahmaputra stock Padma stock and the Upper Meghna stock. The Brahmaputra stock is the largest stock in Bangladesh, and its spawning grounds are located in the Southern tributaries of the Brahmaputra river in the Assam Hills and Letha Range, Assam. Upstream migration of adult major carps in the Jamuna/Brahmaputra River starts in March, coinciding with the gradual rise of water level. Spawning starts in May, with the onset of the Southwest monsoon, and continues till the end of July (Tsai and Ali, 1985).

The long range of the migration of reverie fish and the return of the larvae makes them vulnerable. Large numbers of adults are caught before they reach the spawning place. The newborn larvae are searched for by predators and fishermen and encounter numerous water management structures such as sluices and regulators before they are back in the floodplains. Consequently their numbers decline significantly on their way down to wards the floodplain as indicated (Tsai and Ali, 1985).

2.6 Mechanism of Fish Migration

The migration timing depends on interaction between physiological state of the fish and external triggering factors in the environment (Hoar 1958, 1976; Fontaine 1975; Woodhead 1975; Meier and Fivizzani 1980; Northcote, 1984). The thyroid hormone is the important factor for migration (Godin et al 1974) but also for orientation (move upstream or downstream) The thyroid activity also may in part be timed by the lunar cycle (Grau 1982). Further more due to thunder some of the catfish in the beel also triggered in the preparation for thyroid activity. *Hilsha* can migrate from sea to fresh water as it body has osmo-regulatory capability to adjust both saline and non-saline condition but carp can not. The sensor system of a fish received signals from the environment and affects its migratory behavior. The environment stimulus such as hydrology, water current, light or temperature acts as a "director" of movement.

2.7 Migration Factor of Fish

Migrations are mostly for spawning take place when fishes actively flee adverse conditions. Many factors influence migratory movements, they may be grouped for convenience as (Lagler, 1967)

- Physical
- Chemical; and
- Biological

Physical factors include bottom materials, water depth, pressure (water and almospheric), current and tide, turbidity, topography, gradient, temperature and light-intensity, photoperiod and quality.

Chemical factors are salinity, alkalinity, hydrogen ion concentration, dissolve gases, odors, taste and pollutants.

Biological factors of migration are blood pressure, sexual development, phototaxis, social response, predators, competitors, hunger, food, memory, physiological clock and endocrine state.

The foregoing factors intact in various ways to continue direct and arrest migrations and movements. Throughout, nervous and endocrine mechanisms are important in orientation and timing.

2.8 Hydrology, Hydraulic and Fish Migration

Hydrological and hydraulic changes influence the total process of fish migration. The migration of fish for breeding, grazing and recruitment are rearranged along with the hydrological and hydraulic changes (FAP 6, 1998).

Table 2.1 shows the influences of hydrology and hydraulics on fish of northeastern region but can be applied in other parts of Bangladesh with some modifications, especially with the time factor (EGIS, 1997).

Table 2.1: Influence of Hydrology and Hydraulic on Fish Activity in Northeast Region

SL. no.	Hydrological and Hydraulic Factors	Beginning/Usual Time	Influence on Fish Activity
1	Rain	February-April	Influence to breed small fishes
2	Thunder	February-March	Breed small fishes and prepare big fishes for breeding, spawning migration of carps and catfishes
3	Water Level Rise	March-May	Breeding of small fishes, Spawning migration, dispersion of hatchlings of small fishes
4	Water Current (pre-monsoon)	March-May	Spawning migration and hatchling distribution
5	Inundation	June-September	Grazing and feeding in the floodplain
6	Flood	June-September	Mixing and dispersion of species, migration and movement
7	Fluctuation of Water Level	May-August	Dispersion of fish and breeding
8	Water Recession	September-November	Taking shelter to perennial water bodies
9	Drought	December-February	Shelter in deeper water bodies

Source: EGIS, 1997

Both longitudinal and lateral migration is strongly influenced by hydrology, Hydraulic factors and its seasonality. Table 2.1 summarized the influence of hydrology on fish activity. At the onset of monsoon, March to May, rain starts with thunder and water accumulated in low pockets and beels. The river water level start rising and eventually inundates the floodplain. Water from river and with the rainfall run off brings more food in the beels for aquatic ecosystem. The rapid growth of fish food in the floodplain making it suitable for spawning, feeding and growth of fish During early part of the pre-monsoon the major carp moves longitudinally from the beels and duars against the river current in the river to the spawning ground.

At the recession of monsoon, the fish start migrating to the deeper water bodies. After spending three to six months in the floodplain, some of the fish species at all growth stages migrate back through the canals to the river. This outward migration, predominantly passive migration, starts from mid-September and continue up to November. Some fish migrate from river to the beels and remain refuge in the winter. Early rainfall and flooding enhance and widen the spawning and spawning migration while late monsoon can delay or migration and productive activities.

CHAPTER THREE

OPEN WATER FISHERIES AND FISHPASS STRUCTURES

3.1 Introduction

More than 266 species of indigenous fish (IUCN, 2000) and over 20 species of indigenous prawns have been recorded in the open inland water system (Rahman, 1998). Many of these species migrate considerable distance upstream (under the stimulus of rising water) to reach spawning areas; the fish then move out over the floodplain as water extend laterally (Ali, 1989). A direct relationship can be drawn between the magnitude of the annual flood event and total fish production (FAP 6, 1994). Breeding of inland fish are intimately bound to the sequence of annual flooding (Welcome, 1985). Monsoon floods connect the primary habitats types like rivers, canals, floodplain, haors, and beels of the inland of the open water to increase fish population in number and biomass. Nutrition-rich and food-rich floodplain also provides nursery and feeding ground for hatchling, fry, and juveniles and of a number of river-breeding and floodplain-breeding species (Ali, 1991). Young fish utilize floodplain nursery and grow-out habitats for four to five months before entering riverine or estuarine habitats (Agure, 1989). Hence to sustain fish production needs to maintain the fish habitat and proper connectivity with the river/flow system.

3.2 Fish Habitats

Water creates fish habitat and without habitat there is no fishery. The amount of water necessary to provide adequate and stable habitat will also provide for a healthy fishery. Fish preferred specific depth classes on a floodplain and biodiversity is related to the subsistence fishing activity in the floodplain (EGIS, 1997). Hence, it is important to allocate the minimum amount of water necessary to protect and maintain habitat. By protecting habitat automatically protect fisheries and fish biodiversity. Five primary maintenance habitats relate to major fish divisions:

Perennial Beel: all major fish species can be found in small to large beels which hold water throughout the year.

Seasonal Beel: small fish species utilize small, seasonal beels early in the season and then hold in very shallow areas within vegetation as water recedes.

Khals: khals (canals) are habitat which connect beels with rivers and distributory channels and provide migratory routes for fish between rivers and floodplain-beels. Fish species frequently hold over in isolated pools and pockets of water.

Rivers: the principle source of migratory species and other riverine species which migrate out of the floodplain with receding water to hold in pools and other deep water.

Pagar: most ponds in Bangladesh are maintained for fish culture purposes and the fish species are typically aquaculture species. Pagars are small seasonal ponds defined only after water recedes from the floodplain in beels where subsistence fishing occurs.

Flood control or other water development inputs on fisheries can then be predicted as the loss of specific fish habitat quantities (i.e., amounts of spawning, nursery) and the reduction of aquatic habitat.There are two principle seasons in Bangladesh (wet and dry) which define the available fish habitat at any given time. Fish species native to Bangladesh waters have evolved with and adapted to the hydrologic cycle. During the monsoon season (May through October) fish expand their range throughout the floodplain, while in the dry season fish seek refuge in discrete bodies of standing water. During each of the two seasons fish life cycles are quite different and have evolved to capitalize on habitat which has been created by hydrologic conditions (FAP 17, 1994).

3.2.1 Dry Season

The dry season starts from December and ends in March/April In the dry season fish are confined to several types of habitat. During the dry season, which is the most stressful time of the hydrologic cycle, fish are in a maintenance or holding cycle in standing water. Except for a few small fish species, spawning and early rearing does not occur during the dry season. Recruitment of young-of-the-year fish into the population has already occurred, and dry season habitat can therefore be defined as maintenance habitat.

At the end of dry season, breeding activities triggered depending on the rainfall and water volume in the floodplain. Magur, shingi, koi, and gazar start breeding at the end of March and early April.

3.2.2 Wet Season

In the wet season, the floodplain environment offers a dramatically increased living space and availability of resources. During the peak monsoon period, floodplain rich with food supply and development of young fishes is extremely rapid and eggs tend to hatch relatively quickly – for example the eggs of major carps hatch within 16 hours.

The wet (monsoon) season habitat can be termed life cycle habitat. Fish initiate migration and spawning activities in response to rising water levels across the floodplains Those fish holding in beels, canals, and rivers emerge from the dry season habitat and move to spawning areas. While spawning and nursery grow-out occur primarily in shallow water areas of the floodplain.

3.3 Fish production

The fish production includes the standing stock and production estimates for number of habitats such as river, beels and floodplains. The fish population consists of a stock which may represent a single species, a group of species having simular recruitment, growth and mortality characteristics, or a community interaction through the flood regime and its ecosystem (Welcomme & Hagborg, 1977)

In Bangladesh, over 266 species, several type habitats and further more complex hydrology which make complicated to estimate fish production. Catch of fish is used to visualize the size of the fisheries population. Prior to 1983/84, fish production estimates were based primarily on fish consumption data generated by the Nutrition Survey of Rural Bangladesh for 1962-64, 1975-76 and 1981-82. Bangladesh Fisheries Survey Statistics (BFRSS) uses different statistical approaches for different water bodies groups such as river fisheries, beel and subsistence catch on flood lands (BFRSS, 2000).

River fisheries production is estimated to use CAS (Catch Assessment Survey) at selected fish landing points. Beel production estimates are derived by determining

mean yield per unit area for some selected beels through surveys, and then multiply by the total area of beels in each greater (old) district. Where subsistence catch on the flood lands is determined by CAS of sample households in selected villages to determine the mean catch per households and then multiply total households by districts.

3.3.1 Fish catch trends

The open water inland capture fisheries grew by 5% per annum from 1984/85. Species composition of capture fisheries production is dominated by miscellaneous species (mainly chotomach). Carp and Ilsha are the boromach, which contribute to the total fish production about 20% and 18 percent respectively.

About 63 percent of the open water inland fisheries contribute from boromach of which 50% from culture fisheries. The trend of catch statistics of boromach and chotomach of capture inland fishery is shown in Figure 3.1.

Rivers are the most important harvesting habitat which accounts for 17% of the inland fish production. The river and estuaries production reduce about 2.5% per annum since 1984. The lower and Upper Meghna River contribute about 75% of the total river production. The *Hilsa* is the major species (about 80% of the overall principal river production) in the river and highest catch in the lower Meghna River. While carp and miscellaneous species mainly concentrated in the Jamuna and Brahmaputra river (FAP 17, 1994).

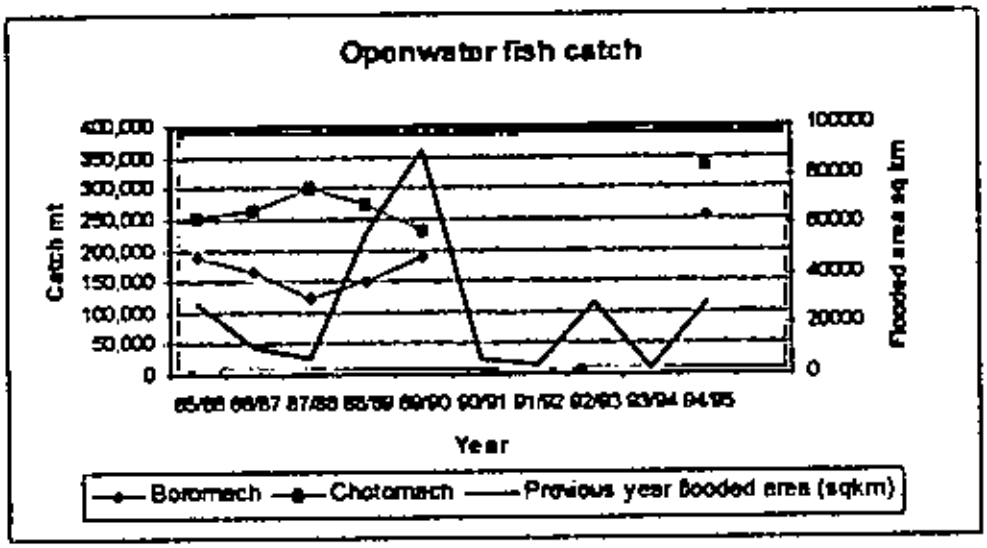


Figure 3.1: Open water fish catch (boromach and chotomach)
Source: FAP 17, 1994

The closed water (pond) culture production grew from 112,000 mt to 262,000 mt over the period of 11 year since 1984. Pond contributes about 23% of overall production. Pond production in greater Mymensingh district is mainly carps. More culture fisheries growing because of more awareness and knowledge about the financial benefits, micro-credit and more lands are protected by flood control projects.

The fish production for the floodplains, based on world wide data, snggests that values typically range from 40-60 kg/ha/year (Welcomme 1979; 1985). Welcomme (1985) estimated that the mean yield for tropical rivers at maximum flood is between 16-40 kg/ha/yr. Accounting for effort, Bayley (1988) suggested that maximum potential yields from tropical floodplains are of 110-160 kg/ha/year that means 13 fisherman/km2 including both full-time and part-time fishermen. The widely used Welcomme empirical equation for estimating floodplain fish catch prediction a MSY (Maximum Sustainable Yield) of 45 kg/ha/year. FAP6 made an estimate on nominal yield for the upper Meghna river floodplain in Bangladesh range from 37 to 45 kg/ha/year, suggesting that the floodplain is fully exploited and there may be worst then this case for the other floodplain in the country.

In Bangladesh, floodplain productivity ranged from 86kg/ha/year to 180kg/ha/year based on Third Fisheries project. The FAP 17's estimated mean yield for all open water floodplain was 107 +16 kg/ha/year. The catch per unit area (CPUA) for different fisheries habitats as obtained from different monitoring programs in Bangladesh is shown in Table 3.1.

Table 3.1: Catch per unit area (CPUA) by habitat

Habitat type	Unit	FAP1 7	FAP 20	FAP 5.2	FAP 3.1	FAP 6	Govt
Per. pond (cult.)	Kg/ha				2100		1820
Seasonal pond (cult.)	Kg/ha				600		
Beels (perennial)	Kg/ha				515	165	51?
Flooded land	Kg/ha				10		130
F3	Kg/ha	450	403	489			

F2	Kg/ha	110	123	152		132	
F1	Kg/ha	60	58			30	
F0/FF	Kg/ha	0	0	0		5	
Major river	Kg/km						
Regional river	Kg/km				158		
Canal							

Source: FAP 17, 1994.

3.3.2 Fish consumption

The fish is main source of animal protein in the rural area. The current national per person supply is calculated by FAO (Laureti 1991) as 7.2 kg per year. BFRSS data indicate that 11 million house holds carried out subsistence fishing in Bangladesh in 1991/92, catching 20.94 kg per house hold. Assuming that the average size of the house holds is 5; the estimated per capita supply from subsistence fishing is only 4.2 kg per person, which is an about half of the FAO estimate. However, if the subsistence catch is underestimated in BFRSS statistics (World Bank, 1991) the consumption per capita even less.

However, this estimate In Bangladesh, the historical trend in fish consumption is declining. In 1961, per capita supply was 14.4 kg/year but this decrease to 7.2 kg/year in 1989 almost 50% reduction shown in Figure 3.2.

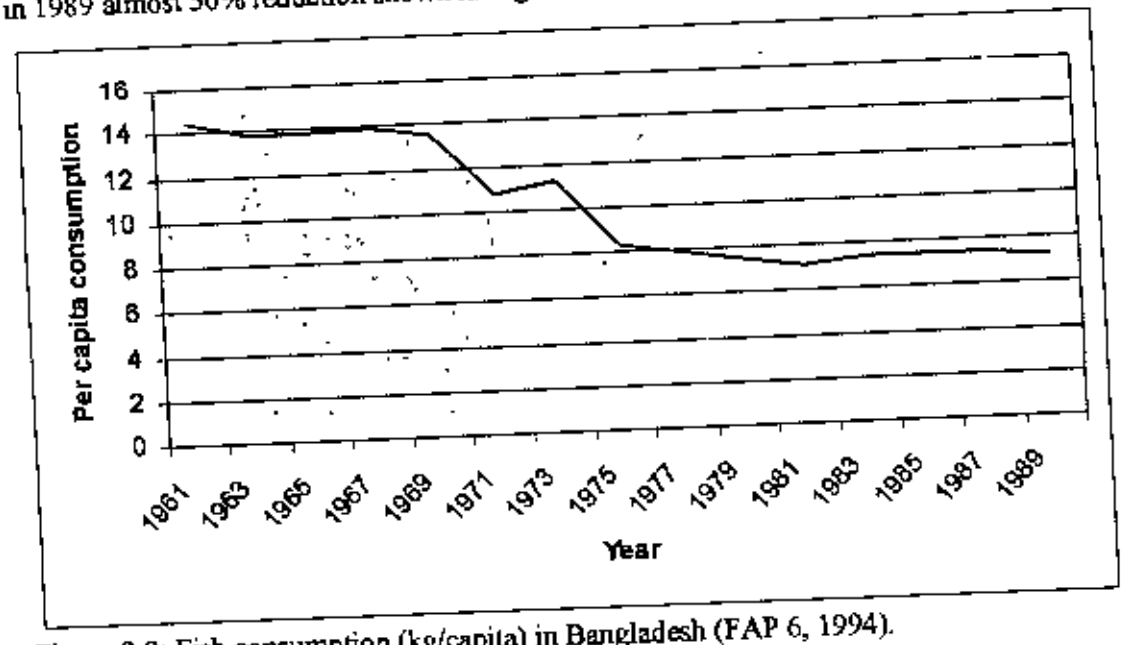


Figure 3.2: Fish consumption (kg/capita) in Bangladesh (FAP 6, 1994).

3.4 Flood control impacts on fish production

Flood control structures almost certainly entail the greater use of embankments to control or partially control the encroachment of floodwater (FAP 17, 1993). Though the evidence is fragmentary, it is clear that flood control does have an impact on fish production from the open water fisheries by obstructing the access of riverine fish to the flood-plain; thereby restricting their opportunities for feeding and reproduction. This obstruction would also limit the numbers of fish available to households living on the flood-plain.

Reduction of flood extent will decrease the extent of the feeding grounds for fish with a consequent fall in production of the fisheries. Reduction of flood depth may increase productivity of the aquatic environment and increase the availability of nesting sites for "blackfish" species; the effect of this on overall fisheries production is uncertain but could well increase the productive potential of the residential "blackfish" species. Restriction of river bank overspill will delay the inundation of the flood which will disrupt the breeding cycles of "whitefish" species and decrease the distribution of "whitefish" hatchlings over the flood-plain. This would have a major impact on the biodiversity of the fishery, with an unknown effect on the productive potential of the fishery. In addition, restricted access to the flood-plain through channels and regulators would allow application of more efficient fishing techniques, leaving the fishery more susceptible to over fishing with a consequent fall in long-tem production. Reduction of water flow through the flood control scheme will increase the risk of pollution with a consequent degradation of land and water resources leading to a fall in production. Finally increased drainage congestion would increase the aquatic habitat but the effect on environmental capacity is uncertain given the possible impact on water quality; the effect on fisheries production is therefore uncertain (FAP 17 Technical Document, 1993).

3.5 Fish Pass and Fish Friendly Structure

Fish-Pass structure may be defined as the structure through which all kind of fishes can move throughout the year (monsoon and Pre-monsoon). This type of structure is

very efficient in reducing big head differences between the River side and Country side (bed /floodplain). The structure elements of Fish Pass are so arranged that the difference in head be easily minimized. The structure is suitable for all kind of hydrological conditions in partial flood control, full flood control and tidal environments (Husain, 1998). A typical vertical slot fish –pass structure is shown in fig – 3.3

Fish-Friendly structure are generally designed to ensure flow from river to flood plain during monsoon (from June to September) period and are normally constructed as a part or adjacent to an existing regulator The main function of the structure is the safe movement of fish spawn, fish fry and fingerling including bigger fishes through it . The structure is suitable in full flood embankment. A Fish-Friendly structure is shown in fig 3.4.

In Bangladesh, structures to be circumvented are generally relatively low, and differences in water height are likely to be small when compared for example to hydro electric dam. However ideally there should he difference in water height across the structure since a flow of water is required to attract the migratory fish. A comparison between a Fishpass and Fish friendly structure is shown in table 3.2

Table 3.2: **Comparison of Fish-Pass and Fish-Friendly Structure**

Sl. No.	Fish-Pass Structure	Fish-Friendly Structure
1.	Suitable for all season.	Generally workable in monsoon season
2.	Effective in both partial and full flood control embankment projects	Effective in full flood control embankment projects.
3.	Ensure safe movement of all kind of fish round the year.	Ensure safe movement of fish fry, fish hatchling and fingerling
4.	A relatively bigger structure and expensive.	Comparatively small structure and less costly

Source: Draft Feasibility Report, 2000

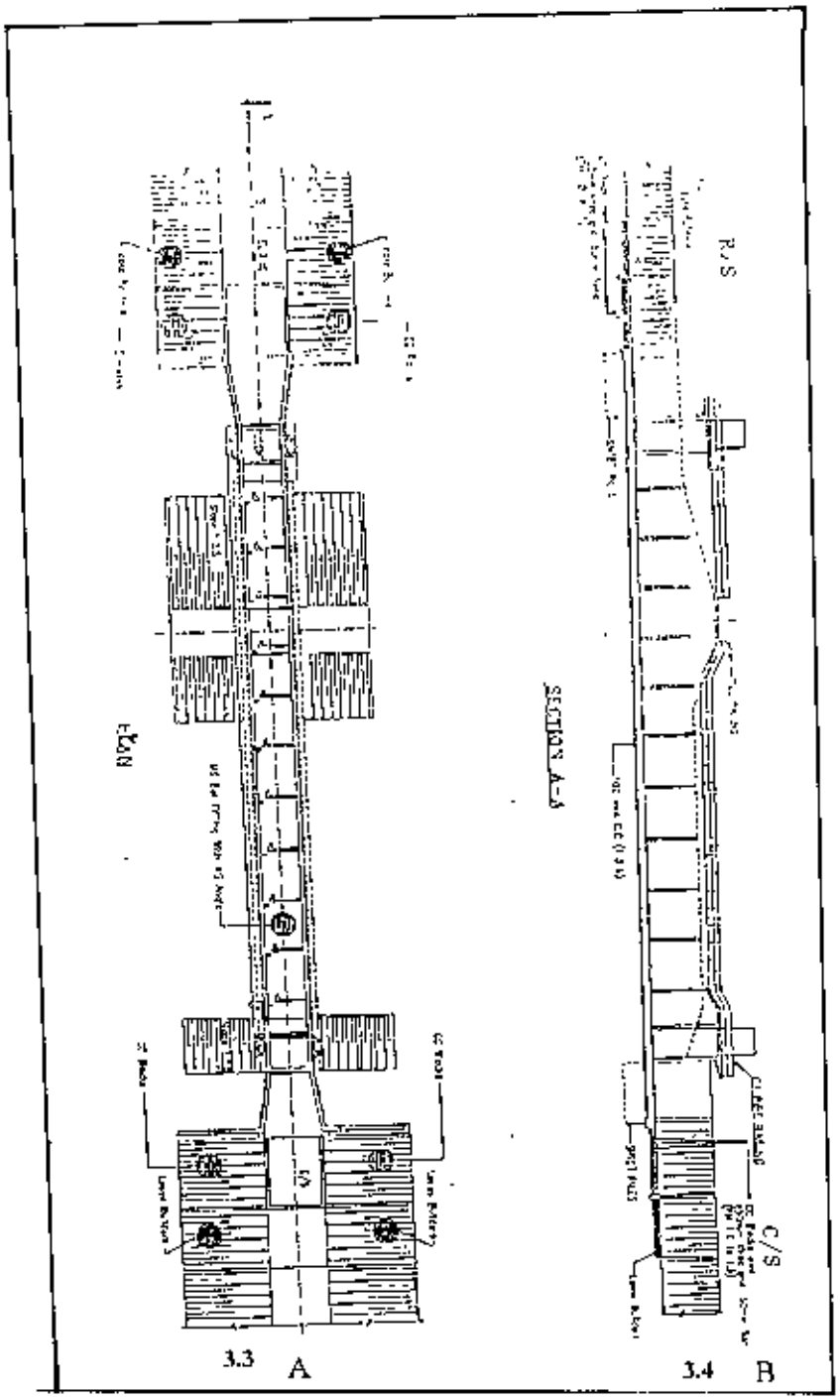


Fig. 3.3: A typical vertical slot fish –pass structure.(A)

Fig. 3.4: A Fish-Friendly structure.(B), (Source: Draft Feasibility Report, 2000)

3.6 Example of Fishpass and Fish Friendly Structure in Bangladesh

There are two fish pass structures and two fish friendly structure already constructed in Bangladesh is shown in photo 3.1 and some are planned to be constructed is near future. They are shown in the following table3.3.

Table 3.3: Locations and types of Fishpass and Fish Friendly Structure in Bangladesh

Sl. No.	Location	Regulator type	Constructed by
1.	Sariakandi, Bengali Nadi, Siragonj	Fish Pass	BWDB
2.	Kashimpur, Kawadighi Haor, Moulvibazar	Fish Pass	BWDB (FAP-6)
3.	Jugini, Lohajong River, Tangail	Fish Friendly Structure	BWDB (FAP-20)
4.	Morichardanra, Chapai Nababgonj	Fish Friendly Structure	BWDB

Source: Draft Feasibilirty Report, 2000.

3.7 Further Construction of Fish Pass in Bangladesh

To mitigate the negative impacts of FCDI projects on open water fisheries. feasibility studies (phase-I) of fish-pass and fish friendly structures are to be carried out in the completed 27 BWDB scheme distributed in 7 districts of Bangladesh. The districts are Sunamganj, Kishoreganj, Faridpur, Bagherhat, Gopalganj, Barguna and Patuakhali.(Draft Feasibility Report, August 2001)

Suitability of 27 sites in 7 districts are to be studied by the consultants. Table 3.4 and Table 3.5 show the district wise allocation of Fish-Pass and Fish-friendly structures. Out of 27 identified locations, 15 (8 for Fish-pass and 7 for Fish-friendly) structures are to be finally selected and a ranking for the implementation of the structures are to be provided on the basis of importance and feasibility.

Table 3.4 : **District wise allocations for Fish-Pass Structures**

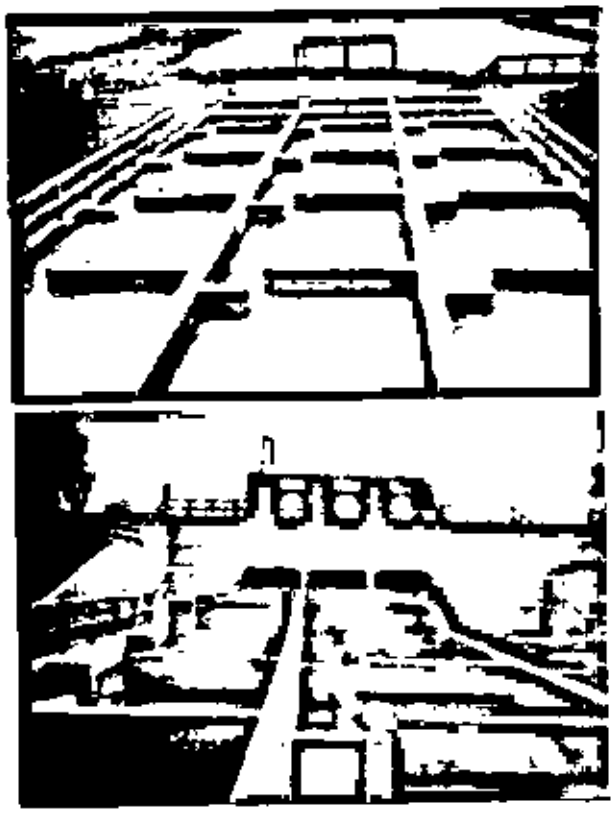
Sl. No.	District	Number of Structures	Comment
1.	Sunamganj	6	Out of 12 Fish-pass structures, 8 are to be finally selected
2.	Gopalganj	2	
3.	Kishoreganj	2	
4.	Bagherhat	2	
Total		12	

Source: Draft Feasibility Report August, 2001

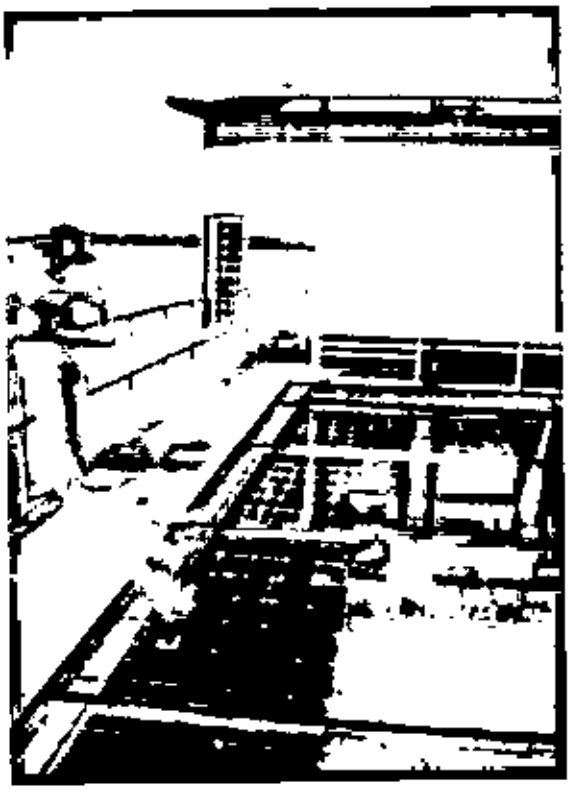
Table 3.5 : **District wise allocations for Fish-friendly Structures**

Sl. No.	District	Number of Structures	Comment
1.	Sunamganj	4	Out of 15 Fish-friendly structures, 7 are to be finally selected
2.	Gopalganj	2	
3.	Kishoreganj	1	
4.	Bagherhat	4	
5.	Barguna	2	
6.	Patuakhali	1	
7.	Faridpur	1	
Total		15	

Source : Draft Feasibility Report August, 2001



Sariakandhi Fishpass



Kashimpur Fishpass

Tangail Fish riendly Structure

Chapainawbganj Fish Friendly Structure

Photo 3.1: Fishpass and Fish Friendly Structures in Bangladesh.

CHAPTER FOUR

METHODOLOGY

4.1 Introduction

The methodology used in the present study is mainly the analysis of information collected from field visit, literature and secondary data.

4.2 Field Visit

Several field visits have been made in the study area during the study period (From March 2005 to March 2006). Field visits were made basically to collect primary data.

4.3 Literature Review

A detailed literature review related to fish migration and fish pass structure has been made.

4.4 Data Collection. Primary and Secondary data have been collected. During the field visit questionnaire survey was conducted and other data were collected. In addition to this, the data which have been collected by the questionnaire survey was verified through Focus Group Discussion (FGD). The movement of different types of fish has been observed. Fishing activities in and around the fishpass have also been carefully observed which was very essential to identify the problem prevailing for the fishpass structure. As such the main focus of the field visit was to assess the physical Structure and surrounding conditions of fishpass.

4.4.1 Secondary Data Collection:

Secondary data have been collected from different agencies and GoB publication. Information about fish migration characteristics and biological characteristics of fish has been collected from the following reports :

- Report of fourth Fisheries Project. Ministry of Fisheries.
- FAP 6 and FaP 17
- CEGIS report on fisheries and fishpass management.
- Small Scale Water Resources Development Project, LGED.
- Repots/ documents of the Bangladesh Water Development Board (BWDB), International Union of Conservation of Nature (IUCN), BETS, WARPO publication and other relevant literatures.

4.4.2 Primary Data Collection:

Fishermen opinion on project performance and fish migration were collected through questionnaire survey. The questionnaire was designed considering the objective of the present study. Questionnaire schedules were used to collect various information, viz. Name of the seasonal migratory fish species (Fish fry, Hatchling species and Spawning species).

a. Questionnaire Survey

Questionnaire Survey is a special decision making tool that will analyze the criteria to attend the management goals and will present the alternatives with scope the managers to take decisions. In another word questionnaire survey is the process to identify any potential conflict of interest and possible solution of such problems. A structured questionnaire (attached in Annexure) covering technical, institutional, beneficiaries participation, socio- economic, environmental and legal framework issues has been used to gather information from the local beneficiaries. The survey has been conducted in 4 unions (42 households of 12 villages) namely : Fulbari, Narchi, Sariakandi and Kutubpur in the floodplains of Jamuna and Bangali Rivers where the fish pass has direct impact. Among these Union Sariakandi Union is critical considering its location of the fish pass.

Questionnaire survey has been conducted in the area where the fish pass has direct or indirect impact in terms of fish production. To substantiate survey findings Four group discussions with the beneficiaries were carried out at important locations of the project area. Besides, interview session was also carried out with local BWDB and DoF officials.

b. Focus Group Discussion (FGD).

A total of four FGDs were carried out at the study site. Specific knowledge was gathered from an interagency coordination meeting arranged in the office of the Sub-Divisional Engineer, BWDB. Participation of all relevant stakeholders, such as , fishermen, farmers, businessmen, local elites, member of local government

institutions (LGIs), representatives from relevant NGO along with the government agencies (e.g., BWDB, DoF, LGED) have been ensured in that discussion.

Information from BWDB officials (Sub- Divisional Engineer, Sub- Assistant Engineer, Fishpass Operator etc), Department of Fisheries (DoF) officials (Upazila Fisheries Officer. Upazila Fisheries Extension Officer), LGED (Upazila Engineer, Sub- Assistant Engineer), Department of Agricultural Extension (DAE) officials, LGI members (Chairman, Member), local elites , school teachers and relevant NGO (TMSS) have been brought together to identify fisheries resources the factors that affect the management of the fishpass. A Total of 84 participants attended in 4 FGD session during the study period .

4.5 Sample collection

4.5.1 Sample period:

Seasonal variation of fish migration is divided into four period; such as over wintering dry season (mid December-mid March), spawning migration season (mid April-mid June), nursery/grow-ont season (mid June-mid Sept), and flood recession seaso n (mid Sept-mid December).

4.5.2 Sample frequency:

Fish species from the study area were collected twice per month.

4.5.3 Sampling procedure.

- Fish movement through fish pass has been observed and species have been collected and identified group wise.
- From the collected sample, size has been measured. The individual number of each species in a sample have been recorded.
- Sample collected from fish pass area have been preserved in laboratory, IWFM.
- Seven major types of fishing gears and traps were used. (Gillnet, Lift net, Scine net, Cast net, Long lines, Ghunrs Charus).

4.6. Catch Assessment Survey

Twice a month, the fishermen of the area catch fishes from the sanctuaries of the Bangali River. The Thengamara Mohila Sabuj Sangha (TMSS, a partner NGO) collects data on fish catches and fills up a form, which records both catch and effort. The TMSS staff collects catch data to estimate monthly catches. These data has been collected from the office of the TMSS and DoF office at Sarikandhi, Bogra.

4.5.3.1 Catch Assessment Survey data Analysis

Total catch : The relationship, which is used to estimate the total catch, is :

Total catch = (catch per unit effort) × (total effort)

The amount of catch per unit of fishing effort is termed as Catch per Unit Effort (CPUE).

Active fishing days : It is defined (gear specific) as the number of days in a reference period (e.g., a calendar month) during which fishing activities are normal. Usually this variable is defined in reverse manner, that is, by subtracting from the calendar days those days known for zero or negligible activity.

Effort: A fishing unit is defined by a fisher (or group of fishers in the case of gears such as the commercial seine nets) with a given types of gear and eventually the fishing craft used. One unit effort is defined by the fact that a given unit has fished during the past 24 hours. Two units mean that one fishing unit fished in two calendar days or two distinct units fished the same day. The definition does not account for differences in hours actually spent for fishing or in the time of the day, the fishing did occur. The estimated total effort is calculated separately for each group of fishing unit as follows :

Total effort = (N fishing unit) ×(days in the month) × C_A

The total number of fishing units (N) is known from regular standardized counting of the number of fishermen and the number of gears used at different sanctuaries in a month. The proportion of fishing units that are expected to fish during any given days is called the Activity Coefficient. CA

Total catch is being calculated to identify the impact of fish pass. The species composition and number of species that has been caught in a specific year can also be known from this assessment. It gives a clear idea about fish diversity and availability of missing species in the Bangali River after implementation of the fishpass. In a word this assessment provides the impact of fishpass on fisheries resources of Bangali River after implementing the structure.

CHAPTER- FIVE

Description of the Study Area

5.1 Introduction

Fish fry, hatchling, and spawning movement from Jamuna to Bangli river was the main objectives of Sariakhandi fishpass project. The construction work of embankment on eastern bank of Jamuna River started in 1996-97 and completed in 1998 while the construction work of the fish pass started in 1998 and completed in 1999.

5.1.1 Brahmaputra Right Embankment

The Brahmaputra- Jamuna River System is the largest river system in Bangladesh. An earth embankment, known as the Brahmaputra Right Embankment (BRE) was built during the late 1950s and mid 1960s along the west, or right bank of the Jamuna, extending for some 220km, as a protection against flooding

5.1.2 The River Bank Protection Project

River Bank Protection Project (RBPP) comprises of construction of river training works at 2 locations, site B1 at Sariakandi and site B2 at Sirajganj.

Site B_1

Under contract B_1, river training works have been constructed at the following 3 locations of Sariakandi Upazilla in Bogra district.

a) Rehabilitation of Kalitola Groyne
b) Construction of Sariakandi Hard Point
c) Construction of Mathurapara Hard Point

Construction of 6km of embankment to join the Kalitola groyne with the river bank protection works at Mathurapara, including provision of a fishpass structure has been completed under the Project at a cost of TK.187.58 million.

Site B_2

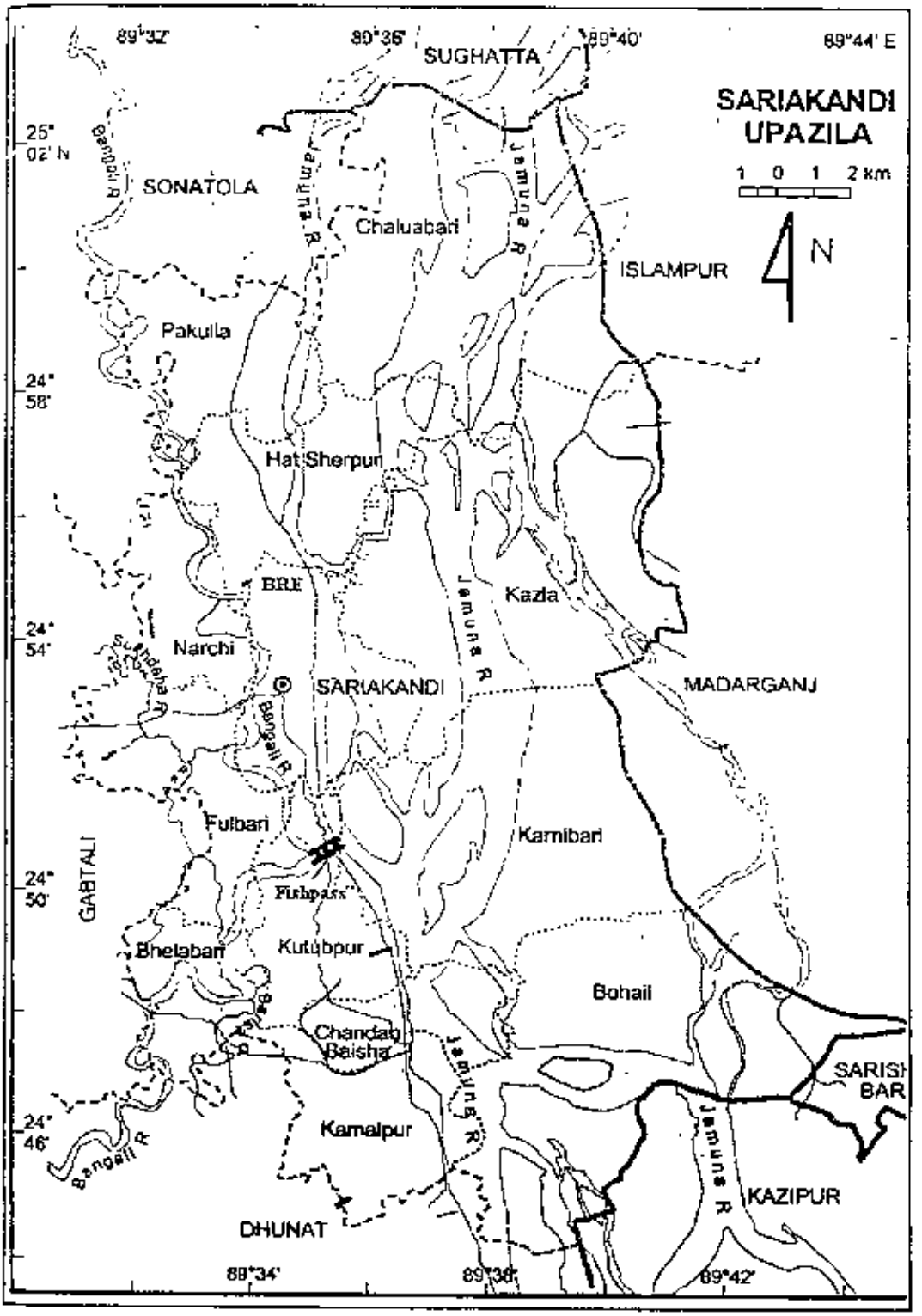
Under contract B2 a long reach of 2.55km revetment for river training works has been constructed at adjacent to Sirajganj Town.

5.2 Location of the study area

Sariakandhi thana is located in the Eastern part of Bogra district . The project area is bordered on the north by Sonatola and Saghata thana in Gaibandha district , on the east by Jumuna river, Islamganj and Motherganju thana in Jamalpur district, on the south by Kazipur thana in Sirajgonj district and on the west by Dhunut, Gabtoli and Sonatola thana in Bogra district .

Sariakandhi is located between 24°44' and 25°03' north latitudes and between 89°30' and 89°45' east longitudes. Road distance between Bogra district and Sariakandi thana is 22 km. The thana occupies an area of 433 km^2 including 112 km^2 Bangli and Jamuna river, 2 km^2 water bodies and Sand dunes of 49 km^2.

Sariakandi thana consists 13 Unions, 134 Mauzas and 164 Villages. Information of sariakandi upazila with reference to its fisheries is given in Table 5.1 and location map of sarikandi upazila is shown in Figure 5.1.



Source: Field Survey, 2006 and TFO, Sariakandi

Fig. 5.1: Location map of Sarikandi upazila.

Table 5.1: Detailed information of Sariakandi Upazilla with reference to its fisheries.

Number of Paurashava			1
Number of Unions			12
Number of households			51,000
Total population			28,9710
Fishermen (Source: TFO, Sariakandi,2004-05)		Full time	1500
		Part time	2000
		Subsistence	700
		Total fishermen	4300
Fishermen cooperative society	Number of cooperative society		8
	Total member of cooperative society		250
Ponds	Government	Number	0
		Area (ha)	0
	Non-government	Number	3000
		Area (ha)	250
	Total	Number	3000
		Area (ha)	250
Beels		Number	6
		Area (ha)	50
Rivers		Number	3
		Area (Km)	47(Km)
Flood plain area (ha)			200
Total area of water bodies			250
Fish market		Mobile	10
		Permanent	4
			14
Total production/catch of fish (Metric ton)		Pond	340
		Beel	90
		River	490
		Flood plain	180
		TOTAL	1100
Need of fish (80g/man/day)			3105
Deficit			- 2005

Source: Field Survey, 2006 and TFO, Sariakandi

5.3 Description of the Sariakandi Fish Pass

The Sariakandi fish pass in Bogra District is the largest and newest fish pass of the country.
Sariakandi fish pass is located at the western part of the Bolai canal - a link canal between the Jamuna River and the Bangali River close to Pardevdanga village under Sariakandi Upazila of Bogra district Bangladesh Water Development Board (BWDB) established the fish pass in the year 1999.
The fish pass located at the village Debdanga of kutupur Union of Sariakandi Upazila
The site of the fish pass is located about 25 km far from Bogra district town and 3 km far from Sariakandi upazilla head quarters The fish pass is at the nearest corridor between Jamuna and Bangali Rivers. The fish pass is situated between the Sariakandi and Mathurapara Hard Points. This is integral part of the Brahmaputra Right Embankment that allows fish movement between the Jamuna and Bangali Rivers.

5.4 Operations and Management of the Fishpass

5.4.1 The Management Committee

Sub-Divisional Engineer, BWDB organized a meeting in August 2001 regarding formation of the management committee. About 15 participants from different disciplines, viz. government officials. local elected representatives, community members attended the meeting. An 11-member Fish Pass Management Committee (MC) was formed in that meeting. management committee of Sariakandi fish pass is shown in Table 5.2

Table5.2: Composition of Management Committee of Sariakandi Fish Pass

Persons/Designation	**Position in the committee**
1. Upazila Fisheries Officer, Sariakandi	Convenor
2. Sub-Assistant Engineer, BWDB	Member Secretary
3. Upazila Agriculture Officer	Member
4. Upazila Livestock Officer	Member
5. Chairman, Kutubpur UP	Member
6. Member, Kutubpur UP	Member
7. Member, Kutubpur UP	Member
8. Local School Teacher	Member
9. Local Farmer	Member
10. Local Fish Pond Operator	Member
11. Local Fish Pond Operator	Member

Source : (Ghosh 2003)

5.4.2 Management of the Fish Pass

Though there is a management committee, in fact, the fish pass is solely managed by the BWDB. A gate-man for the fish pass has been deployed on temporary basis. He operates the fish pass as per the instructions of the BWDB officials (viz. SDE, Sub-Assistant Engineer or Section Officer). BWDB people do not share ideas regarding operation & management of the fish pass with other committee members or any member of the community.

There are four sanctuaries managed by the FFP (Fourth Fisheries Project), DoF in association with a local NGO named TMSS. Thangamara Mohila Somobae Somitee (TMSS) has organized communities for the management of sanctuaries but they are not involved in the management of the fish pass People involved with the sanctuary management alleged that the objective of the fish pass is not achieved due to following reasons:

i. Real fishers and poor people from within the communities are not included in the management process.

ii. Migratroy fish cannot reach the sanctuaries (caught before reaching sanctuary areas).
iii. Gates usually remain closed during peak fish migration period.
iv. Bed level of the channel (as well as fish pass) is higher in the early monsoon, water from the Jamuna River cannot enter and so not the fish immigrated in to the floodplains inside.
v. Usually the gates are opened at that point of time when water level of the Jamuna River remains high that creates higher current and turbulence caused higher mortality of hatchlings.

5.4.3 Management Problems of Fish pass

i) Community representation was not reflected in the Fish pass management committee (women, landless, and fishers are excluded from the committee)
ii) No meeting of the Fish Pass Management Committee was held after formation.
iii) Fishing (hatchlings, fingerlings and brood fish) in the fish pass channel hamper fish migration.
iv) There is no indication how the recurrent cost for operation, management and maintenance of the fish pass will be met.
v) Due to lack of community participation, community disowns the structure.

5.4.4: Recommendations

i) Meeting of the committee should be held on a regular basis.
ii) To make the fish pass effective, closed season and regulatory measures should be adopted.
iii) Representation of fisher, landless and women in the committee should be kept in to account.

iv) Committee members should be trained up on technical and operational aspects.

v) Mechanism should be developed for raising fund for the committee that can be used for holding meetings, management and maintenance cost of the fish pass.

5.5 Status of Fisheries Resources

As reported by the communities, fish catch has been drastically reduced in the project area (inside of the embankment) immediately after construction of the embankment. Availability of some commercially important fish species like, *golda* shrimp, *rui, kalibaus, bacha, chital* and *boal* was abundant before the construction of JRE (Jamuna Right Embankment) and those species now became rare in the area. But in the recent past, abundance of those fish species has been observed a bit higher compared to the situation immediately after construction of the JRE. People had varied opinion that this is not only due to the fish pass, rather the upper part of the Bangali River is connected with the Ghaghat River in Gaibandha district also contribute to reappearance of those species (Ghosh, 2003).

Facilities of fish culture increased inside the embankment. Presently, people can safely culture fish in suitable habitats that has contributed to increase overall fish production in the area. The opinion of the local community regarding availability of fishes in the study area is given in Table 5.3.

Table 5.3: Opinion of the local people about the fish species in the study area

Available Fish Species	Threatened Fish Species	Rare Fish Species
Katla, Rui, Puti, Tengra, Taki, Chanda, Small prawn, Chikra, Chela	Large prawn, Rui, Kaliboush, Chitol, Boal, Lal Machh, Shing, Magur, Gojar	Meni (Bheda), Pabda, Koi,

Source: (IUCN 2001).

5.6 Status of Biological Resources

In the study of performance evaluation of Sanakandhi fishpass (Ghosh, 2003), it was found that there are a total of 104 different fish species, 55 genera, 24 families under 10 order identified that are given in (Appendix-1). Most of the fish species are commercially important that is outstanding carps, catfish, eel fish and other fishes. In same study, it was also found that there are 3 phyla of fisheries item under the classes Crustacean (Arthropoda), Gastropoda (Mollusca), Amphibia, Reptilia, Mammalia (Chordata), that represents different species of fisheries item (Appendix-2).

CHAPTER SIX
RESULTS AND DISCUSSIONS

6.1 Introduction

Migration is an important biological feature of many fish species, but it has been adversely affected by flood control measures, which caused reduced water extent and connectivity. In order to permit fish migration, it is necessary to maintain conditions that favor migrants to reach their spawning ground. Hence the hydraulic structures must be designed such that fish can pass through without incurring damage to them.

6.2 Monitoring of hydraulic characteristics of Jamuna and Bangali river

6.2.1 Water Level

The water level data (1999-2001) at fishpass site has been collected from BWDB office of Sariakandi, Bogra. The data shows that there are two peaks in this river system. One minor peak develops at the onset of monsoon in July with major peak at the end of August. The duration of minor peak is higher than the major peak.

Almost all the time the water level of Jamuna River is higher than the Bangali River. It implies that the direction of water flow is from Jamuna to Bangali. Only at the end of major peak during the recessing stage, the water level of the Bangali occasionally crosses the water level of Jumuna River. The water level of Bangali crosses the danger level from July to mid September (Figure 6.1). On the other hand during July and August when the minor and major peaks develop, the water level crosses the danger level of Jumuna River. The extended minor peak facilitates the migration of fish from the breeding ground to the feeding ground. From the fish migration calendar it has been observed that the migration timing varies with category of fishes. The peak migration timing for carp and catfish is May to July. The carp and cat fishes start migration from April. In this river system the water levels start rising at this time which provide favorable environment for migration.

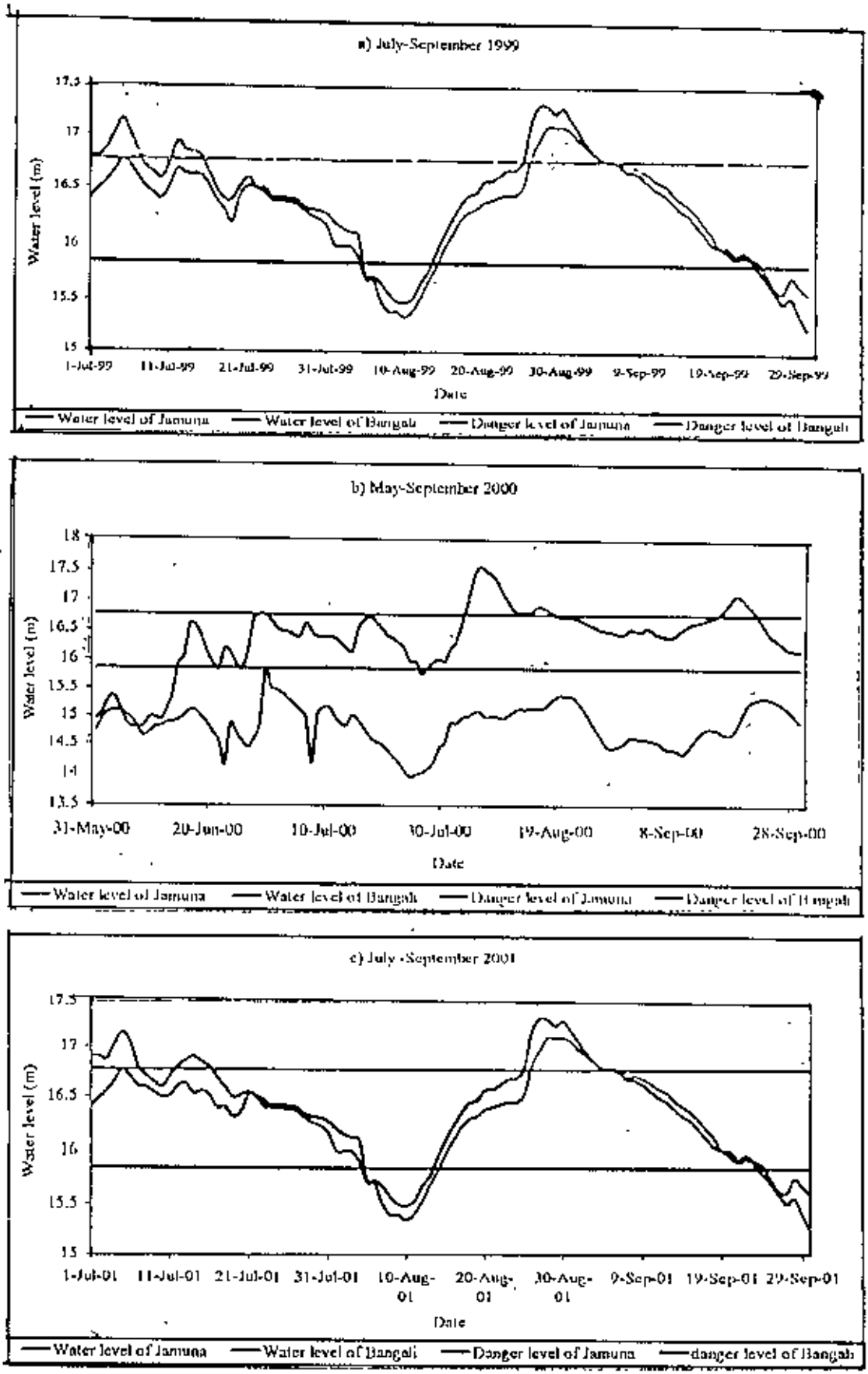


Figure 6.1: Variation of water levels in Jumuna and Banglai Rivers at Fishpass site

Source: BWDB at Sariakandi Office, Bogra.

6.2.2 Measured velocities at the Fishpass

The maximum velocity that an adult fish and juvenile can tolerate varies from species to species. For upstream migratory fish species threshold velocity (minimum velocity, which leads to an orientation reaction to move against the current, values range from 1-30 cm/sec) is another important parameter needs to be looked after. On the other hand critical velocity is appeared as another important parameter. Each species has a distinctive range of critical velocities (the minimum velocity at which fish just begins to be carried away by the water flow) which represents the maximum permissible velocity through the fish friendly structure or fish pass. The velocity in the left and middle vent of the fish pass from Mid September continuous up to Mid December is shown in Table 6.1 & 6.2.

Table: 6.1: Measured velocities at the left vent for different head differences at Fish pass area. **Source:** Biswas, (2007).

Head difference for Fish pass area (m)	Position and Velocity (m/s) (Left Vent	
	Upstream (m/s)	Downstream (m/s)
0.50	1.00	0.82
0.85	1.16	0.99
0.95	1.19	1.03
1.10	1.25	1.05
1.15	1.28	1.08
1.20	1.30	1.10
1.28	1.35	1.13

Table: 6.2: Measured velocities at the middle vent for different head differences at Fish pass area.

Head difference for Fish pass area (m)	Position and Velocity (m/s) (Middle Vent)	
	Upstream (m/s)	Downstream (m/s)
0 50	1.12	0 86
0.85	1.19	1.02
0.95	1.22	1.06
.1.10	1.27	1.13
1.15	1.30	1.15
1.20	1.31	1.17
1.28	1.37	1 21

The main objective of construction of vertical slot fishpass is that this type of structure enhances energy dissipation and provide resting zone for the fish to gain energy. After gaining energy it will travel the slot in a single effort and then it will again take rest. If the pool length and pool width is higher then more energy will dissipate within the pool. This will be lead to a decrease of velocity in the slot opening. It will also provide more area where the speed is equal to or less than cruising speed of fish.

6.3 Monitoring of Fish Movement

Information on movement of fish through the fish pass was acquired primarily by the fishermen who are used to catch fish in the fish pass area, and secondarily from visual observations of the water surface of the pools during seasonal basis, during a period from 10 March, 2005 to 10 March 2006. Migratory fish species are as groups categories like Carp, Catfish, Eel, Spiny eel, Knife fish, Sardine, Needle fish, miscellaneous species and prawns. Generally these fish species take shelter in the Bangali river during flood recession period. During sampling period presence of these fish species in the catch from the Bangali river, were collected. From the abundance of species in the catch and the catch frequency related that in the year 2004-05, the Knife fish (Chital) movement was high, but in the year 2005-06, the Carp fish as (Rui and Catla) are dominant species in the study area. The major migratory fish species, which moves through the Shariakandhi Fishpass, are listed in the Table 6.3.

Table 6.3: Group wise migratory species through Shariakandhi Fishpass

SL No.	Group	Common Name	Scientific Namh	Type of Fish	Total length (cm)		Breeding Season	Average catch (%) of total collection
					Min.	Max.		
01.	Native Major Carps	Rui	*Labeo rohita**	P	22	83	Apr-Jul	40
02.		Catla	*Catla catla**	P	24.5	80.5	Apr-Jul	
03.		Mrigel	*Cirrhinus mrigala**	P	20.5	80	May-Jul	
04.		Kalbaus	*Labeo calbasu**	P	23	48	May-Jul	
05.	Minor Carp	Bhagna/Raik (Lachu)	*Cirrhinus reba**	P	17	24	Apr-Jul	
06.	Minor Carp	Goni/Gonia	*Labeo gonius*	P	14	38	Apr-Jul	

07.		Sarputi	*Puntius sarana*	P	12	22	Apr-Jul	
08.		Puti	*Puntius sorphore**	P	7	12	Apr-Jul	
09.	Large Catfish	Boal	*Wallagu attu**	B	35	96	May-Jul	32
10.		Air	*Aorichthys aor*	B	31	81	Apr-Jul	
11.		Bagha Air	*Baharius yarrellii*	B	36	90	Apr-Jul	
12.		Rita	*Rita rita*	B	19	44.5	Not known	
13.	Small Catfish	Pabda	*Ompok pabda**	P	8	17	Not known	
14.		Kani Pabda	*Ompok bimaculatus*	P	10	18	Jun-Aug	
15.		Bacha	*Eutropiichthys vacha*	P	12	16.5	Not known	
16.		Garua	*Clupisoma garua**	P	8	18	Mar-Jul	
17.		Batashi	*Pseudotropius atherinoides*	P	4.5	9	May-Jul	
18.		Baspata	*Ailia punctata*	P	3.5	8.5	May-Jul	
19.		Tengra	*Batasio batasio*	B	3	5.5	Apr-Jul	
20.		Gulsha	*Mystos bleekeri*	B	9.5	17.5	Not known	
21.		Magur	*Clarias batrachus*	B	6	19	Not known	
22.		Shing	*Heteropneustes fossilis*	B	5	15		
23.		Kuwa	*Gagata cenia*	B	3	5		
24.		Kazoli	*Ailia coila**	B	2	5		
25.	Spiny eel	Bain	*Mastacembeleus armatus*	B	21.5	56	Apr-Jul	1.5
26.		Tara Bain	*Macrognathus aculeatus*	B	9.5	21.5	Not known	
27.	Losch	Rani	*Botia dario*	B	3.5	7.5	Not known	1
28.	Knife fish	Chital	*Notopterus chitala**	P	22.5	45.5	Apr-Jul	6
29.		Foli	*Notopterus notopterus*	P	16.5	34.5	May-Jul	
30.	Sardine	Chapila	*Gadusia chapra*	P	4.5	12.5	Not known	1.5
31.	Needle fish	Kaikka	*Xenentodon cancila**	P	11.5	21.5	Not known	1

32.	Miscellaneous species	Bele	*Glossogobius giurius*	P	9.5	23	Mar-Oct	14
33.		Shol	*Channa striatus**	P	12	42	Apr-Jul	
34.		Taki	*Channa punctaus**	P	6	18	Apr-Jul	
35.		Potka	*Tetraodon potoka*	P	3	8	Not known	
36.		Chela	*Dino deverio**	P	3	7	Apr-Jul	
37.		Fulchela	*Salmostoma phulo*	P	2	5	Apr-Jul	
38.		Chanda	*Chanda nama*	P	2	4.5	Mar-Oct	
39.		Kholisha	*Colisa fascianus*	P	3.5	6	Mar-Oct	
40.		Mola	*Amblypharyngodon mola**	P	2.5	5	Apr-Nov	
41.	Prawns	Golda Chingri	*Macrabrachiun rosenbergii*	P	8	14	Not known	3
42.		Icha	*Macrabrachiun spp*	P	2	5		
	Total							100

Source: Field study Survey, 2005-2006

Notes:

P	=	Pelagic Species
B	=	Benthic Species
Min.	=	Minumum size of fish Species
Max.	=	Maximum size of fish Species
*	=	Dominant Migratory Species

The migratory species collected from study area are analyzed and is found that the dominant fish species group is Carp and second dominant group is Catfish where as, Needle and Losch fish group is found only 1 percent. The percentage of each group of fish species is shown in Figure 6.2 and carps, catfish, and other fish species found in study area are shown in Photo 6.1 and 6.2.

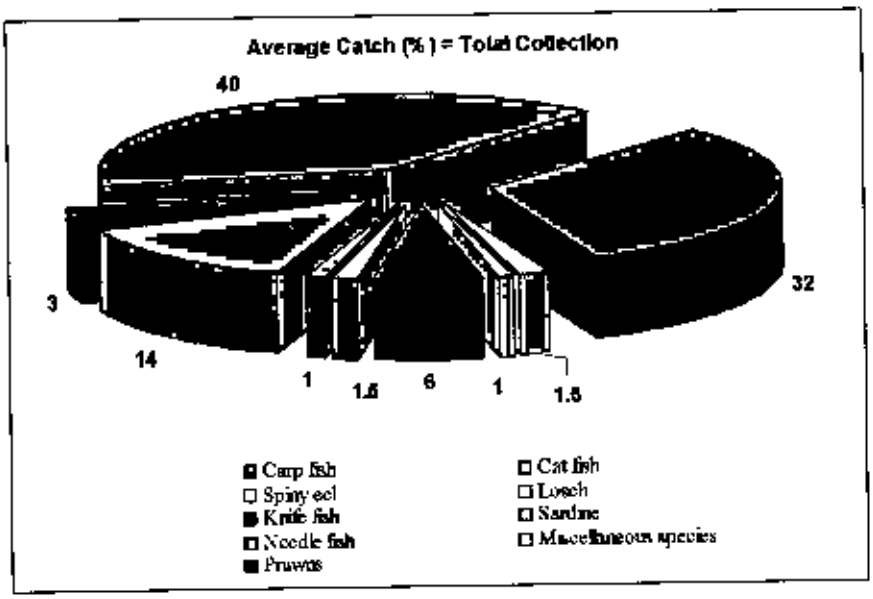


Figure 6.2: Percentage of different migratory species caught at Shariakandi Fishpass area.

6.3.1 Monitoring of fry (hatchlings) movement.

Movement of fish population to defined direction at defined period of time is known as migration. The causes of migration are mainly for spawning or egg releasing. The larvae or fish fry needs the ecological parameters, which are not similar to that of the adults need. In search of such suitable place the brood fishes migrate to spawning grounds. Some specie moves up streams and other move down streams for migration. Accordingly the spawn of those species are found at defined place at defined period of the year.

The dominant larvae found in the study area were carps and catfishes but the other species were not found in a larger scale. During the study period, fry (hatchlings) of the following fish species are available in the fish pass area:

Labeo rohita, Catla catla, Cirrhinus mrigala, Glossogobius giurs, Labeo calbasu.

Clarias batrachus, Puntius spp .

The most important species in the larval drift were *L. rohita*, and *G. giuris*. Among the major carps, all are entering the flood plain within the first 6-8 weeks of the flood.

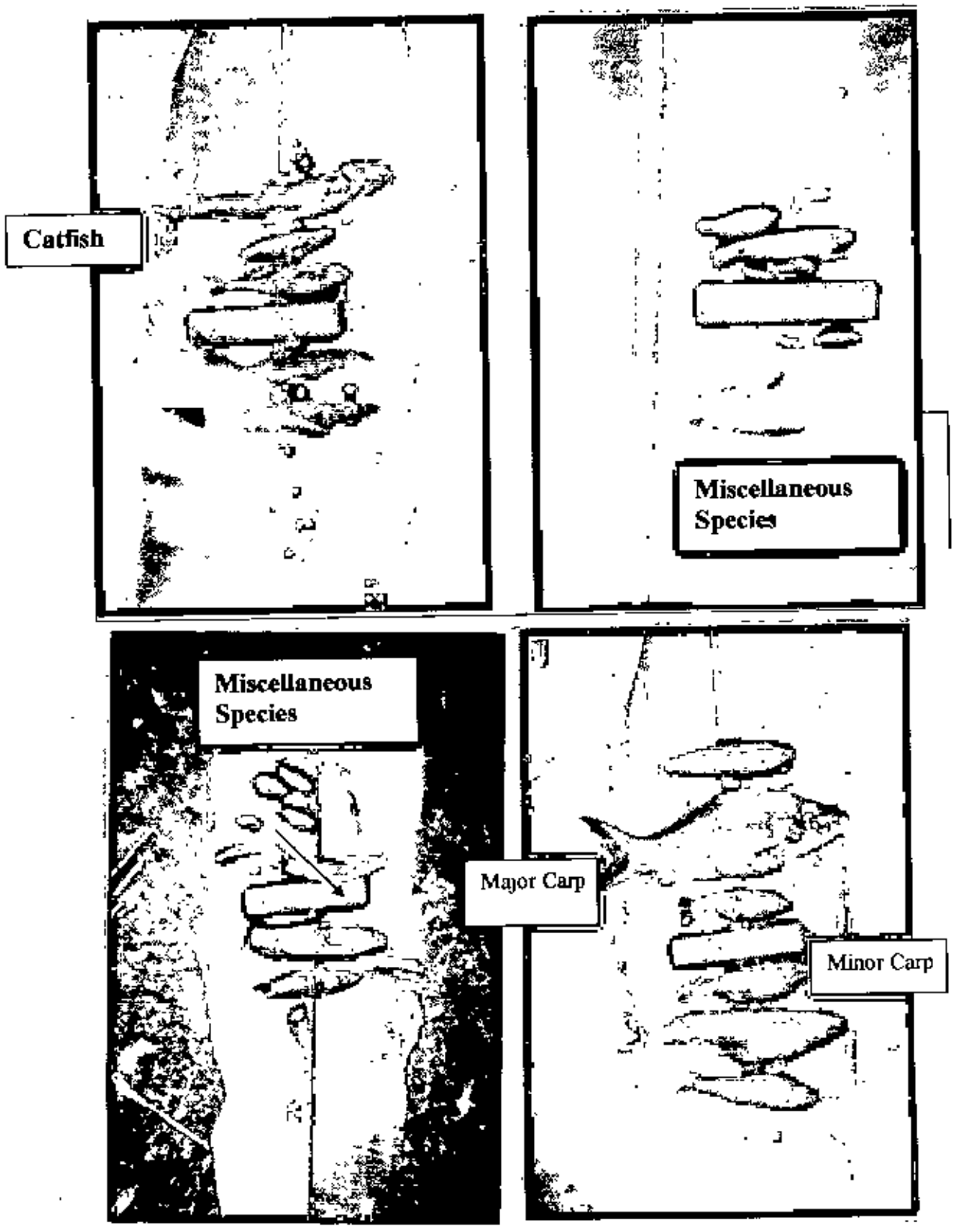


Photo 6.1 Carps, catfish and other fish species found in the study area.

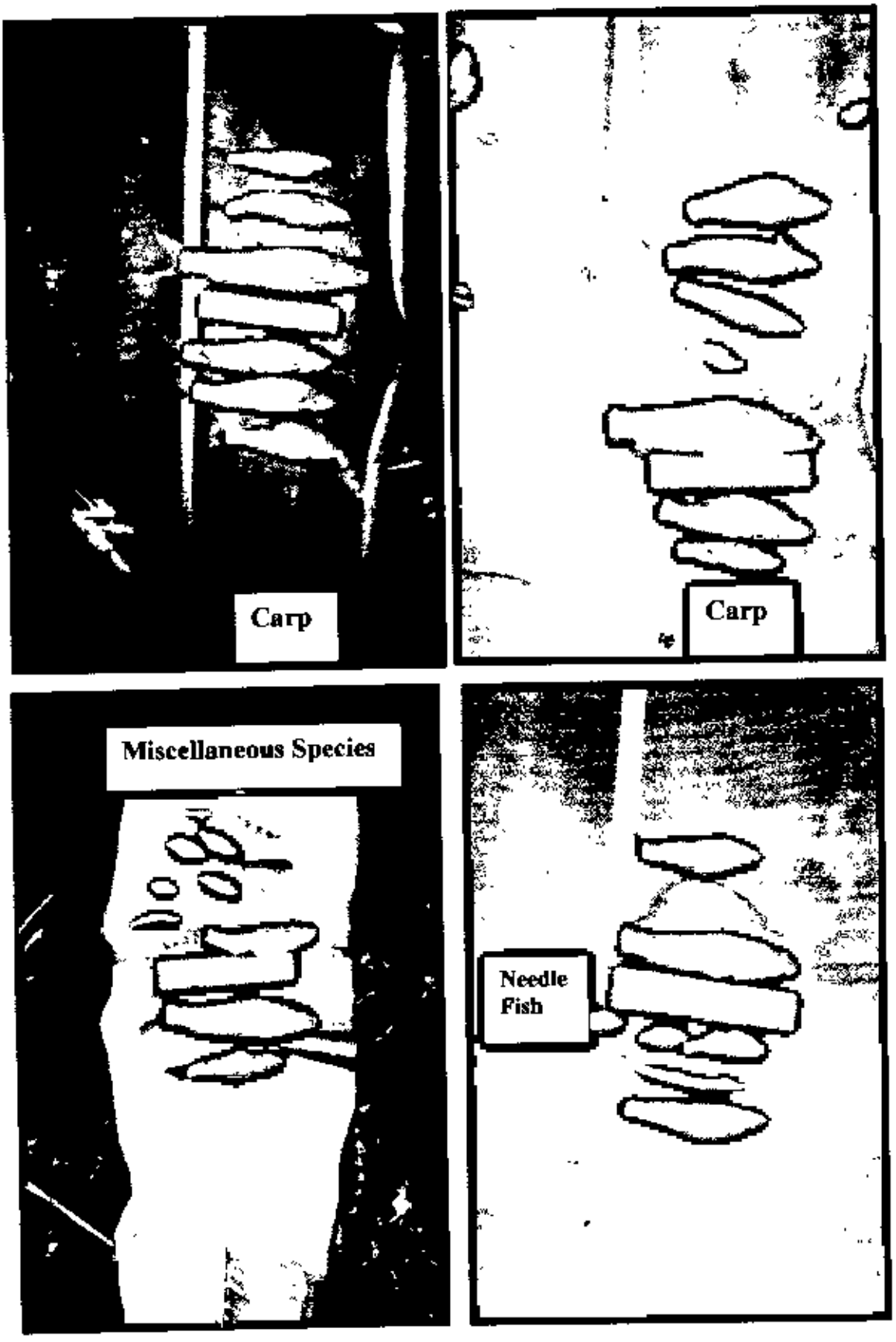


Photo 6.2: Carps, catfish and other fish species found in the study area.

6.3.2 Fish movement Impact of Fish pass

The main purpose of the fishpass is to ensure free movement of migratory fish species and other aquatic species from the breeding ground jamuna to the feeding ground of Bangali and its floodplain to restore natural environment, ecology and biodiversity. The structure has been designed on the basis of limited scientific information on the biological behavior of the local fish species. Thus the hydraulic conditions prevailing at this structure as well as time schedule of operation may not be appropriate and more investigation is required to fine-tune these aspects of design and operation. After the construction of BRE, large prawn (galda), rui, kalibaus, boal gojar were become threatened fish species and the meni, Chitol, pabda and mrigel were missing species until commissioning of the fispass. Missing species are defined as species which were not recorded in the area in recent years but recorded in the same area in previous years. This was due to the interruption in natural floeding system. During focus group discussion and questionnaire survey it has been expressed by the inhabitants of the locality that the production of threatened fish species has increased in Bangali River and the missing fish species are shown in Table 6.4.

Tabel 6.4 Threatened fish species and missing fish species in Bangali River.

Threatened fish species	Missing fish species
Rui	Gonia
Catla	Raik
Mrigel	Sarputi
Kalbaus	Air
Boal	Meni (Bheda)
Pabda	Rita
Chital	Batashi
Mola	Rani
Large prawn	Kholisha

6.4 Major Species wise catch composition in the Bangali River

Bangali River is linked to the Jamuna River though Sariakandi Fishpass which allows different fish eggs, juveniles, fingerlings and adult fish to migrate when the flow and velocity inside the fishpass is not too strong (mainly at the onset of rise of water level in the Jumuna River in (April – May). More than 80% responded that the structure allowed adult fish, fish fry and fingerlings movement through the structure. It is found that the fish catch before the construction of BRE was higher than the present situation. However the present situation is better than that of just after construction of BRE.

The fishpass commenced its operation in April 2001. Since then fish production has increased significantly in Banglai River and are shown Table 6.5.This is due to migration of fish through Sariakandi Fishpass. It has been found that two third of the total catch comprises to two different types of net. In 2002-03, the seine net being used for commercial purposes comprises nearly 60% of the total catch. It shows that fish catch on commercial group basis has improved. On the other hand, before the starting of fishpass, cast net (16.2%) and hooks and lines (23%) were individual prevalent means to catch the fish. However, individual fishing was mainly on predatory fishes like boal (*Wallago attu*), shol (*Channa striatus*), ayre (*Mystus aor*), etc. It shows that the production of all the species has increased due to this structure. The structure is offering migration facilities to the edult fish, fingerling and juveniles and other aquatic species. Due to the construction of BRE in sixties the production of those fishes in Bangali were reduced markedly. But construction of the fishpass has brought change in the production of fish in the Bangali and its adjacent areas.

Table 6.5: Major species wise catch composition in the Bangali River

Fish Species	2001-2002		2002-2003	
	Production (Ton)	Percentage of total	Production (Ton)	Percentage of total
Tengra	0.21	2.89	0.90	1.76
Bacha	0.07	0.96	0.29	0.58
Rakhal	0.35	4.76	2.75	5.41
Mola	0.05	0.64	0.09	0.17

Chela	0.11	1.45	0.24	0.47
Dhela	0.14	1.89	0.60	1.18
Mrigel	0.70	9.51	11.76	23.15
Carpio	0.63	8.54	4.44	8.74
Rui	0.56	7.62	3.31	6 52
Kalibaus	0.49	6 68	4 04	7.96
Boal	0.84	11.41	6.16	12.12
Ayre	0.89	12.00	5.95	11.72
Pogol	0.07	0.97	0.28	0.54
Bagar	0.09	1.25	0.36	0.72
Pabda	0.11	1.42	0.48	0.94
Chitol	0.11	1.42	0.64	1.25
Katla	0.09	1.23	0.54	1.06
Chingri	0.18	2.36	0.52	1.02

Source: TMSS catch survey.

6.5. Spawning Migrational Time

Spawning migration mainly in carp fish, in the study area was found to begin at the 2nd week of May and continue up to the 3rd week of July. Catfish migration began at the last week of March and continue up to the 2nd week of June. Speed and direction of water flow, rise of water level, rainfall, thunder, availability of food items, maturity of breed fish ensure the fish migration. In the study area spawning migration both cross or lateral was found to occur with and against the water current. Table 6.6 shows the spawning migration time of different fish species in the study area.

Table 6.6: Spawning migration period of different fish species in the study area.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Pous	Magh	Falg	Chait	Bais	Jaish	Asha	Srav	Badr	Asw	Kart	Agra	Pous	

Carp fish migration ..... Catfish migration

6.6 Migrational Behaviors of Different Fish Species

Generally two types of migration behaviour found in the fish species. One is spawning and other is feeding Depending on the route of migration of the study area fresh water fish species perform two types of migration, which are.

1. Potamodromy or Limnodromy- when fishes move within the fresh water bodies the migration is called as Potamodromy or Limnodromy, and the fishes as Potamodromous or Limnodromous fishes. In this movement some species prefer to move upstream for spawning whereas, their feeding ground is at a lower range, for example the major carps.

2. Diadromy – when fishes are moving freely between fresh and marine water. The migration is called as diadromy, and the fish as diadromous fish. This migration is divided into two phases according to the habitat towards which the movement is occurring. The types of diadromy migration are:

I. **Anadromy** – when fishes are moving from salt water into fresh water
II. **Catadromy** – when the fish is moving from fresh water into salt water area.

The migration of the fish species during the study period is potomodromous migration. As no Hilsa were found in the collection, so, anadromous migration (adult fish) and catadromous migration (jatka) were not seen.

6.7 Methods of migration

The local fishers categorized whitefish (carp fish) and blackfishes (catfishe) based on their migratory movements. Normally, the carps swim up streams through the surface water. The migratory carps become silvery white in colour on their dorsal surface. The migratory shoals sometimes can easily be seen shown through river water. Whereas, mature catfishes mainly swim at a deeper water layer towards the downstream. The dorsal side or back of these migratory species except *Pabda* and chital become dark or black coloured.

In this study, it is found that the black fishes are Boal, Pabda, Tengra, Magur, Rita, Air, Koi, Shing, Gulsha, Chital etc. Among them Chital, Gulsha and Rita were more dominant species than other species. The white fishes are Rui, Catla, Mrigel, Kalibaush, Gonia, Sarputi, etc, of which Rui, Mirgel, Kalbaush are more dominant species than other species.

6.8 Seasonal Variation of Fish Migration

To determine the seasonal migration of species, fish species have been collected every month from the up and downstream of the study area. From the collected sample, size has been measured and the individual number of each species in a sample has been recorded. The quantitative data of migratory fish species were analyzed group wise on monthly basis.

Seasonal variation of fish migration is divided into four period, such as over wintering dry season (mid December-mid March), spawning migration season (mid April-mid June), nursery/grow-out season (mid June-mid Sept), and flood recession season (mid Sept-mid December). During these period nine group of fish species were identified. Of which most of the dominant group of fish species are carp and catfish.

6.8.1 Over wintering or dry season migration – Brood stocks and mostly the juveniles approaching recruitment size are concentrated in river duars and beels, during a period from mid December to mid March. Migratory movement of large size carp fish takes place during this period. The species showing over wintering or dry season migration are listed in the Table 6.7.

Table 6.7: Different fish species found during over wintering or dry season migration.

SL. No.	Group	Common Name	Scientific Name	Type of fish	Comments
01.	Native Carps	Rui	*Labeo rohita*	P	Peak time migration for large sized carps
02.		Catla	*Catla catla*	P	
03.		Mrigel	*Cirrhinus mrigala*	P	
04.		Kalbaus	*Labeo calbasu*	P	
05.		Bhagna/Raik (Lachu)	*Cirrhinus reba*	P	

06.		Goni/Gonia	*Labeo gonius*	P	
07.	Minor carp	Sarputi	*Puntius saran*	P	
08.		Puti	*Puntius sophore*	P	
09.	Cat fish	Magur	*Clarias batrachus*	B	Peak time migration for these two species
10.		Shing	*Heteropneustes fossilis*	B	
11	Knife fish	Chital	*Notopterus chitala*	P	
12.	Sardine	Chapila	*Llisha motius*	P	
13.	Miscellaneous species	Shol	*Channa striatus*	P	
14.		Kholisha	*Colisa fascianus*	P	
15.		Mola	*Amblypharyngodon mola*	P	

Notes:

P = Pelagic fishes; B = Benthic species

Peak time = Dominant fish species in migration

Source: Field study Survey, 2005-2006

6.8.2 Spawning migration season This season usually begins during the pre-monsoon flood phase and continues into the first part of full monsoon flood phase (mid April to mid June). Fish generally move from deeper water to shallower water, breeding takes place in shallower water. During this period, small sized cat fishes and carps were found as dominant migratory species (Table 6.8).

Table 6.8: Different fish species migration during spawning migration season.

SL. No.	Group	Common Name	Scientific Name	Type of fish	Comments
01.	Native Carps	Rui	*Labeo rohita*	P	
02.		Catla	*Catla catla*	P	
03.		Mrigel	*Cirrhinus mrigala*	P	
04.		Kalbaus	*Labeo calbasu*	P	
05.		Bhagna/Raik (Lachu)	*Cirrhinus reba*	P	
06.	Large Catfish	Boal	*Wallagu attu*	B	
07.		Air	*Aorichthys aor*	B	

08.		Bagha Air	*Baharius yarrellii*	B	
09.		Rita	*Rita rita*	B	
10	Small Catfish	Pabda	*Ompok pabda*	P	Peak time of migration for small sized catfish
11.		Kani Pabda	*Ompok bimaculatus*	P	
12.		Bacha	*Eutropiichthys vacha*	P	
13.		Garua	*Clupisoma garua*	P	
14.		Batashi	*Pseudotropius atherinoides*	P	
15.		Baspata	*Ailia punctata*	P	
16		Tengra	*Batasio batasio*	B	
17.		Gulsha	*Mystos bleekeri*	B	
18.		Magur	*Clarias batrachus*	B	
19		Shing	*Heteropneustes fossilis*	B	
20.	Knife fish	Chital	*Notopterus chitala*	P	
21.	Prawns	Golda Chingri	*Macrabrachiun rosenbergii*	P	
22.		Icha	*Macrabrachiun spp*	P	

Notes:

P = Pelagic fishes; B = Benthic species

Peak time = Dominant fish species in migration

Source: Field study Survey, 2005-2006

6.8.3 Nursery/Grow-out migration season This is the season of rapid fish growth Fingerlings of those fish which bred on the floodplain. The spawns were later drifted to the nursery ground so they do not have an access problem But the fingerlings which hatched from the river breeding species need to get up to the floodplain. Major migratory species are carp and cat fish So, the migration of these fingerlings to the floodplain after passing certain grow out period starts from mid June-mid September The species which migrated in this period are shown in Table 6.9

Table 6.9: Different fish species those migrate during Nursery/Grow-out season.

SL. No.	Group	Common Name	Scientific Name	Type of fish	Comments
01	Native Carps	Rui	*Labeo rohita*	P	Carp migration peak time
02.		Catla	*Catla catla*	P	
03.		Mrigel	*Cirrhinus mrigala*	P	

04.		Kalbaus	*Labeo calbasu*	P	
05.		Bhagna/Raik (Lachu)	*Cirrhinus reba*	P	
06		Goni/Gonia	*Labeo gonius*	P	
07.	Minor Carp	Sarputi	*Puntius sarana*	P	
08.		Puti	*Puntius sorphore*	P	
09.	Large Catfish	Boal	*Wallagu attu*	B	Large catfish migration peak time
10.		Air	*Aorichthys aor*	B	
11.		Bagha Air	*Baharius yarrelli*	B	
12		Rita	*Rita rita*	B	
13.	Small Catfish	Pabda	*Ompok pabda*	P	Small catfish migration peak time
14		Kani Pabda	*Ompok bimaculatus*	P	
15		Bacha	*Eutropichthys vacha*	P	
16.		Garua	*Clupisoma garua*	P	
17.		Batashi	*Pseudotropius atherinoides*	P	
18.		Baspata	*Ailia punctata*	P	
19.		Tengra	*Batasio batasio*	B	
20		Gulsha	*Mystos bleekeri*	B	
21.		Magur	*Clarias batrachus*	B	
22.		Shing	*Heteropneustes fossilis*	B	
23.		Kuwa	*Gagata cenia*	B	
24		Kazoli	*Ailia coila*	B	
25.	Spiny eel	Bain	*Mastacembeleus armatus*	B	Other fishes migration peak time
26.		Tara Bain	*Macrognathus aculeatus*	B	
27.	Losch	Rani	*Botia dayi*	B	
28.	Knife fish	Chital	*Notopterus chitala*	P	
29.		Foli	*Notopterus notopterus*	P	
30.	Sardine	Chapila	*Llisha motius*	P	
31.	Needle fish	Kaikka	*Xenentodon cancila*	P	
32.	Miscellaneous species	Bele	*Glossogobius giurius*	P	
33.		Shol	*Channa striatus*	P	
34		Taki	*Channa punctaus*	P	
35		Potka	*Tetraodon cutcutia*	P	
36.		Chela	*Dino deverio*	P	
37.		Fulchela	*Salmostoma phulo*	P	
38.		Chanda	*Chanda nama*	P	
39.		Kholisha	*Colisa fasciatus*	P	

40.		Mola	*Amblypharyngodon mola*	P	
41.	Prawns	Golda Chingri	*Macrabrachiun rosenbergii*	P	
42.		Icha	*Macrabrachiun spp*	P	

Source: Field study Survey, 2005-2006

Notes:

P = Pelagic fishes; B = Benthic species

Peak time = Dominant fish species in migration

6.5.4 Flood recession migration season Floodwater starts receding from mid September continuous up to mid December As water area shrinks fish move into deeper water navigating along khals and river channel. Majority of the species migrate to deeper water during flood recession. A fish moving from floodplain out in to river normally moves along the khal. Large sized carps are dominant migratory species during this period. The species those migrate during this season are listed in Table 6 10

Table 6.10 : Different fish species migration during Flood recession season.

SL. No.	Group	Common Name	Scientific Name	Type of fish	Comments
01.	Native Carps	Rui	*Labeo rohita*	P	Peak time for large sized carps
02		Catla	*Catla catla*	P	
03.		Mrigel	*Cirrhinus mrigala*	P	
04		Kalbaus	*Labeo calbasu*	P	
05.		Bhagna/Raik (Lachu)	*Cirrhinus reba*	P	
06.		Goni/Gonia	*Labeo gonius*	P	
07.	Minor Carp	Sarputi	*Puntius sarana*	P	
08.		Puti	*Puntius sorphore*	P	
09.	Large Catfish	Boal	*Wallagu attu*	B	Peak time for large sized catfish
10.		Air	*Aorichthys aor*	B	
11.		Bagha Air	*Baharius yarrellii*	B	
12		Rita	*Rita rita*	B	
13.	Small Catfish	Pabda	*Ompok pabda*	P	

14		Kani Pabda	*Ompok bimaculatus*	P	
15		Bacha	*Eutropiichthys vacha*	P	
16.		Gulsha	*Mystos bleekeri*	B	
17.	Spiny eel	Bain	*Mastacembeleus armatus*	B	
18.		Tara Bain	*Macrognathus aculeatus*	B	
19	Losch	Rani	*Botia doyi*	B	
20.	Knife fish	Chital	*Notopterus chitala*	P	
21.		Foli	*Notopterus notopterus*	P	
22.	Sardine	Chapila	*Llisha motius*	P	
23.	Needle fish	Kaikka	*Xenentodon cancila*	P	
24.	Miscellane ous species	Shol	*Channa striatus*	P	
25.		Potka	*Tetraodon cutcutia*	P	
26.		Chela	*Dino deverio*	P	
27.		Fulchela	*Salmostoma phulo*	P	
28		Chanda	*Chanda nama*	P	
29.		Kholisha	*Colisa fasciatus*	P	
30		Mola	*Amblypharyngodon mola*	P	

Source: Field study Survey, 2005-2006

Notes: P = Pelagic fishes; B = Benthic species

Peak time = Dominant fish species in migration

6.9 Types of migration per season in major carps and catfishes

There obtained a number of different spawning types in the carps and catfishes. The carps showed five types of migration as brood migration and then return migration of the fingerlings in the floodplains and then in the beels and rivers. During two harvesting seasons January- March and November- December the carp species were dominated. The fingerlings prefer to dispersers in floodplain from last of May up to October, and return to river by September to November (Table 6.11).

The catfishes migrate to floodplain from March to May to breed (May- August) These fishes return to standing water from October to early December; and reside there from January- early April and November- December (Table 6 12).

The Tables 6.11 and 6.12 show the fish migration of white fish (Carps) and black fish (catfish) species at different stage of their life cycle, collected from study area

Table 6.11: Seasonal migration of major carp fish (White fish) at different stage of life cycle.

Periods	J	F	M	A	M	J	J	A	S	O	N	D
Spawning migration					—	—	—					
Fingerling migration						—	—	—				
Dispersal of Young Over Floodplain					—	—	—	—	—	—		
Return of Young to Beel and River									—	—	—	
Hervesting Beel and River		—	—	—							—	—

Table 6.12: Seasonal migration of catfish (Black fish) at different stage of life cycle.

Periods	J	F	M	A	M	J	J	A	S	O	N	D
Spawning migration					—	—	—	—				
Dispersal of Floodplain			—	—	—							
Dispersal and Growth						—	—	—	—			
Return to Standing water of young's										—	—	
Hervest					—	—	—	—	—	—	—	—
Dry Season Resident in Standing Water	—	—	—	—							—	—

Source : Field Study Survey, 2005-2006

6.10 Velocity and migratory species:

Velocity was measured (Biswas, 2007) inside the fish pass from the Mid May and continue up to the Mid July, 2005. Velocity was measured at the middle, left vent and two side of the fish pass, both for upstream and downstream. Later, from observation, different migratory species were identified at different parts of the fish pass. When this information was superimposed, a relation can be obtained which migratory

species favours which velocity. The results are shown in Table 6 13 and 6.14 It has been observed that carpfish favours a higher velocity range (1.02 m/s to 1.25 m/s) than the catfish (0 94 m/s to 1.05 m/s).

Table 6.13: Velocity and Migratory species of U/S Jumuna River.

side	Average Head difference (m)	Average Velocity m/s	Migratory speacies
Left Vent	1.00	1.05	Batasi, Chitol, Garua, Kazoli, Tengra,
Middle Vent	1.18	1.25	Rui, Mrigel, Calbasu, Catla

Table 6.14: Velocity and Migratory species of D/S Bangali River River.

side	Average Head difference (m)	Average Velocity m/s	Migratory speacies
Left Vent	1.00	1.02	Rui, Mrigel, Calbasu, Catla
Middle Vent	1.18	0 94	Batasi, Chitol, Garua, Kazoli, Tengra,

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

- The fish pass is contributing positively towards growth of open water fishery resources in the study area.

- The fish catch in the fish pass area fish catch before the construction of BRE was higher than the present situation However the present situation is better than that of just after construction of BRE

- Spawning migration mainly in carp fish, in the study area was found to begin at the 2nd week of May and continue up to the 3rd week of July Catfish migration began at the last week of March and continues up to the 2nd week of June
- Seasonal variation was found in four periods of fish migration;

  -Firstly over wintering or dry season migration, in this period the large size carps and small catfish especially Magur and Shing showed peak migration.

  -Secondly, spawning migration season, small size catfishes showed peak migration.

  -Thirdly, nursery/ grow out migration season, carps, catfishes and other fishes showed peak migration.

  -Fourthly, flood recession migration season, large size carps and catfishes showed peak migration.

- All the fish species during the study period showed patamodromous migration.
- Carpfish migrates in a higher velocity, whereas, catfish migrates in a lower velocity.

7.2 Recommendation for Further Study

The study identified some research for further studies. Following recommendations have been made based on the outcome of this study

1 *Study on morphological control on fish movement* :

A detail study should be carried out to identify the morphological controls over the fish movement during the migration period More specifically, to know the carp breeds, whether outside the territory

2. *Study on fish mortality rate*

A study should be initiated to assess the mortality rate under different velocity, head and turbulence and different sediment concentrations

3 *Study on effect of hydraulic characteristics on migration*

A study should be initiated to assess the relationships between hydraulics characteristics and migrational behaviour of different fish species.

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Appendix

Appendix-1

Appendix- 1. Check list of the fishes of the Jamuna and Bangali river at Sariakandi District of Bogra.

Sl. no.	Systematic account	Local name	Maximum length (cm)	Seasonal availability	Abundance	Breeding season
	Class- Osteichthyes (Bony fishes)					
	Order (1) - Clupeiformes Family (I) - Notopteridae (Feather backs) Genus - *Notopterus*, Lacepede, 1800					
***1.	*N. notopterus* (Pallas. 1769)	Foli, Phali, Pata	34.5	A	F	May to July
***2.	*N. chitala* (Hamilton, 1822)	Chital	45.5	All	C	April to July
	Sub order - Clupeoidei Family (ii) - Engraulidae (Anchovies) Genus - *Setipinna*, Swainson, 1839					
***3.	*S. phasa* (Hamilton, 1822)	Phasa	16	All	F	February to March
	Family (iii) - Clupeidae (Shads, herrings) Genus - *Corica*, Hamilton, 1822					
4.	*C. soborna* (Hamilton)	Gura-mach, Kanchki	3.5	All	C	Not known
	Genus - *Hilsa*, Regan, 1917 = *Tenualosa*					
***5.	*H. ilisha* (Hamilton)	Ilish, Jatca, Ilsha	34 5	R	F	January to March and July to November
	Genus - *Ilisha*, Gray, 1845					
6.	*I. motius* (Hamilton)	Chapila, Khorchona	6.5	R	VR	Not known
Sl. no.	Systematic account	Local name	Maximum length (cm)	Seasonal availability	Abundance	Breeding season
	Genus - *Gadusia*, Fowler, 1911					
***7.	*G. chapra* (Hamilton)	Chapila	16.5	R	C	Not known

8.	*G. variegata* (Day, 1878)	Khaira, Khori	7	R	VR	Not known
	Genus - *Gonialosa*, Regan, 1916					
**9.	*G manminna* (Hamilton)	Koh-chapila	8	R	R	April to July
	Order (2) - Cypriniformes Family (iv) - Cyprinidae (Carps, Barbs) Genus - *Catla* Valenciennes, 1844					
***10.	*C. catla*	Katal, Catla, Catol	46.5	All	C	April to July
	Genus - *Rasbora*, Bleeker, 1860					
11.	*R. elanga* (Hamilton)	Along, Elong, Elgena	18.5	All	C	April to July
* 12.	*R rasbora* (Hamilton)	Darkina, Leazza	7.5	All	VC	April to July
* 13	*R. daniconius*	Darkini, Darkina	6.5	All	VC	April to July
	Genus - *Puntius*, Hamilton, 1822					
** 14.	*P. sarana* (Hamilton)	Sarpunti	29.5	A	R	April to July
* 15.	*P. sophore* (Hamilton)	Punti, Jut puti, Vadi punti	10 5	R	C	April to July
* 16.	*P. chola* (Hamilton)	Chala puti	7.5	All	F	Apnl to July
* 17.	*P. ticto* (Hamilton)	Titputi	5.5	All	F	April to August
18.	*P. gonionotus* (Hamilton)	Thai sarputi	16	All	F	April to July
19.	*P. casuatis* (Hamilton)	Kusuputi	6	R	F	April to July
	Genus - *Chela*, Hamilton, 1822					
20.	*C. cachius* (Hamilton)	Chep chela	4.5	All	F	Not known
21.	*C. phulo* (Hamilton)	Phul chela	4.5	All	F	Not known
	Genus - *Aspidoparia*, Heckel, 1845					
**	*A. jaya* (Hamilton)	Jaya, Piali	8.5	All	F	Not

22.						known
	Genus - *Esomus*, Swainson, 1839					
23	*E. danricus* (Hamilton)	Darkina, Darka, Danrika	7.5	All	VC	August to October
	Genus - *Amblypharyngodon*, Bleeker, 1859					
** 24.	*A. mola* (Hamilton)	Mola, Maya	8.5	All	VC	April to November
25.	*A. microlepis* (Bleeker, 1860)	Mohula, Mola	7.5	All	R	April to November
	Genus - *Oxygaster*, Van Hasselt. 1823					
26.	*O. gora* (Hamilton)	Ghora chela	12	All	C	April to November
27.	*O. bacaila* (Hamilton)	Chela	9.5	All	F	April to August
** 28.	*O. phulo* (Hamilton)	Ful chela	5.5	All	R	April to November
	Genus - *Labeo*, Cuvier, 1817					
* 29.	*L. gonius* (Hamilton)	Gonia, Goinna	27.5	All	VR	June to August
** 30.	*L. nandina* (Hamilton)	Nandina, Nandul	40	All	R	Not known
***31.	*L. calbasu* (Hamilton)	Calbasu, Kalibaus	52	R	C	April to July
32.	*L. boggut* (Hamilton)	Bagi mach	50	R	VR	Not known
***33.	*L. rohita* (Hamilton)	Rui, Rohit	54.5	All	C	April to July
34.	*L. bata* (Hamilton)	Bata machh	24.5	All	R	Not known
	Genus - *Cirrhinus* (*Oken*), Cuvier, 1817					
***35.	*C. mrigala* (Hamilton)	Mirke, Mrigel	46	All	C	May to July
***36.	*C. reba* (Hamilton)	Raik, Tatkini	30.5	R	C	April to July
	Genus - *Cyprinus*					
** 37.	*C. carpio* (Linnaeus)	Common carp, Carpio	34	R	F	Not recorded in open water

** 38.	*C carpio* (Var. *Specularis*)	Mirror carp	32.5	R	F	Not recorded in open water
	Genus - *Danio*, Hamilton, 1822					
** 39	*D devario* (Hamilton)	Chap chela, Banspata	7.5	All	C	April to July
**40.	*D. rerio* (Hamilton)	Rajga, Darika, Anju	2.5	All	F	Not known
	Genus - *Hypophthalmichthys*					
** 41.	*H. molitrix* (Valenciennes)	Silver carp	42.5	All	F	Not recorded in open water
	Genus - *Ctenopharyngodon*					
* 42.	*C. idella* (Valenciennes)	Grass carp	36	All	F	Not recorded in open water
	Family (v) - Cobitidae (Loaches)					
	Genus - *Botia*, Gray, 1831					
43.	*B. dayi*- (Hora, 1932)	Bou machh, Rani machh	7.5	A	F	Not known
44.	*B. dario* (Hamilton)	Rani, Beti	8.5	A	VR	Not known
	Genus - *Lepidocephalus*, Bleeker, 1858					
45.	*L. guntea* (Hamilton)	Puiya machh	5	All	F	Not known
46.	*L. annandalei* (Chaudhuri, 1912)	Gutum machh	4.5	All	R	Not known
	Order (3) - Siluriformes					
	Family (vi) - Siluridae (Butter Catfishes; Freshwater Shark)					
	Genus - *Wallago*, Bleeker, 1851					
** 47.	*W. attu* (Bloch, 1801)	Boal, Boali	52	All	VC	May to July

	Genus - *Ompok*, Lacepede, 1803					
** 48.	*O. pabda* (Hamilton)	Pabda, Palda	18.5	R	C	Not known
** 49.	*O. bimaculatus* (Bloch, 1794)	Kani pabda, Modhu pabda	16.5	R	VR	June to August
	Family (vii) - Schibeidae Genus - *Clupisoma*, Swainson, 1839					
** 50.	*C. garua* (Hamilton)	Garua, Ghara	24	All	F	March to July
** 51.	*C. tuakree* (Day)	Tin-kanta	11.5		F	May to July
** 52.	*C. atherinoides* (Bloch, 1801)	Banspati, Batasi	12	All	R	May to July
	Family (viii) - Schilbeidae Genus - *Silonia*, Swainson, 1839					
** 53.	*S. silondia*	Sillong, Shilon	29.5	All	R	Not known
	Genus - *Pseudotropius*, Bleeker, 1863					
54.	*P. atherinoides* (Bloch, 1794)	Batasi	12	R	F	Not known
	Genus - *Eutropiichthys*, Bleeker, 1862					
***55.	*E. vacha* (Hamilton)	Bacha, Bhacha	34.5	R	R	Not known
	Genus - *Ailia*, Gray, 1831					
56.	*A. coila* (Hamilton)	Banspati, Kajuli	12.5	All	VR	Not known
	Genus - *Ailiichthys*, Day, 1878					
** 57.	*A. punctata* (Day, 1878)	Kajuli	9	All	R	Not known
	Genus - *Pangasius*, Valenciennes, 1840					
***58.	*P. pangasius* (Hamilton)	Pangas, Pungwas	63.5	All	VR	March to July
	Family (ix) - Bagridae					

	Genus - *Rita*, Bleeker, 1858					
** 59.	*R. rita* (Hamilton)	Rita, Eta	32.5	A	R	Not known
	Genus - *Mystus*, (Gronow) Scopoli, 1777					
***60.	*M. aor* (Hamilton)	Air, Ayir	36.5	All	C	April to July
61.	*M. menoda* (Hamilton)	Gang tengra	20	All	F	April to July
** 62.	*M. cavasius* (Hamilton)	Kabasi tengra, Ramesha tengra	20.5	All	VC	April to July
** 63.	*M. vittatus* (Hamilton)	Tengra, Gulsha	15.5	All	C	April to August
64.	*M. armatus* (Day, 1865)	Guchi tengra	6.5	All	VC	April to July
** 65.	*M. bleekeri* (Day)	Gulsha tengra, Gulsha	20	All	R	Not known
	Genus - *Letocassius*, Bleeker, 1858					
66	*L. rama* (Hamilton)	Gura tengra	5	All	VC	April to July
	Genus - *Batasio*, Blyth, 1860					
67.	*B. batasio* (Hamilton)	Tengra	4.5	All	VC	April to July
	Family (x) - Claridae (Air-breathing catfish)					
	Genus - *Clarias*, (Gronow) Scopoli, 1777					
68.	*C. batrachus* (Linnaeus, 1758)	Magur, Mojgur	28	All	C	May to July
	Family (xi) - Heteropneustidae (Stinging catfish)					
	Genus - *Heteropneustes*, Muller, 1840					
69.	*H. fossilis* (Bloch, 1797)	Shing, Jiol	25.5	All	C	Not known
	Family (xii) - Sisoridae					
	Genus - *Gagata*, Bleeker, 1858					
70.	*G. gagata* (Hamilton)	Gang-tengara, Hadda	18 5	All	F	Not known

71.	*G. youssoufi*	Gang tengra	9.8	All	R	Not known
72.	*G. cenia* (Hamilton)	Jangla cenia	5	All	R	Not known
	Genus - *Bagarius*, Bleeker, 1853					
* 73.	*B. bagarius* (Hamilton)	Bagor, Baghair, Bagaaier	55.5	All	VR	April to July
	Order (4) - Anguilliformes (Freshwater eels) Family (xiii) - Anguillidae Genus - *Anguilla*, Shaw, 1803					
Sl. No.	Systematic account	Local name	Maximum length (cm)	Seasonal availability	Abundance	Breeding season
74.	*A. bengalensis* (Gray & Hardwicks)	Baim, Bamosh	19.5	All	VC	Not known
75.	*A. nebulosa* (McClelland)	Bamosh, Banohara	15.5	All	F	Not known
	Order (5) - Beloniformes (Freshwater gars) Family (xiv) - Belonidae Genus - *Xenentodon*, Regan, 1911					
* 76.	*X. cancila* (Hamilton)	Kakila, Kakla, Kanhya	26.5	All	VC	Not known
	Order (6) - Perciformes Family (xv) - Anabantudae (Climbing perches, Goramies) Genus - *Colisa*, Valenciennes, 1831					
77.	*C. fasciatus* (Bloch & Schneider, 1801)	Khalisa, Colisa, Khaila	7.5	All	C	June to October
78.	*C. labiosus* (Day, 1878)	Chuna Khalisa	6.5	All	F	June to October
79.	*C. lalius* (Hamilton)	Lal Khalisa, Ranga Khalisa	6.5	All	VR	June to October
* 80.	*C. chuna* (Hamilton)	Lal Khalisa	4.5	All	VR	June to October
	Genus - *Ctenops*, McClelland, 1844					

81.	*C. nobilis* (McClelland)	Naftani	14	All	R	Not known
	Genus - *Anabas*, Cuvier, 1818					
***82.	*A. testudineus* (Bloch, 1795)	Koi	16.5	All	C	March to October
	Family (xvi) - Cichlidae (Peters) Genus - *Tilapia*, Gunther, 1889 = (*Oreochromis*)					
83	*T. mossambica* (Peters, 1852)	Telapia	12	R	F	Around the year
84.	*T. nilotica* (Linnaeus, 1766)	Nilotica	12	R	F	Around the year
	Family (xvii) - Nandidae (Muds Perch) Genus - *Nandus*, Cuvier, 1831 (Valenciennes)					
* 85.	*N. nandus*	Meni, Nodoi, Bheda	14 5	All	F	April to August
	Family (xviii)- Centropomidae (Giant perch, Glass perch) Genus - *Chanda*, Hamilton, 1822					
86.	*C. nama* (Hamilton)	Chanda, Nama chanda	5.5	All	VC	March to October
87.	*C. ranga* (Hamilton)	Lal chanda	4.5	All	R	Not known
88.	*C. baculis* (Hamilton)	Phopa chanda	4	All	VC	Not known
	Family (xix) - Scianidae (Jaw fish croakers) Genus - *Poma*, Fowler, 1933					
* 89.	*P. poma* (Hamilton)	Poa	14	All	R	Not known
	Genus - *Johnius* (Bloch, 1793)					
90.	*J. coitor*	Poa, Vull	13	All	R	Not known
	Family (xx) - Gobidae (Gobies, Mud skippers) Genus - *Glossogobius*, Gill, 1859					
91.	*G. giuris* (Hamilton)	Baila, Bele, Baillya	25.5	All	VC	March to October
	Genus - *Awaous*, Valenciennes, 1837					

92.	*A. stamineus* (Valenciennes, 1842)	Bele, Bala	19.5	All	C	March to October
	Order (7) - Channiformes Family (xxi) - Channidae (Snake heads) Genus - *Channa*, Scopoli, 1777					
93.	*C. striatus* (Bloch, 1794)	Shoil, Shol	48.5	W	C	April to July
94	*C. marulius* (Hamilton)	Gajor, Gajar, Sol	54.5	W	F	April to July
95	*C. punctatus* (Bloch, 1794)	Taki, Lata, Lati	24	All	C	April to October
96.	*C. orientalis* (Schneider, 1801)	Cheng	22	All	F	April to October
97.	*C. gachua* (Hamilton)	Gachua, Lotya	18	All	F	April to June
	Order (8) - Mugiliformes Family (xxii) - Mugilidae (Mullets) Genus - *Rhinomugil*, Gill, 1863					
** 98.	*R. corsula* (Hamilton)	Korsola, Khalla	22	All	F	Not known
	Genus - *Sicamugil*, Fowler, 1839					
99.	*S. cascasia* (Hamilton)	Kachi bata, Kucha-khalla	5.5	All	R	Not known

Sl. No.	Systematic account	Local name	Maximum length (cm)	Seasonal availability	Abundance	Breeding season
	Order (9) - Tetraodontiformes Family (xxiii)- Tetraodontidae (Puffer fishes) Genus - *Tetraodon*, Linnaeus, 1758					
100.	*T. cutcutia* (Hamilton)	Tepa, Potka, Photka	8.5	All	C	Not known
101	*T. potoca* (Hamilton)	Taptepa, Boga	6.5	All	F	Not known
	Order (10) - Mastacembeliformes					

Family (xxiv)- Mastacembelidae (Spiny eels)

Genus - *Mastacembelus* (Gronow), Scopoli, 1777

** 102.	*M. armatus* (Lacepede)	Shal baim, Bam, Gonti	60.5	All	C	April to July	
* 103.	*M. pancalus* (Hamilton)	Gunchi Baim	13.5	All	C	April to July	

Genus - *Macrognathus*, Lacepede, 1800

** 104.	*M. aculeatus* (Bloch)	Tara Baim, Kota baim	22.5	All	C	Not known

Note:

* Economic importance	S = Summer	VR = Very rare
**More Economic importance	R = Rainy season	R = Rare
*** Most Economic importance	A = Autumn	F = Few
	W = Winter	C = Common
	All = All the season	VC = Very common

Appendix-2

Appendix-2: Checklist of the fisheries item of the river Jamuna and Bangali at Sariakandi upazilla district of Bogra.

Systematic account	English name	Local name	Seasonal availability	Breeding season	Abundance
Phylum – Arthropoda Class – Crustacea Order – Decapoda Family – Palaemonidae					
Macrobrachium lamarrei	Prawn	Gura chingri	All	May - June	VC
M. dayanum	Prawn	Chingri	All	Dec. - Feb	C
M. malcolmsonii	Prawn	Golda chingri	All	Dec. - Feb.	F
Cancer pagurus	Crab	Kakra	All	April - June	C
Phylum – Mollusca Class – Gastropoda Order – Mesogastropoda Family – Taenioglossa					
Pila globosa	Snail	Shamuk	All	April - June	C
Order – Pelecypoda Family – Unionidae					
Unio sp	Mussel	Jhinuk	All	April - June	F
Phylum – Chordata					
Class – Amphibia					
Order – Anura					
Family – Ranidae (Frogs)					
Rana tigrina	Bull frog	Kola bang	R	May - July	C
Class – Reptilia Order – Chelonia Family – Trionychidae (Tortoises)					
Trionyx hurum (Gray)	Tortoise	Kachim,	R	April -	R

		Dura		Sept.	
T. gangeticus (Cuvier)	Tortoise	Kachim, Dura	R	April - Sept.	F
Lissemys punctata (Bannaterree)	Tortoise	Dura, Kachim	R	April - Sept	R
Chitra indica	Tortoise	Kachim, Dura	R	April - Sept.	R
Systematic account	English name	Local name	Seasonal availability	Breeding season	Abundance
Family – Emydidae					
Kachuga tectum (Gray)	Tortoise	Kachim, Dura	R	April - Sept.	R
Herdella thurgi (Gray)	Tortoise	Kachim, Dura	R	April - Sept.	R
Class – Mammalia Order – Cetacea Family – Platanistidae (sushu)					
Platanista gangetica	Freshwater Dolphin Soosuk	Soosuk, Sushu	All	Not known	F

Note:

R	=	Rare
All	=	All the year round
C	=	Common
VC	=	Very common
F	=	Few

Appendix-3

Appendix-3: Questionnaire of the Semi-structured Interview.

সরকারী-বেসরকারী কর্মচারী, কর্মকর্তাবৃন্দ এবং স্থানীয় এলাকাবাসীদের নিকট "Hydraulic impact and Seasonal variation on Fish Migration in Sariakandhi Fish Pass" **এর প্রেক্ষাপটে মৎস্যসম্পদ ও ফিশপাস সম্পর্কিত প্রশ্ন পত্র** (Questionnaire survey–Semi Structured Iutcrview)।

উত্তর দাতার নাম ..... নমুনা নং .....

বয়স ..... তারিখ .....

পেশা..... সময় .....

গ্রাম ..... অবস্থান .....

থানা .....

জেলা .....

(১) ফিশপাস এলাকায় পানির গভীরতা সম্পর্কে বলুন

নদীর নাম	শুষ্ক মৌসুমে পানির গভীরতা	বর্ষা মৌসুমে পানির গভীরতা
যমুনা		
বাঙ্গালী		

(২) ফিশপাস এলাকা উজানের অবস্থা (উজানে আনুমানিক ১০ কিঃমিঃ পর্যন্ত)(√ চিহ্ন দিন)

ক) খালবিদ্যমান/বাধ বিদ্যমান/সুইচগেট বিদ্যমান

খ) বিলের সহিত সংযুক্ত/অন্য নদীর সহিত সংযুক্ত/ হাওরের সহিত সংযুক্ত।

গ) নদীর গতি পরিবর্তনশীল/নদীর গতি অপরিবর্তনশীল

(৩) ফিশপাস এলাকার ভাটির অবস্থা (ভাটির আনুমানিক ১০ কিঃমিঃ পর্যন্ত) (√ চিহ্ন দিন)

ক) খালবিদ্যমান/বাধ বিদ্যমান/সুইচগেট বিদ্যমান

খ) বিলের সহিত সংযুক্ত/অন্য নদীর সহিত সংযুক্ত/ হাওরের সহিত সংযুক্ত।

গ) নদীর গতি পরিবর্তনশীল/নদীর গতি অপরিবর্তনশীল

(৪) ফিশপাস এলাকার উজান ও ভাটি অঞ্চলে ব্যবহৃত কয়েকটি মাছ ধরার সরঞ্জামাদির নাম বলুন।

জলযান / নৌকা	জালসমূহ	ফাঁদসমূহ

(৫) ফিশপাস এলাকায় স্রোতের অবস্থা (√ চিহ্ন দিন)

নদীর নাম	শুষ্ক মৌসুমে পানির গভীরতা	বর্ষা মৌসুমে পানির গভীরতা
যমুনা	শক্তিশালী/মাঝারি/মৃদু	শক্তিশালী/মাঝারি/মৃদু
বাঙ্গালী	শক্তিশালী/মাঝারি/মৃদু	শক্তিশালী/মাঝারি/মৃদু

(৬) ফিশপাস এলাকায় প্রাপ্ত মাছের ১৫টি প্রজাতির নাম বলুন? (মাছ আহরণের সর্বোচ্চ হতে সর্বনিম্ন ভিত্তিতে ১২ মাস আহরণ কাল বিবেচনায়)

(ফিশপাস হওয়ার পূর্বে			ফিশপাস হওয়ার পরে)	
ক্রঃ নং	স্থানীয় নাম	সাধারণ নাম	স্থানীয় নাম	সাধারণ নাম
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১৪				
১৫				

(৭) বিগত ১০-২০ বছরের মধ্যে ফিশাপাস এলাকাহতে ঃ

(ক) বিলুপ্তমাছের প্রজাতির নাম সমূহ বলুন?

ক্রঃ নং	স্থানীয় নাম	সাধারণ নাম	জীব বিজ্ঞানের পরিভাষায় নাম
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৫			

(খ) বিলুপ্তির পথে রয়েছে (কদাচিত দৃষ্টিগোচর হয়) এমন মাছের নাম বলুন?

ক্রঃ নং	স্থানীয় নাম	সাধারণ নাম	জীব বিজ্ঞানের পরিভাষায় নাম
১			
২			
৩			
৪			
৫			

(গ) বংশ বিস্তারে আংশকাজনক ভাবে হ্রাস পাচ্ছে এমন প্রজাতি সমূহের নাম বলুন

ক্রঃ নং	স্থানীয় নাম	সাধারণ নাম	জীব বিজ্ঞানের পরিভাষায় নাম
১			
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(৮) ফিশপাস এলাকায় শুধুমাত্র বাণিজ্যিক ভাবে গুরুত্বপূর্ণ প্রাপ্ত রেণু/পোনা মাছ এর প্রজাতি সমূহের নাম বলুন?

ক্রঃ নং	স্থানীয় নাম	সাধারণ নাম	জীব বিজ্ঞানের পরিভাষায় নাম
১			
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(৯) ফিশপাস এলাকায় কোন প্রজাতি মাছ সবচেয়ে বেশি পাওয়া যায় বলুন?

ফিশপাস হওয়ার পূর্বে	ফিশপাস হওয়ার পরে

(১০) ফিশপাস এলাকায় কোন প্রজাতির মাছ সবচেয়ে কম পাওয়া যায় বলুন?

ফিশপাস হওয়ার পূর্বে	ফিশপাস হওয়ার পরে

(১১) আপনি কি মনে করেন ফিশপাস হওয়াতে অত্র এলাকায় নতুন প্রজাতির মাছ দেখা যায়? (√ চিহ্ন দিন) হ্যাঁ / না

(১২) ফিশপাস হওয়াতে (যমুনা হইতে বাঙ্গালীতে) মাছের প্রজাতি কমেছে না বেড়েছে? (√ চিহ্ন দিন) হ্যাঁ / না

(১৩) যে মাছটি পাওয়া যাচ্ছে না সেটি অন্যত্র অভিপ্রায়ন করেছে কি না? (√ চিহ্ন দিন) হ্যাঁ / না।

(১৪) ফিশপাস এলাকায় মাছ কমে যাওয়ার কারণ কি কি বলুন?

ক)

খ)

গ)

(১৫) আপনার মতে কি কি ব্যবস্থা গ্রহণ করলে ফিশপাস এলাকায় মাছের উৎপাদন বাড়ানো সম্ভব

ক)

খ)

গ)

(১৬) মাছের প্রজনন কালে (এপ্রিল/মে অথবা বৈশাখ/জোষ্ঠ্য) ফিশপাস দিয়ে পানি প্রবেশ করলে কি কি ফসলের ক্ষতি হতে পারে?

ক)

খ)

গ)

(১৭) ফিশপাসের প্রয়োজনীয়তা সম্পর্কে বলুন?

ক)

খ)

গ)

(১৮) ফিশারিজ এর উপর FCDI প্রকল্পের প্রভাব কি?

ভাল .....

মন্দ .....

(১৯) যদি মন্দ হয় তাহলে সমস্যা সমাধানের উপায় কি?

ক)

খ)

গ)

(২০) বর্তমানে যে পদ্ধতিতে ফিশপাস রক্ষনাবেক্ষণ করা হচ্ছে তাতে আপনি সন্তুষ্ট? (√ চিহ্ন দিন) হ্যাঁ/না।

(২১) ফিশপাস রক্ষণাবেক্ষণ কিভাবে করলে আপনারা উপকৃত হবেন?

ক)

খ)

গ)

(২২) যমুনা হতে বাঙ্গালী নদীতে মাছের অভিপ্রায়ন (Migration)

ক) অভিপ্রায়নকারী মাছের বিবরণ

প্রজাতি	অতীত অবস্থা	বর্তমান অবস্থা
কার্পস		
ক্যাট ফিশ		
ছোটমাছ		
অন্যান্য		

(খ) অভিপ্রায়ন এর পথ সম্পর্কে মন্তব্য করুন?

ফিশপাস হওয়ার পূর্বে ঃ

অতীত অভিপ্রায়ন পথ কোথায় ছিল	বর্তমান অভিপ্রায়ন পথ কোথায় আছে	ভবিষ্যতে কোন পথ হতে পারে

ফিশপাস হওয়ার পরেঃ

অতীত অভিপ্রায়ন পথ কোথায় ছিল	বর্তমান অভিপ্রায়ন পথ কোথায় আছে	ভবিষ্যতে কোন পথ হতে পারে

(২৩) আপনি যে সব এলাকায় মাছ ধরেন তার বর্ণনা দিন?

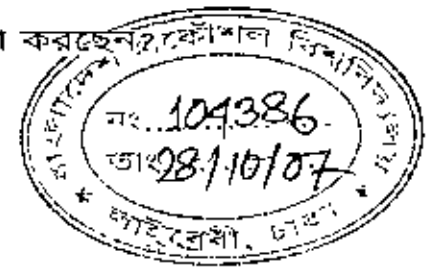
ফিশপাস হওয়ার পূর্বে	ফিশপাস হওয়ার পরে

(২৪) মাছ ধরা/ব্যবসা নিয়ে আপনি কি চিন্তা করছেন?

ক)

খ)

গ)



(২৫) জাত জেলেরা প্রকল্প এলাকায় মাছ ধরতে পারে? (√ চিহ্ন দিন)

ফিশপাস হওয়ার পূর্বে	ফিশপাস হওয়ার পরে
হ্যাঁ/ না	হ্যাঁ/ না

(২৬) মহাজনেরা আর্থিক ভাবে জেলেদের কে নিয়ন্ত্রণ করে কি? (√ চিহ্ন দিন)

ফিশপাস হওয়ার পূর্বে	ফিশপাস হওয়ার পরে
হ্যাঁ/ না	হ্যাঁ/ না

(২৭) মন্তব্য করুন (√ চিহ্ন দিন)

ক) ড্রেনেজ ব্লকেজ/বাধাঃ প্রতিবছর/একবছর পরপর/বছরের ১ বার/প্রতি বছরে..... বার

খ) পলল জনিত সমস্যা ঃ খুববেশী/ মাঝারী ধরনের/ স্বাভাবিক/নাই

গ) নদীর ভাঙ্গন : প্রতিবছর/ একবছর পর পর/ প্রতিবছরে ..... বার

ঘ) উপরে স্তরেরপানির গুনাগুন : শস্য উৎপাদন/ মৎস্য উৎপাদন / কাজের জন্য উপযোগী

ঙ) শস্য উৎপাদন : বেড়েছে/কমেগেছে/কোন পরিবর্তন নাই

চ) মৎস্য উৎপাদন : বেড়েছে/কমেগেছে/কোন পরিবর্তন নাই

ছ) ফিশপাস থাকায় মাছ ধরতে কোন সমস্যা হয় কিনা? হ্যাঁ / না

জ) প্রধান সমস্যা : বন্যার সময় বেকার / কর্মহীন অবস্থা / জলপথে পরিবহন সমস্যা / সড়ক পরিবহনের সমস্যা

গবেষণা কার্যের সুপারভাইজার

ডঃ আনিসুল হক
অধ্যাপক
পানি ও বন্যা ব্যবস্থাপনা ইনস্টিটিউট
বাংলাদেশ প্রকৌশল বিশ্ববিদ্যালয়, ঢাকা-১০০০

অনুসন্ধানকারী

বিজয়কুমার ঘোষ
এম.এস- সি. (এপ্রিল-২০০৩)
পানি ও বন্যা ব্যবস্থাপনা ইনস্টিটিউট
বাংলাদেশ প্রকৌশল বিশ্ববিদ্যালয়, ঢাকা-১০০০