Government of the People's Republic of Bangladesh
Flood Action Plan

FAP 17
Fisheries Studies and Pilot Project

FINAL REPORT

JULY 1995

MAIN VOLUME

ODA
Overseas Development Administration, U.K.

FINAL REPORT

MAIN VOLUME

FAP 17
FISHERIES STUDIES
AND PILOT PROJECT

July, 1995

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1	Fisheries Database Documentation
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ABBREVIATIONS AND ACRONYMS

AEU	Agro-Ecological Unit
b. aman	broadcast *aman*
BBS	Bangladesh Bureau of Statistics
BFRSS	Bangladesh Fisheries Resource Survey System
BRE	Brahmaputra Right Embankment
BSKB	Barnal Salimpur Kola Basukhali (*beel*)
BWDB	Bangladesh Water Development Board
CAS	Catch Assessment Survey
CBP	Chalan *Beel* Polder B
CFP	Chatla-Fukurhati Project
cm	centimetre(s)
CPP	Compartmentalization Pilot Project
CPUA	Catch Per Unit Area
CPUE	Catch Per Unit Effort
DoF	Department of Fisheries
DWR	Deepwater Rice
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization
FAP 12	Flood Action Plan Study No. 12 (FCD/I Agricultural Study)
FAP 5	Flood Action Plan Study No. 5 (South East Regional Study)
FAP	Flood Action Plan
FAP 6	Flood Action Plan Study No. 6 (North East Regional Study)
FAP 20	Flood Action Plan Study No. 20 (Compartmentalization Pilot Project)
FAP 17	Flood Action Plan Study No. 17 (Fisheries Studies and Pilot Project)
FAP 16	Flood Action Plan Study No. 16 (Environmental Study)
FCA	Fish Catch Assessment
FCD	Flood Control and Drainage
FCD/I	Flood Control and Drainage with or without Irrigation
FES	Fishing Effort Survey
FFW	Food for Work
FPCO	Flood Plan Coordination Organization
FPR	Floodplain resident
FRI	Fisheries Research Institute
FRSS	Fisheries Resource Survey System
GIS	Geographical Information System
GoB	Government of Bangladesh
GPS	Geographical Positioning System
H.Q.	Headquarters
ha	hectare(s)
HFC	Household Fishing Category
Hh	Household
HYV	High Yield Varieties
IFDP	Irrigation Fisheries Development Project
IRR	Internal Rate of Return
ISPAN	Irrigation Support Project for Asia and the Near East
kg	kilogram(s)

ABBREVIATIONS AND ACRONYMS (Contd.)

km	kilometre(s)
m/sec	metre per second
m	metre(s)
mg/l	milligram per litre
MIKE11	A microcomputer based modelling system for rivers and channels
MIP	Manu Irrigation Project
MPO	Master Plan Organization
NA	Not Available
NC	North Central
NCR	North Central Region
NE	North East
NFMP	New Fisheries Management Policy
NGO	Non Government Organization
NS	Not Significant
NW	North West
NWR	North West Region
ODA	Overseas Development Administration
pa	per annum
pH	Measure of acidity and alkalinity of water (log of hydrogen ion concentration)
PIRDP	Pabna Irrigation and Rural Development Project
PWD	Public Works Dutum
RFM	River Floodplain Migratory
RRA	Rapid Rural Appraisal
SBP	Satla-Bagda Polder 1
SEV	Socioeconomic Village
SHP	Shanghair *Haor* Project
SW	South West
SWR	South West Region
SWMC	Surface Water Modelling Centre
t	tonne(s)
t. aman	transplanted *aman*
tk	taka
TWDR	Transplanted Deepwater Rice
WARPO	Water Resources Planning Organization (previously MPO, Master Plan Organization)

GLOSSARY

The following is a glossary of Bangla terms encountered during the course of FAP 17 research. It is not a definitive taxonomy of Bangla terms concerned with fisheries and aquatic resources. Such an undertaking would require taking into account the fact that terminologies and usages change radically from region to region and even from village to village. The aim, rather, is to highlight the different meanings some of these words and terminologies may have in different parts of the country. The region(s) where the term occurs is (are) indicated. Cross references to other entries in the glossary are indicated in small capital letters.

The Roman alphabet is rather poor as a vehicle for communicating Bangla terms and the versions given here make no pretence at being definitive. There is no standard procedure for transliterating Bangla, and marked differences in the regional pronunciation of words mean that different spellings of the same word may be equally "correct" in terms of the sound of the word.

Terms used to describe fishing castes/groups

jele	NC/NW/ NE/SW	Generic terms for fishermen.
maimul	NE	Muslim traditional fishermen and traditional leaseholders. A caste-like group sometimes extended for bureaucratic convenience to anyone involved in, or wishing to become involved in, fisheries, including leaseholders.

Terms used to describe actors in fish trading system

aratdar	NC/NW/ NE/SW	Fish wholesaler. A key figure in the marketing chain. Generally the source of credit inputs into the marketing system, advancing money to other actors in the system to ensure fish supply. Usually based in district wholesale markets.
hat	NC/NW/ NE/SW	Daily or weekly market.
mahajan	NC/NW/ NE/SW	A very generic but important term that is most commonly used for moneylenders. Effectively it means almost any rich, influential person in rural areas (closer to its literal meaning, "great man"). These people usually lend money as well. In fisheries, it is commonly used to refer to the leaseholder of a particular water body, the owner of or major shareholder in a particular fishing operation. Also used for many ARATDAR who are generally moneylenders in their own right.

samity	NC/NW/ NE/SW	Association of people grouped together for a common objective or purpose.

Terms used to describe water bodies

beel	NC/NW/ NE/SW	Officially, a "back swamp" or depression. Can be either perennial or seasonal. In reality it used for a wide variety of freshwater bodies (oxbow lakes, old river beds, *KHAL*, even artificial channels). Often refers to flooded areas with no obvious deeper section or depression that used to have perennial areas of water.
baor	NC/SW	An oxbow lake; a cut-off curve or meander of a river. Sometimes completely isolated, sometimes connected seasonally or at one end to the parent river. Also used for old river beds now far from the present course of the river (may also be called a *BEEL*).
char	NC/NW/ NW/SW	*Char* is a mid-channel island which may be seasonal or perennial.
danga	NC/SW	Artificial or natural ditch often formed from homestead borrow pit, usually in floodplain. Shallower than *KUA*. Used very commonly in the North Central Region around Manikganj. Most common usage is for high land.
halot	NC/SW	Depressed pathway running through the village homestead area, generally under community ownership. Dry pathway during the dry season also used for grazing livestock, when inundated used for open-access fishing.
haor	NC/NW/ NE/SW	Depression on the floodplain located between two or more rivers, which functions as a small internal drainage basin.
jalmahal	NC/NW/ NE/SW	A "water estate," now referring to any area of *KHAS* water body controlled by the government and normally leased out for fisheries.
katha	NC/NW/ NE/SW	Cut branches of trees submerged in *BEEL* to attract fish.
khal	NC/NW/ NE/SW	Artificial or natural channel, small river or canal.
kua	NC/NW/SW	Artificial fish pit excavated in the floodplain or *BEEL*. Deeper than a *DANGA*. In the South West Region, sometimes used for borrow pits near homesteads or roads.
maital	NC/NW/SW	Small natural or artificial ditch. In North Central and North West regions usually used for ditches and borrow pits near homesteads. In South West, also used for ditches and fish pits in *BEEL* and floodplain.

pushkunni	NC/NW/ NE/SW	Artificial pond, usually of fairly regular shape and near a homestead. In South West, also widely used for artificial, submersible ponds (*KUA*) excavated in *BEEL* or floodplain.

Terms used to describe administrative divisions and human settlements

abadi	NE	The settlers in *HAOR* areas who have come from outside districts within the last one or two generations.
khas	NC/NW/ NE/SW	Government owned land.
mauza	NC/NW/ NE/SW	The smallest recognised administrative unit. It not the same as a village. Some *mauza* in the *HAOR* area have no villages in them at all although a *mauza* can cover anything from a single village or hamlet to 12 or more villages.
para	NC/NW NE/SW	Usually a subdivision of a village, or *GRAM*. Sometimes constitutes a village or hamlet in its own right. Fishing communities frequently live in their own *para*, often referred to as the *JELE para*.
thana	NC/NW/	Equivalent of a sub-district or county. Groups together between 10 and 20 UNIONS. Seat of the *thana nirbahi* committee, which plays an important role in allocating fisheries leases and, under the NFMP, in the identification and licensing of fishermen.

ACKNOWLEDGMENTS

This report is based on the concerted efforts of a large number of people most of whom were based in field stations established in each region studied. Responsibilities included field data collection by fisheries and socioeconomic research teams; administrative support both in the field and in Dhaka headquarters; entry of data into computers; management of databases; analyses and interpretation of results, and report preparation. In addition, numerous short-term local and expatriate consultants made important contributions mainly in the form of supporting desk studies.

The effort of individual members of research teams, administrative support and computer operators have been acknowledged previously in a series of Supporting Volumes to the Main Volume of the Final Report. Senior permanent project personnel contributing to the production of the Final Report are listed below.

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PREFACE

The Fisheries Studies and Pilot Project (FAP 17) was funded by the British Overseas Development Administration (ODA) in conjunction with the Government of Bangladesh. The national implementing agency for the Fisheries Studies was the Department of Fisheries of the Ministry of Fisheries and Livestock. FAP 17 also reported to the Flood Plan Coordination Organisation of the Ministry of Water Resources. The project was one of a number of supporting studies of a broader programme known as the Flood Action Plan (FAP) of Bangladesh. The FAP consisted of a series of eleven major engineering studies, five of which comprised separate regional studies which aimed to identify feasible large-scale flood control and drainage projects through which it would be possible to regulate the extent of flooding during the monsoon. The engineering components were supported by a range of complementary studies, several of which were designed to address various social and environmental impacts which were anticipated to result from large-scale flood control.

FAP 17 was designed to address issues relating to fisheries and aimed to collect, analyse and interpret information on which to base predictions of the impacts of the planned flood control action upon the inland capture fisheries of Bangladesh. To do this, quantitative baseline fisheries and socioeconomic data were collected from inside and outside a range of different types of flood control projects in four of the five FAP regions of the country.

A total of eight FCD/I projects was studied and detailed analyses, results and interpretations of results of each study were documented in a series of Supporting Volumes (Fisheries Studies) of the project Final Report (see list of reports on page xi). Three further fisheries studies were completed, one of which described the fisheries of the main rivers Jamuna and Padma (Supporting Volume No. 10). The others investigated the movements of a) adult and juvenile fish and b) fish hatchlings in regulated and unregulated rivers and assessed the impact of regulators on these movements (Supporting Volume Nos 5 and 11). A parallel set of socioeconomic studies was carried out and the results documented in seven Village Study Reports (Supporting Volumes 12-18). In addition to the fisheries and village studies, several other studies, mainly desk studies, were completed during the course of the project. These provided background information on fish, the environment and socioeconomics (Supporting Volumes No. 19-28). Most of these studies were documented previously as annexes to the FAP 17 Interim Report. However, to ensure wider circulation, they were also included as part of the Final Report.

One extremely important output from the FAP 17 study was the establishment of a detailed and comprehensive fisheries database which provides quantitative baseline information on inland fish resources and fisheries in Bangladesh. Fisheries and socioeconomic databases were submitted to the Government of Bangladesh through the Flood Plan Coordination Organisation of the Ministry of Water Resources and the Department of Fisheries in the Ministry of Fisheries and Livestock. Documentation of each database was included as Appendices 1 and 2 of the Final Report. Descriptions of the methods employed for field data collection, laboratory studies and analyses of data were provided in the FAP 17 Inception and Interim Reports and were presented again with some additions as Appendix 3 of the Final Report.

The FAP 17 Fisheries Studies (Phase I) had three levels of reporting. The first was the establishment of the database accompanied by database documentation (Appendices 1 and 2). The second was a series of Supporting Volumes of fisheries and socioeconomic (village) studies together with additional special studies. These contained data analyses and interpretations of results of each flood control project studied. The third level of reporting was the present Main Volume of the Final Report. The purpose of this report was to draw together the major findings presented in the supporting volumes and to summarise identified impacts of flood control on fish resources and or rural communities which exploit these resources.

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1 INTRODUCTION

1.1 Background

FAP 17: Fisheries Studies and Pilot Project, was one of the supporting studies of the Flood Action Plan. It was the only FAP project entirely devoted to inland fisheries issues. FAP 17 was designed as a two-phase project. Phase I, the Fisheries Studies, was a biological and socioeconomic research project which aimed to provide baseline data on capture fisheries and to provide impact assessments of a range of different types of FCD/I projects on fish resources and on the fishing communities dependent to varying degrees on these resources. Phase II, the Pilot Project, was designed to demonstrate feasible strategies to reduce the adverse impacts of flood control on capture fisheries through the integration of fisheries into water management. Proposals for this study were submitted as a Project Memorandum of Phase II which formed part of the documented output of Phase I. The present report is the Final Report of Phase I.

The project was funded by the British Overseas Development Administration (ODA) in conjunction with the Government of Bangladesh (GoB). The national implementing agency for Phase I was the Department of Fisheries (DoF) of the Ministry of Fisheries and Livestock, and the project also reported to the Flood Plan Coordination Organization (FPCO).

The Project Memorandum for Phase I of FAP 17 was formally approved by the GoB on 28 August 1991, and the project became operational on 17 December 1991. The original planned duration was two years, but the project was later extended by six months to a revised completion date of 30 June 1994.

1.2 Objectives

FAP 17 Phase 1 has seven immediate objectives:

1 Development of guidelines for the assessment of impacts of future flood control measures on communities and the fisheries resources they use.

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2 Assessment of those changes in the economic and nutritional status of different groups which are due to the impact of flood control on fish production.

3 Assessment of the factors affecting the flow and distribution of benefits from fisheries production.

4 Evaluation of the effects of different flood control measures on the production of fish.

5 Evaluation of the effects of different flood control measures on the movement and population of fishes.

6 Assessment of the feasibility of technical and developmental measures to compensate for or reduce potential losses to fisheries due to flood control.

7 To increase local expertise in the assessment of fisheries.

In accordance with standard FAP procedures, the project produced both Inception and Interim Reports.

The revised version of the Inception Report was submitted to GoB in April 1993. It detailed the scope of issues addressed by FAP 17 and described the design process for activities of the Fisheries Assessment and Socioeconomic components of the project. Criteria used for selection of sampling sites were described, as well as the chosen sites themselves where these had been fixed by the date of preparation of the first draft of the report. Methodologies to be used for collection and analysis of data were presented to the level of detail which had been established at that time.

The Interim Report, submitted in July 1993, finalized the above issues and described project progress. It presented data collected by FAP 17 and gave preliminary examples of how these were being analysed and the results used towards the achievement of project objectives. Detailed schedules for production of outputs were given. The results of those sections of the project's work which had already been completed were presented as finalized reports in five annexes to the Interim Report.

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The present report is the Main Volume of the FAP 17 Final Report. The purpose of this report is to draw together the major findings presented in the supporting volumes and to summarise identified impacts of flood control on fish resources and on rural communities which exploit these resources.

To understand more clearly the impacts of flood control on fisheries it is important to appreciate the different ways in which flooding patterns are altered by the design and operation of flood control structures. Section 2 of the report therefore first describes the natural flooding patterns in the areas studied and examines how these patterns have been modified by different types of FCD/I projects. Since modifications to flooding patterns in functional projects were determined by agricultural objectives, it was also necessary to describe these. Section 3 is based on the results presented in the series of FAP 17 fisheries studies. In this section summary descriptions of fisheries on unregulated floodplains, *beel*, canals and rivers are given to provide a baseline against which to assess the various impacts of flood control. Section 4 is based on the results of a series of socioeconomic (village) studies. This section provides a characterisation of the different types of fishing groups and an assessment of the varying degrees of economic dependence of each group on capture fisheries. The final two sections of the report recommend measures to mitigate identified harmful impacts of flood control on fisheries and present guidelines for the assessment of impacts of future proposed projects.

2 FLOODING PATTERNS

2.1 Natural Flooding Patterns

Flooding in Bangladesh is caused by a combination of local rainfall and rivers which bring floodwaters from catchments outside the country. Many of the catchments immediately border Bangladesh and include hill areas with high precipitation, especially in the North East Region. These catchments supply important internal river systems such as the Surma and Kushiyara in the North East and the Atrai and Teesta of the North West. The catchment areas of the two largest rivers entering Bangladesh, the Brahmaputra/Jamuna and Padma, extend for a considerable distance and encompass the Himalayas. River flows are therefore determined both by rainfall and snowmelt from this mountain range.

The magnitude, timing and seasonal fluctuations in flooding patterns vary from year to year and no two flood years are identical. The following section describes the flooding patterns on unregulated floodplains in the four study areas during the study period 1993/94.

In February 1993 heavy rainfall occurred throughout most of Bangladesh. It lasted for a few days only and caused no permanent flooding on most floodplains although in the North East, and to a lesser extent, on low areas of the South West, water depths in *beel* increased and their areas expanded to flood their surrounding low-lying floodplains up to depths of 2 m in the North East. This early flooding is particularly important for fisheries since it stimulates the start of spawning of many floodplain resident species of fish. During March and April intermittent rainfall continued but caused no extensive flooding in the North Central and North West although it again resulted in the inundation of the lowest land in the North East and South West. In May persistent heavy rainfall connected floodplains and *beel* with adjacent rivers in all regions. At this time seasonal rivers were transformed from a series of disconnected pools to continuous flows.

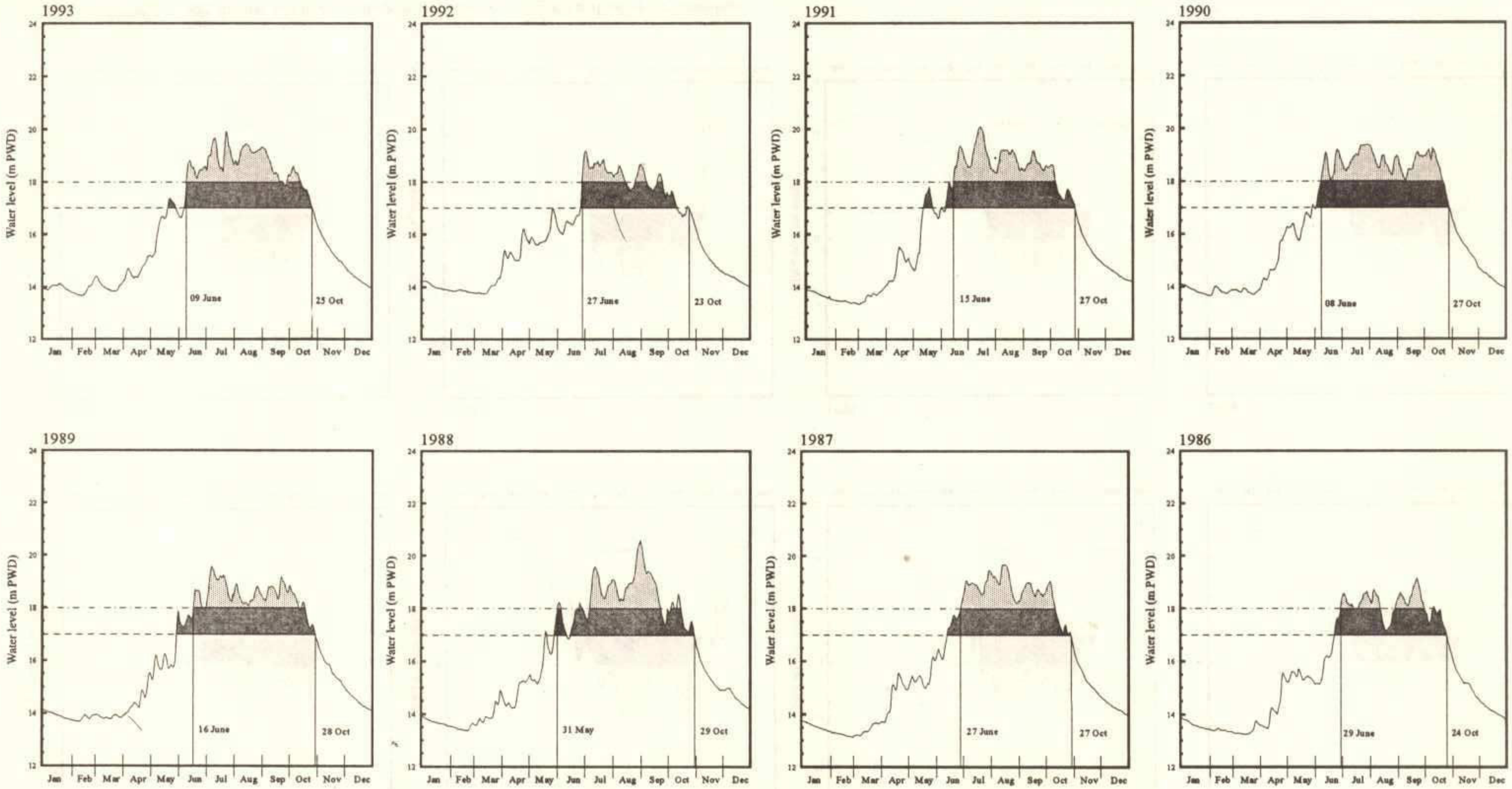
In mid-June the level of the Jamuna rose rapidly and connected with unregulated seasonal distributary rivers in the North Central Region. It also caused a rapid rise in the lower Padma which in turn supplied distributaries in the South West Region downstream of its confluence with the Jamuna. The rise in river levels caused a reversal in the direction of flow in canals draining floodplains and river floodwaters first entered floodplains at this time. The timing of the ingress of river floodwaters has important implications for agriculture and fisheries. Early flooding can, if sufficiently high, damage winter rice crops prior to harvest which usually occurs in May or early June. The same floods also carry spawn or hatchlings of fish, particularly major carps, and transport them by passive downstream drift on to floodplains where they feed, grow and shelter from predators. By relating the timing of the first entry river waters on to floodplains in the North Central Region to levels in the Jamuna it was possible to estimate the frequency of occurrence of risks to winter rice harvests by early floods and the variation in timing of supply of carp hatchlings to floodplains (Fig. 2.1).

Figure 2.1 showed that the first river floods entered floodplains between 31 May and 4 July and that in 12 of the previous 16 years first floods arrived on or after 14 June. This demonstrates clearly that river flooding posed no major threat to the harvest of winter rice which normally occurred in late May, extending at the latest to the first week or two in June. The first fish hatchling, particularly major carps, would be transported on to floodplains between early June and July. In most years, however, initial lower flood peaks occurred in May and it is known from data on commercial savar fisheries which collect live carp hatchlings, that first spawning often coincides with these first floods. These hatchlings would not be able to enter floodplains by passive drift but would be transported downstream into the lower Padma and Meghna systems where they would either be swept out into the Bay of Bengal or grow sufficiently large to return upstream actively.

In the North West Region, analyses of flooding patterns on unregulated areas of Chalan *Beel* showed that only once (1993) in the past 16 years were river levels sufficiently high in May to pose a threat to the *boro* harvest, and that even in the year, the crop was successfully harvested (Fig. 2.2). Data in Figure 2.2 highlight the considerable variability in flooding patterns between years. This can be represented in a number of different ways (Fig. 2.3). The duration of flooding either by rainfall, river or both and the maximum depth of flooding, which also determines flood extent, were combined to provide an annual flood index (Fig. 2.3c). The index represents the area under the flood profile which can then be related to annual fish production. This method has been used previously during the course of the FAP in both the North Central Region[1] and the North East.[2]

In the North East Region, patterns of early river flooding differed from those in other areas of Bangladesh. Here, heavy rainfall on surrounding hills of India caused widespread flash flooding in early May when unregulated floodplains were inundated throughout the region.

Figure 2.1 Seasonal changes in water levels on the Jamuna River at Bahadurabad in relation to floodplain flooding in the North Central Region, 1978 - 1993



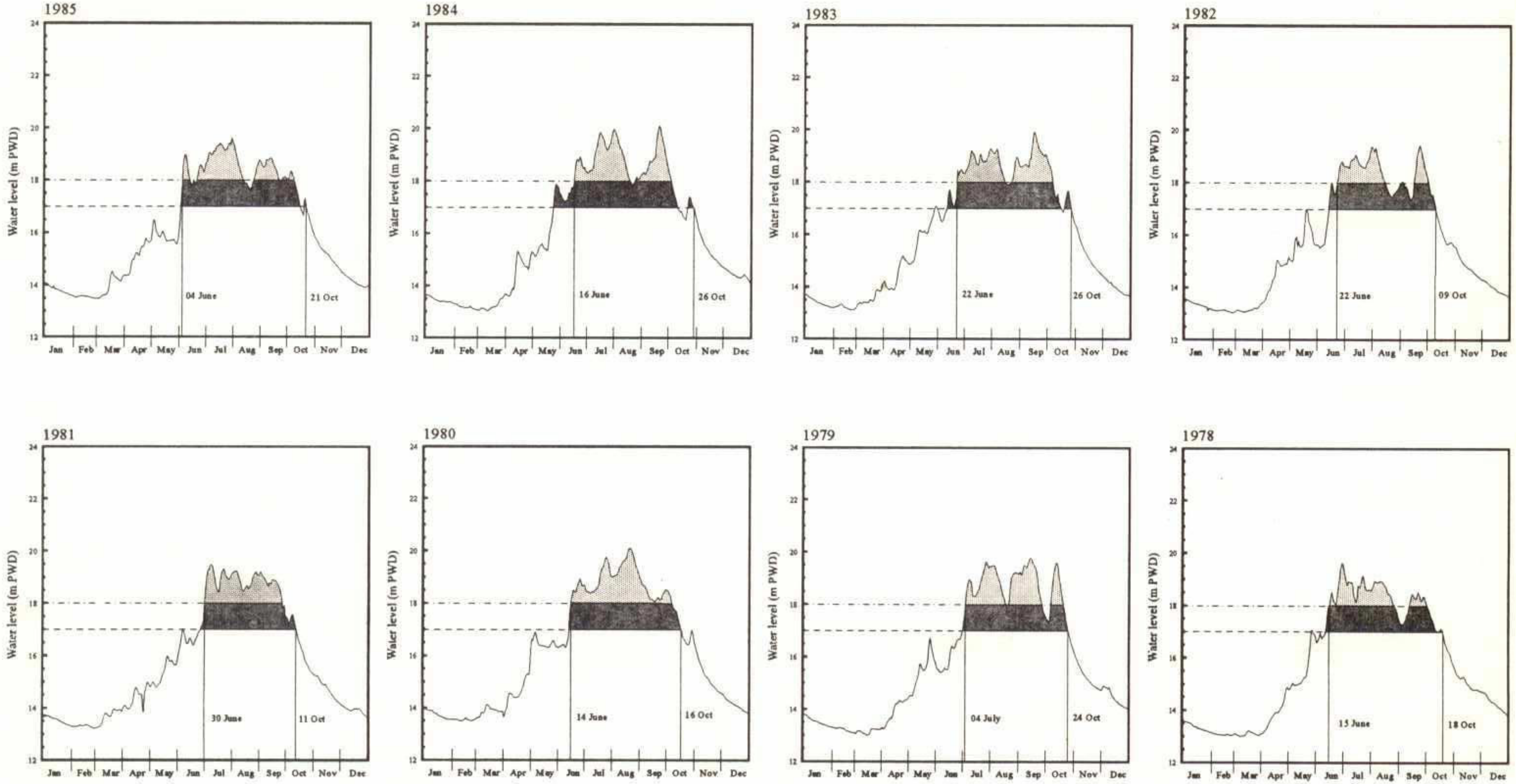
Notes: Rainfall and river flooding on floodplains   River flooding on floodplains

-·-·- Denotes the level above which river waters enter floodplains

- - - - Denotes the level at which most floodplains dry out during the drawdown

Vertical lines identify a) date of first entry of river waters on to floodplains and b) the date of the flood drawdown

Figure 2.1 (Continued)



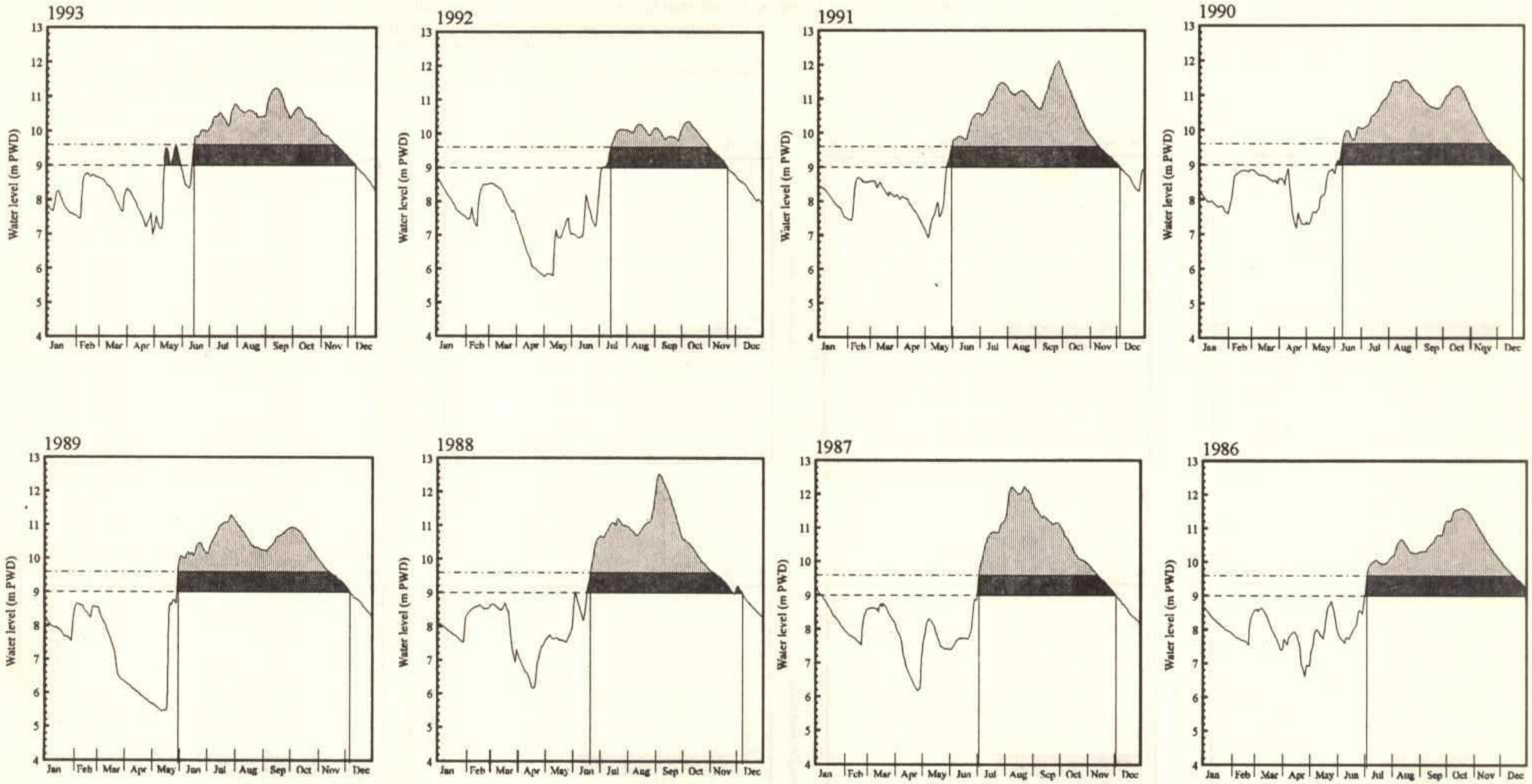
Notes: Rainfall and river flooding on floodplains River flooding on floodplains

-·-·- Denotes the level above which river waters enter floodplains

- - - - Denotes the level at which most floodplains dry out during the drawdown

Vertical lines identify a) date of first entry of river waters on to floodplains and b) the date of the flood drawdown

Figure 2.2 Annual changes in flooding on Chalan Beel



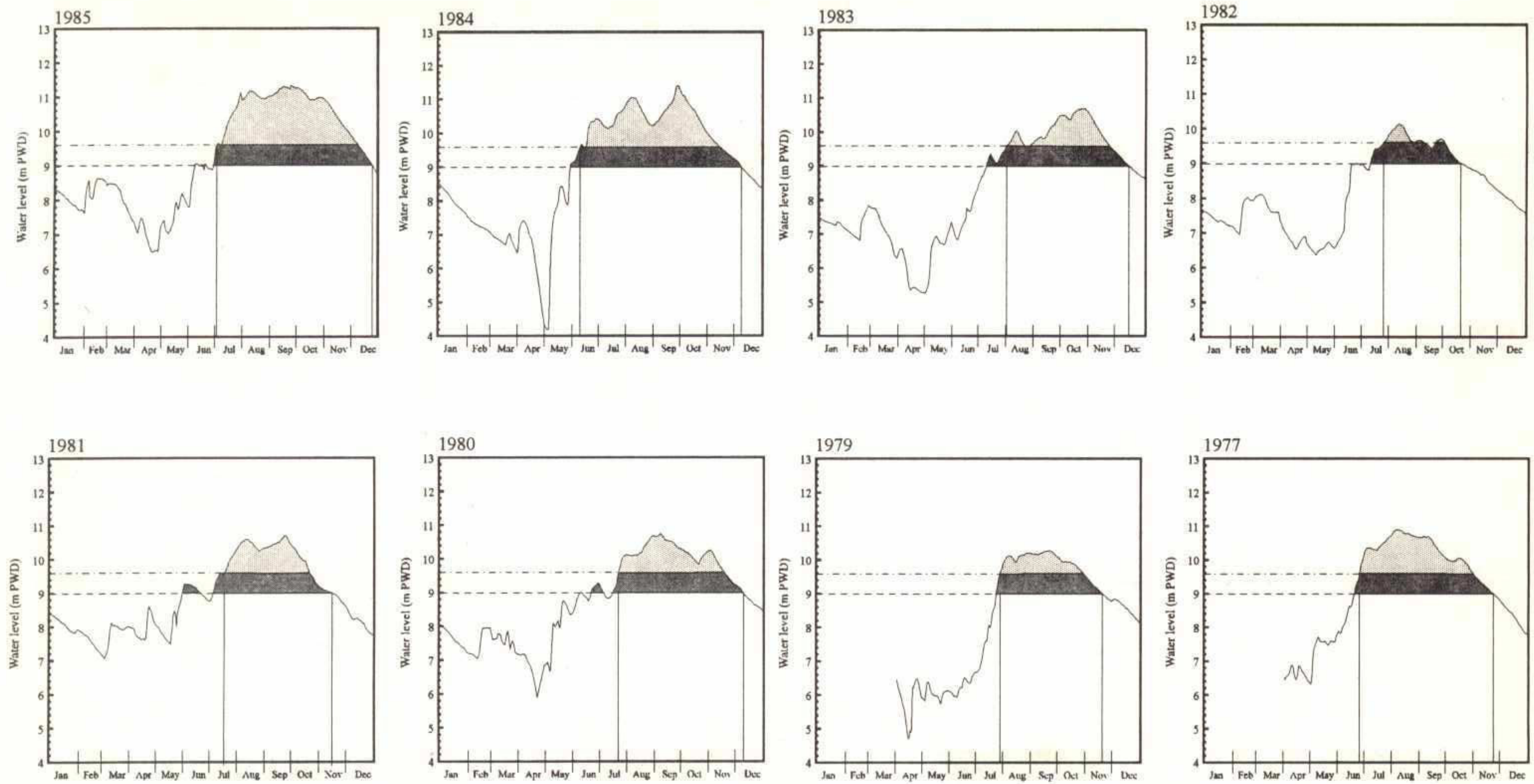
Notes: ■ Rainfall and river flooding on floodplains ▒ River flooding on floodplains

-·-·- Denotes the level above which river waters enter floodplains

- - - - Denotes the level at which most floodplains dry out during the drawdown

Vertical lines identify a) date of first entry of river waters on to floodplains and b) the date of the flood drawdown

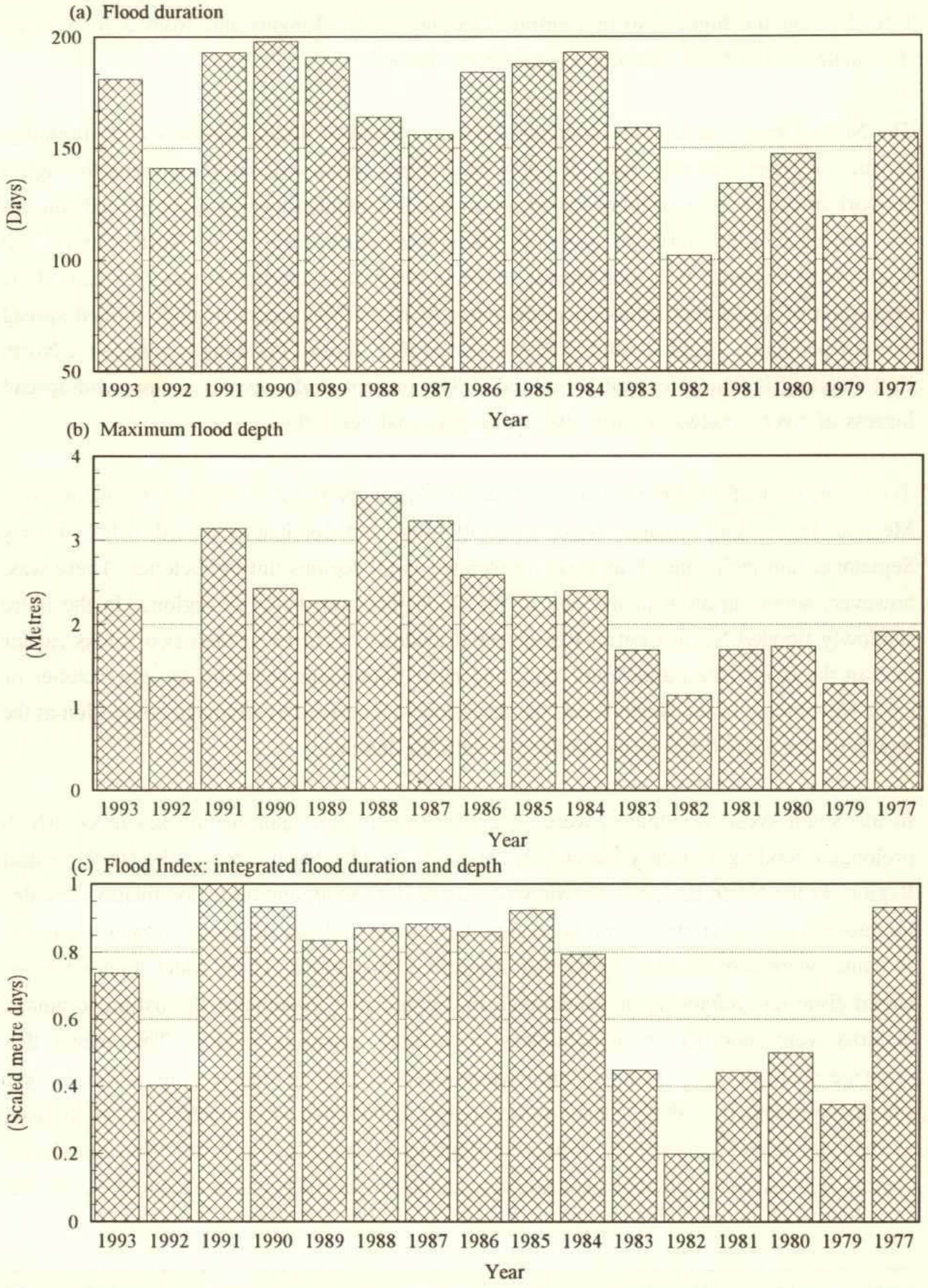
Figure 2.2 (Continued)



Notes: Rainfall and river flooding on floodplains   River flooding on floodplains

- - · - Denotes the level above which river waters enter floodplains
- - - - Denotes the level at which most floodplains dry out during the drawdown
Vertical lines identify a) date of first entry of river waters on to floodplains and b) the date of the flood drawdown

Figure 2.3 Inter-annual variations in flooding patterns on the unregulated floodplains of Chalan *Beel*, 1977-1993



Note: Scaled metre days is a flood index based on the integration of depth and duration of flooding. Annual values are expressed as a proportion (decimal) of the maximum value recorded

This was followed by higher river flooding in June which caused flood levels of 6 to 8 m in many *haor*. In other regions peak water depths during the monsoon generally ranged from 1 to 2 m on the higher North Central floodplains near Tangail and from 2 to 3 m on floodplains in the North West and South West regions.

The North East differed from other regions in its extent of direct overbank river flooding. In other regions this was rare and most river floodwaters entered floodplains through a network of canals. The extent of ingress on to the floodplains appeared quite limited and this was reflected in the clarity of waters in many areas particularly in the North Central and South West regions. It is not known to what extent this clarity of water is caused by deposition of suspended solids on initial entry of river floodwaters or their limited spread across floodplains. Previous studies have reported that on most floodplains outside the North East flooding is mainly caused by rainfall.[3] The present study reveals a more widespread ingress of river floodwaters principally through canal networks.

The timing of the flood drawdown was determined principally by the levels in the main rivers Meghna, Padma and Jamuna. Water levels of rivers and floodplains started to fall in early September and their rate of decrease accelerated in all regions during October. There was, however, some variation in the rate of the flood recession between regions. In the more shallowly flooded North Central Region the drawdown occurred at least two weeks earlier than in the North West and South West and most floodplains were dry by late October or early November. In the North West, the recession was delayed by drainage congestion at the mouth of the Atrai River at its confluence with the Jamuna.

In the South West, floodplains were generally lower, some approaching sea level, which prolonged flooding into early December, about one month later than that in the North Central Region. In the North East, the drawdown occurred in October and most floodplains were dry by mid-November. However, in this region the number and size of perennial *beel* remaining in winter were considerably higher than those in other regions. These water bodies formed leased fisheries, *jalmahal*, in which even on unregulated floodplains the natural drainage patterns were modified by leaseholders to facilitate intensive fishing. This meant that drainage channels were dammed until leaseholders wished to release waters which were subsequently heavily fished. Canals were blocked again whenever outside river levels rose, as they did in February 1994, to prevent flooding of *beel*. In the North West and North Central regions, most drainage canals lost connection with rivers and *beel* during November whereas in the South West connections were retained longer, up to January in some cases, on low-lying floodplains. In all regions outside the North East most seasonal *beel* dried out completely in January 1994.

2.2 Flood Control and Agriculture

To understand more clearly the potential impacts of flood control on fisheries it is important to appreciate the different ways in which flooding patterns may be altered by the design or operation of flood control structures. To understand how flooding patterns can be modified by flood control it is first necessary to take account of the agricultural objectives in flood controlled areas since it is these which in functional projects determine the nature of modified flooding patterns.

National water planning in Bangladesh started in the 1960s with the formulation of a 20-year Master Plan (1965-1985). The plan was prepared by the predecessor of the present Bangladesh Water Development Board (BWDB) and comprised 58 large-scale flood control, drainage and irrigation projects (FCDI). The objective of the plan was to increase agricultural (mainly rice) production to satisfy increasing national demand. The projects were selected on the basis of engineering and economic criteria only and no consideration was given to the potential harmful impacts on capture fisheries and the wetland environment.

There were two principal ways in which rice production could be increased. Firstly, by dry season irrigation of modern high yielding varieties (HYV) of rice and secondly by converting seasonally flooded land into drier land on which HYV *t. aman* could replace deepwater rice (*b. aman*). During the 1980s the total rice production in Bangladesh increased considerably due largely to the increase in the irrigated HYV *boro* crop. This expansion had little connection with flood control developments but resulted rather from the rapid expansion of tubewell irrigation facilities.[4] Only in those areas where pre-monsoon flash flooding occurred could the increase in HYV winter rice be attributed to flood protection. These areas included parts of the North East Region and areas in the South East and North West which were situated immediately downstream of hill regions in India. However, even in some of these areas - for example, Sunamganj in the Central Sylhet Basin - the rapid expansion of partial flood control projects during the 1980s was of little apparent benefit to the production of HYV winter rice.[5]

Outside the North East Region and other localised areas of flash flooding, the objective of flood control is to enable the expansion of HYV *t. aman* on areas which previously supported *b. aman*. In three projects studied by FAP 17 which were structurally secure and designed for full flood control, local farmers chose to permit the controlled entry of external river waters for the continued production of deepwater rice rather than attempt to grow HYV *t. aman*. They did this because rainfall flooding could not be drained from these projects due to higher levels in external rivers. The cultivation of HYV *t. aman* which requires more expensive inputs than *b.aman* was considered to be a risky option even with the capability of excluding external river flooding. The preference by farmers for a more reliable crop of deepwater *aman* rather than a risky crop of HYV *t. aman* was reported by the North West Regional Project (FAP 2) to be widespread throughout the lower Atrai Basin.[6] In contrast, the FAP 12 study of the impact of flood control on agricultural practices in 17 projects throughout Bangladesh reported that there had been a shift from *b. aman* to HYV *t. aman* in 12 of these projects.[4] This shift was reported even in the Silimpur-Karatia Project (now CPP) where no change in flooding patterns were found. The reported widespread extent of this shift in rice crops should be viewed with some caution since the results of a complementary study by FAP 13 revealed that in 12 of these same flood control projects, embankments had been breached and more than 50% of the length of embankment in each was in poor condition.[7] Under these conditions it is doubtful whether flooding could have been controlled sufficiently degree to persuade farmers to adopt the high risk strategy of growing relatively expensive HYV *t. aman* on low-lying floodplains. The FAP 12 study was based largely on rapid rural appraisal (RRA) techniques carried out between mid-April and mid-July and not on direct observation of cropping patterns.

FAP 17 fisheries surveys outside the North East Region recorded deepwater *aman* grown on all low-lying floodplains. HYV *boro* was also recorded in the same fields later in the year. This double-cropping pattern is normally regarded as difficult to achieve because of the overlap in the times of harvest of *boro* and planting of *b. aman*. This has important implications for the potential expansion of *b. aman* since most farmers prefer to grow the most important cash crop, which is HYV *boro* where reliable irrigation facilities are available. Annual crop statistics which have been reported to be of dubious reliability[8] indicate that during the 1980s as the national production of HYV *boro* increased, the area planted and production of *b. aman* decreased. On lowlands, however, farmers developed different methods of obtaining two rice crops. They may plant winter rice and *b. aman* together (ratooning) or broadcast (sow) *aman* immediately after the harvest of *boro* or transplant deepwater *aman* in July. Transplanted deepwater *aman* (TDWR) is reported to a fairly recent innovation in the North West Region but one which is spreading.[6] An earlier, very detailed study of cropping patterns in deepwater rice fields in four districts of Bangladesh revealed that 23% of farmers in Tangail District had already adopted a double-cropping system of HYV *boro*-TDWR by 1983.[9] Unfortunately, this shift in agricultural practice has not been recorded in the Government agricultural statistics since transplanted deepwater rice is not recorded separately from local varieties of transplanted rice which require shallower flooding.

In addition to the harmful effects on fisheries of growing HYV *t. aman* rather than deepwater *aman* on low wetlands (see section 3.6), there are several agricultural advantages in the continued production and development of deepwater rice. In a detailed and comprehensive review, Catling[10] dispelled certain myths surrounding deepwater rice. The most important of these was that yields of DWR are low and usually less than 1 t/ha. Using the most complete data available for Bangladesh, Catling showed that between 1977 and 1979 yields of unmilled paddy from several districts averaged 2.3 t/ha. This study was based on crop cuts from 291 fields of which 13% yielded between 3 to 4 t/ha. The average yield was about 50% higher than those reported in annual government statistics which indicated an average yield of about 1.5 t/ha. National statistics indicated that recent average yields of HYV *t. aman* and *b. aman* were 3.4 t/ha and 1.5 t/ha respectively, a difference of 1.9 t/ha. In contrast, a survey of 423 farmers in the North West Region carried out in 1991 by FAP 2, indicated that yields of HYV *t. aman* and *b. aman* were 3.2 and 2.0 t/ha respectively, a difference of only 1.2 t/ha[11]. In a survey of Chalan *Beel* Polders A, B, C and D, yields of 2.34 t/ha and 1.46 t/ha of HYV *t. aman* and *b. aman* were reported in 1991, a difference of only 0.9 t/ha between the two crops[12]. Yields of 3.2 t/ha and 1.9 t/ha of HYV *t. aman* and *b. aman* were reported from a survey carried out in 1991 in the lower Atrai Basin as part of a study of the Pabna Irrigation and Rural Development Project[13]. It is clear from these results that the differences between the yields of HYV *t. aman* and *b. aman* are not as large as the values derived from national statistics which are often applied in economic analyses of the performance of flood control projects. It is also clear that the yield of just over 3 tonnes/ha of HYV *t. aman* reported by farmers in the North West Region is well within the upper range of yields of *b. aman* recorded in various regions of the country. Catling concluded that the yield potential for the best traditional varieties of *b. aman* in Bangladesh was about 4 tonnes/ha.[10] In areas of flood control however, he believed that the development of new varieties of deepwater rice may produce 5 tonnes/ha. The reduced differential between yields of HYV *t. aman* and *b. aman* has considerable implications for the economic viability of many flood control projects, especially when the value of high fish losses associated with HYV *t. aman* production is also taken into consideration. Under these circumstances it seems probable that many projects would fail to produce viable economic rates of return.

From a nutritional perspective, the shift in recent years towards rice monoculture and the concomitant reduction in the production and consumption of traditional dry season crops of oilseeds, pulses and vegetables, has reportedly increased the risk of occurrence of nutritional deficiencies.[14] In this respect there is an added advantage of growing deepwater rice on lowland followed by a variety of dry section pulses or vegetables. On some farms in the North Central Region it was found that the economic returns of deepwater rice followed by *rabi* crops were higher and less risky than a single crop of high-input HYV *boro*.[15]

Deepwater *aman* rice is produced principally on small farms ranging in size from 0.6 to 1.3 ha [9, 10, 15]. It is a highly versatile and diverse crop with a staggering 2000 cultivars (varieties) grown in the varied agroecological niches of Bangladesh. Such diversity facilitates a complex and rich variety of cropping patterns which farmers rely on to adjust to changes in flooding patterns between years. Deepwater rice is a valuable crop for the small subsistence farmer since it requires only a small cash input and, although a labour intensive crop, much of the labour can be supplied by the family and the crop mixed with others to spread the risk of loss or damage. Other increased benefits obtained from deepwater *aman*, as opposed to HYV *t. aman*, include a valuable supply of fresh cattle fodder which can be cut from the rice plant during its growth period without affecting rice yield. The crop also provides higher yields of good quality straw used for cattle fodder or thatching, while the stubble is a major source of fuel in rural areas and serves also as a mulch for dry season crops.

2.3 Impacts of Flood Control on Flooding Patterns

2.3.1 Data sources

Four data sources provided quantitative and qualitative descriptions of flooding patterns inside and outside flood control projects. The first was information collected directly during fisheries surveys. At each floodplain and *beel* site, water depths were measured every two weeks at fixed points on different land heights. At the same time, the extent of the flood was recorded on sketch maps.

The second and third sources of data were provided by BWDB. Daily water level data in external rivers were used to obtain a continuous record of flooding pattern on adjacent unregulated floodplains, while daily water level data inside and outside regulators were used to compare flooding pattern in and out of projects. The fourth data source was available only in two projects, the PIRDP and MIP where more detailed analysis of flooding inside these projects was done by SWMC[16] and FAP 6[17] respectively.

2.3.2 Selection of projects

Eight flood control projects were selected in four FAP regions (Table 2.1). The projects were selected to cover a range of different types of flood control which were representative of current developments in Bangladesh. The distribution of projects between regions was rather uneven; three in the North West and one in the North Central Region but this reflected differences in the extent of flood control development between these regions.

The eight projects were divided into three categories based on the degree of flood control achieved during the study period. The three categories are listed below:-

a) **Full Flood Control**: this was achieved in only one project, the BRE. In the study area and year of study entry of floodwaters from the Jamuna River was highly restricted by regulators. In other locations in previous years the BRE was repeatedly breached by erosion by the Jamuna.

b) **Controlled Flooding**: achieved in three structurally secure full flood control projects. These projects were designed to exclude external river flooding and to convert seasonal wetland into drier land on which to expand the production of HYV *t. aman* at the expense of *b. aman*. In practice, however, farmers chose to operate the project for the continued production of deepwater *aman* by allowing the controlled entry of external river floodwaters when needed.

c) **Partial Flood Control**: achieved by a range of different types of project either by design or accident which resulted in control of flooding at restricted times of the year and/or in limited areas.

Table 2.1 Flood control projects studied by FAP 17

Type of flood control	Name of project	Type of project	Performance
Full Flood Control	Brahmaputra Right Embankment (BRE) (NW)	Full river embankment	Successful full flood control embankment in area and year studied. In several other locations the embankment was repeatedly breached by erosion by the Jamuna.
Controlled Flooding	Pabna Irrigation and Rural Development Project (PIRDP) (NW)	FCDI	Structurally secure project designed for full flood control but in which external river waters were allowed entry for the production of deepwater *aman*. This produced controlled deep flooding. Pumped drainage not fully functional up to 1994.
	Chalan *Beel* Polder B (NW)	FCD	Structurally secure project designed for full flood control but in which external river waters were allowed entry for the production of deepwater *aman*. This produced controlled deep flooding.
	Satla-Bagda Project Polder 1 (SBP) (SW)	FCD	Structurally secure project designed for full flood control but in which external canal waters were allowed entry for the production of deepwater rice. This produced controlled deep flooding.
Partial Flood Control	Shanghair *Haor* Project (SHP) (NE)	FCD - with submersible embankments	Structurally secure partial flood control project using submersible embankments to prevent river until May after which floodwaters overspilled. Monsoon flooding unaffected.
	Manu Irrigation Project (MIP) (NE)	FCDI	Full flood control project in which embankments were cut when outside river levels were high resulting in flooding of the project. Pumped drainage and winter gravity-fed irrigation not fully functional.
	Chatla-Fukurhati Project (CFP) (SW)	FCD	Full flood control and drainage project in which external river flooding occurred due to non-functioning regulators and damaged embankments.
	Compartmentalization Pilot Project (CPP) in Tangail (NC)	FCD	Flood control and drainage project which did not prevent river flooding due to poor design of original project (Silimpur-Karatia) and non-completion of current design (CPP).

2.3.3 Impacts

Full Flood Control

Brahmaputra Right Embankment (BRE)

Closure of Bauitara regulator on the Old Hurasagar River, a distributary of the Jamuna, from June to September effectively prevented river waters entering adjacent floodplains. As a result, the duration of river flooding on floodplains inside the BRE was reduced to only 3 weeks in late August and early September compared with 16 weeks on unregulated floodplains from mid-June onwards. The first entry of river floodwaters was thus delayed by 9 weeks and early flooding was due solely to local rainfall.

Both flood depths and extents were considerably reduced inside the BRE but these could not be quantified accurately. The duration of flooding on the lowest part of unregulated and regulated *beel* was similar but the flood drawdown on higher land occurred one month earlier inside the BRE. The reduction in river flooding was reported by local fishermen and farmers to have reduced the dry season area and depth of *beel* inside the BRE and the small area of perennial water remaining was used to irrigate surrounding fields of winter rice.

Controlled Flooding

Controlled flooding was observed in three structurally secure projects which were designed for full flood control. Two were in the North West Region, the PIRDP and Chalan *Beel* Polder B, and one, Satla-Bagda Polder 1, in the South West. Daily water level data from BWDB were available only for the two projects in the North West (Figs 2.4 and 2.5). Several impacts on flooding patterns can be identified from Figures 2.4 and 2.5.

i) External river flooding was reduced inside polders; therefore a greater proportion of the monsoon flood was derived from rainfall.

ii) As a result of gate closures in May and/or June the onset of extensive inundation of floodplains was delayed by 2 to 4 weeks.

Figure 2.4 Comparison of water levels inside and outside Koitala and Talimnagar regulators in the PIRDP, May - December, 1993

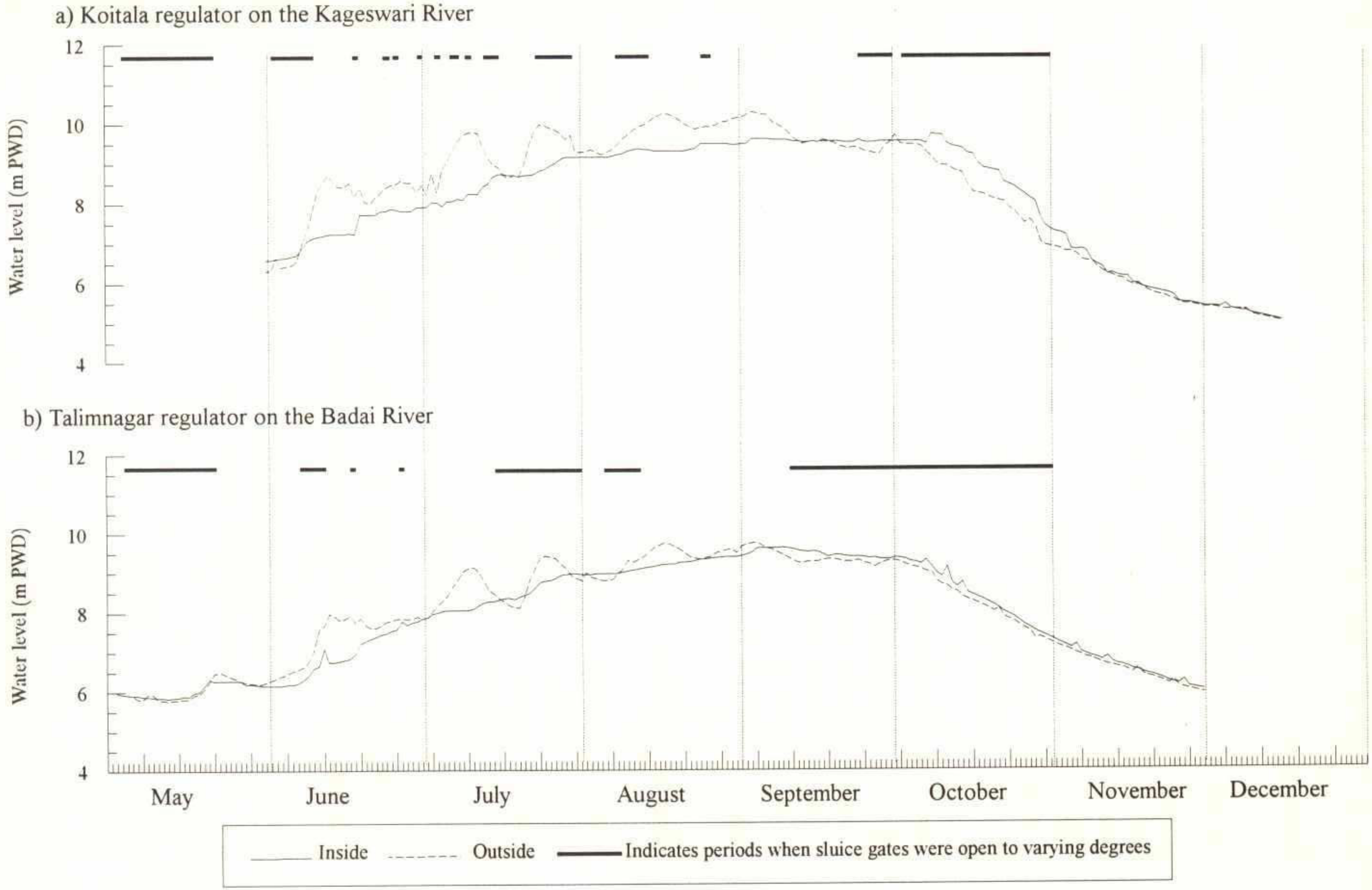
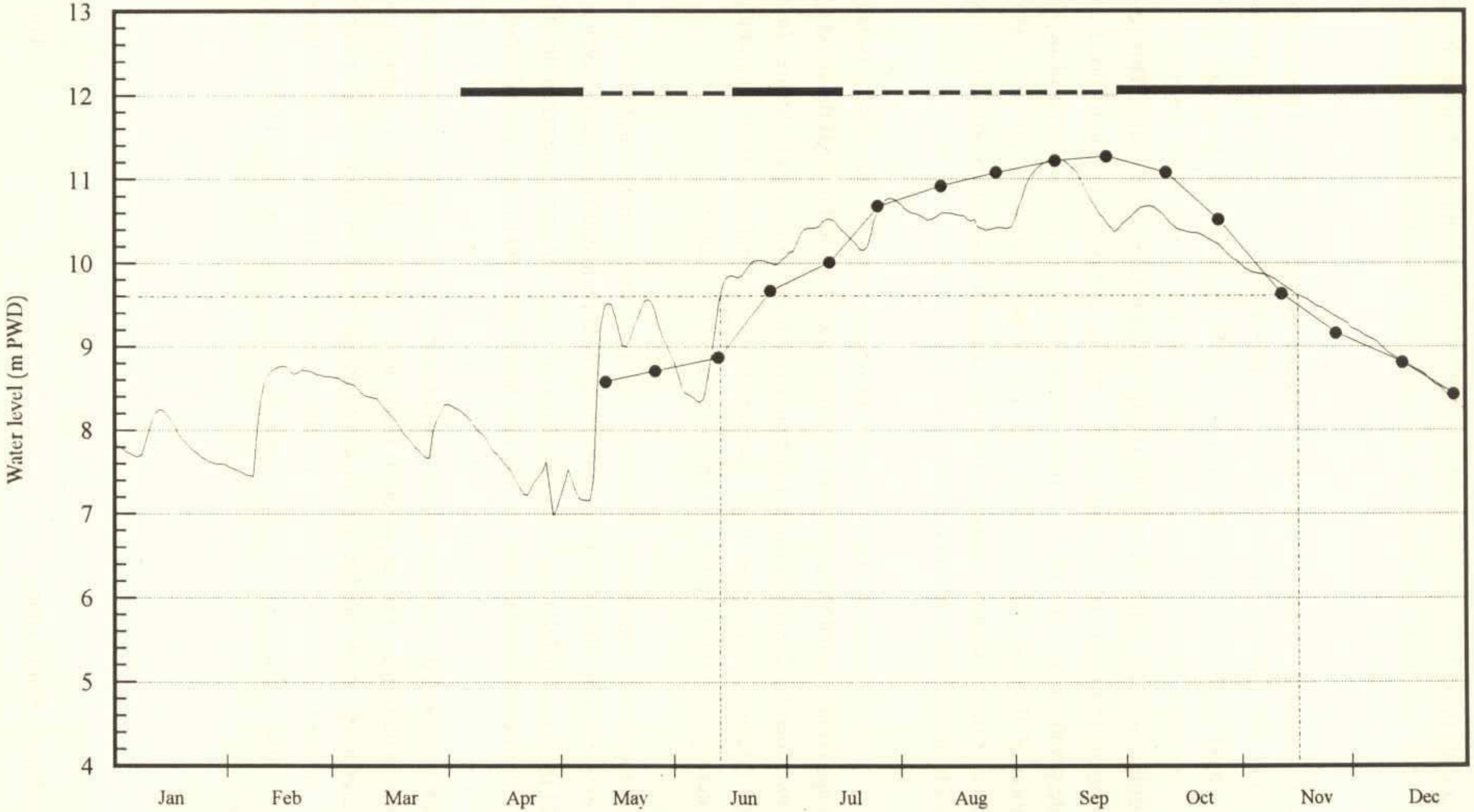


Figure 2.5 Comparison of water levels in Haribhanga *Beel* and the unregulated Chalan *Beel*, January 1993 - December 1993



Notes:
1. ——— Denotes water level in Atrai River and on the unregulated Chalan *Beel* between June and November
2. —●— Denotes water level in Polder B
3. - - - - Denotes level and date at which Atrai River flooded the unregulated Chalan *Beel*
4. ▬ - - Solid and dashed lines denote sluice gates open and closed respectively

iii) During the monsoon sluice gates were opened intermittently to provide a gradual increase in flood levels to depths of up to about 3 m reaching a peak in September and thereby avoiding rapid seasonal fluctuations in water levels ranging from 0.5 m to 1.0 m recorded on unregulated floodplains.

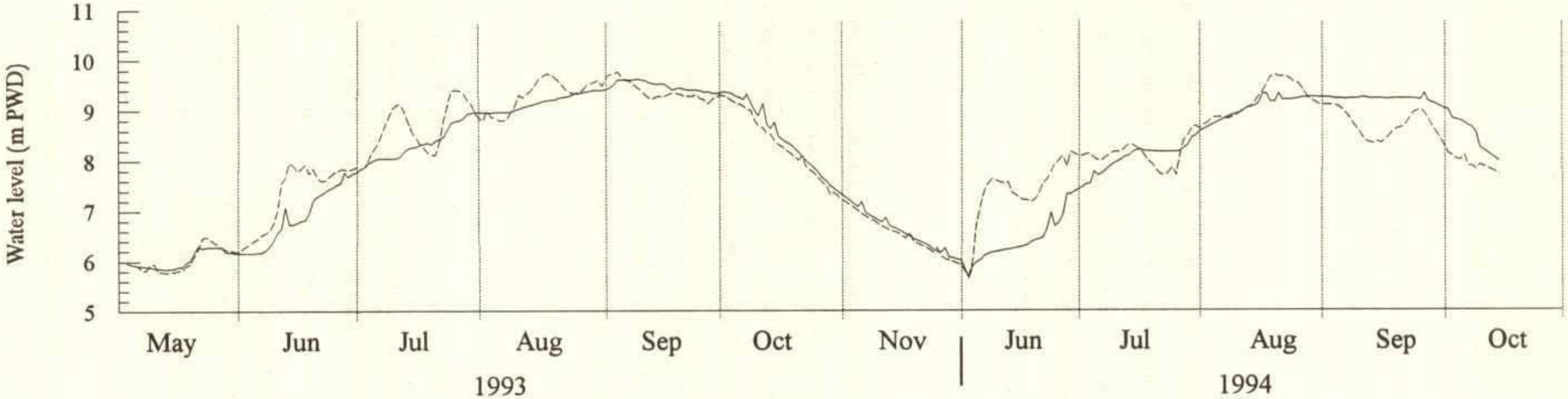
iv) Peak flood levels in the PIRDP were reduced by 0.5 to 1.8 m. This resulted in reductions in the flood extent which varied between different internal drainage basins. Peak flood levels were not reduced in Polder B. Between mid-June and mid-July, however, water levels inside were 0.3 to 0.8 m lower than those outside but from mid-July onwards, water levels were 0.5 to 1.0 m higher than outside. This resulted in an increased extent of flooding up to 1,668 ha of floodplain due to flood control for deepwater rice cultivation. A flood index based on the integration of depth and duration of flooding was 18% higher inside Polder B than that outside. Assuming other determining factors remained the same, a higher flood index would be expected to result in increased fish production.

v) The duration of flooding was increased up to one month in the PIRDP because of drainage congestion at sluice gates during the drawdown. In Polder B the flood season was extended by 2 weeks during December due to temporary gate closure. In Satla-Bagda Polder 1, sluice gates were operated to allow canal diversions, damming and dewatering to completely fish out the main drainage channel.

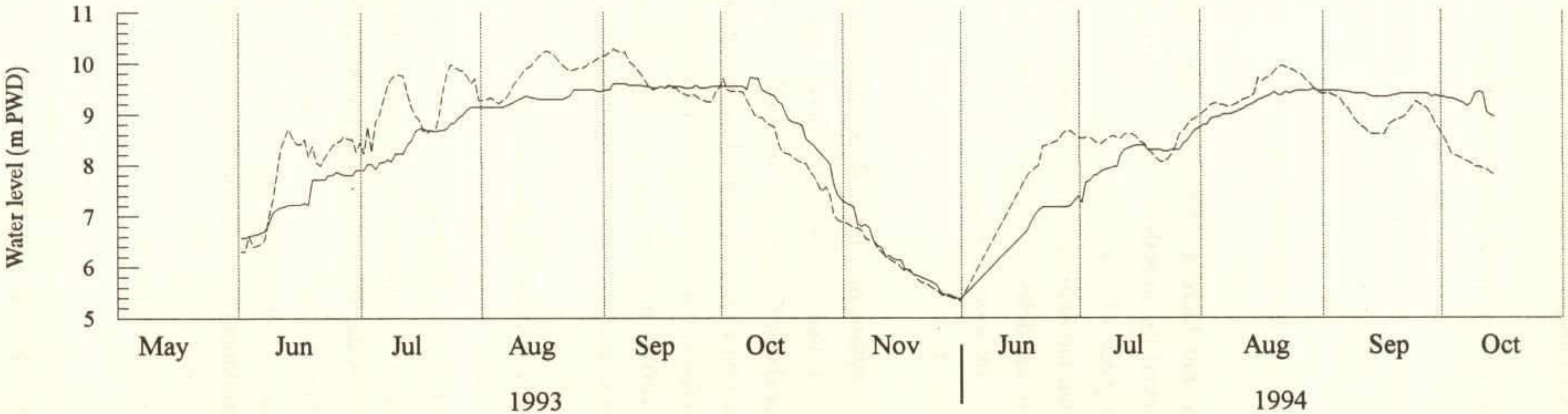
Controlled flooding for deepwater rice also reduced inter-annual variations in flood magnitude, extent and duration compared with those on unregulated floodplains. Water level data obtained from the PIRDP in 1993 and 1994 reveal great similarities between flood levels inside the polder despite the fact that in July and September 1994 it was considerably drier than in the same months in 1993 (Fig. 2.6). In high flood years, controlled flooding in polders which remained structurally secure, would result in substantial reductions in the flood extent and this would in turn be expected to result in lower fish catches. In drought years, however, water levels inside polders are conserved by gate closures when outside river levels drop. Thus, in these years floods will be relatively higher inside than outside polders and differences in fish production may therefore be lower than in high flood years (see section 3.6).

Figure 2.6 Comparison of water levels inside and outside Koitala and Talimnagar regulators on the PIRDP during 1993 and 1994

a) Talimnagar regulator on the Badai River



b) Koitala regulator on the Kageswari River



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Partial Flood Control

Four projects provided partial flood control. Of these only one, the Shanghair *Haor* Project (SHP), was structurally secure and designed specifically to provide this type of flood protection. It was difficult to generalise about the impact of partial flood control on flooding patterns; each project is therefore described separately in the following discussion.

Shanghair Haor Project (SHP)

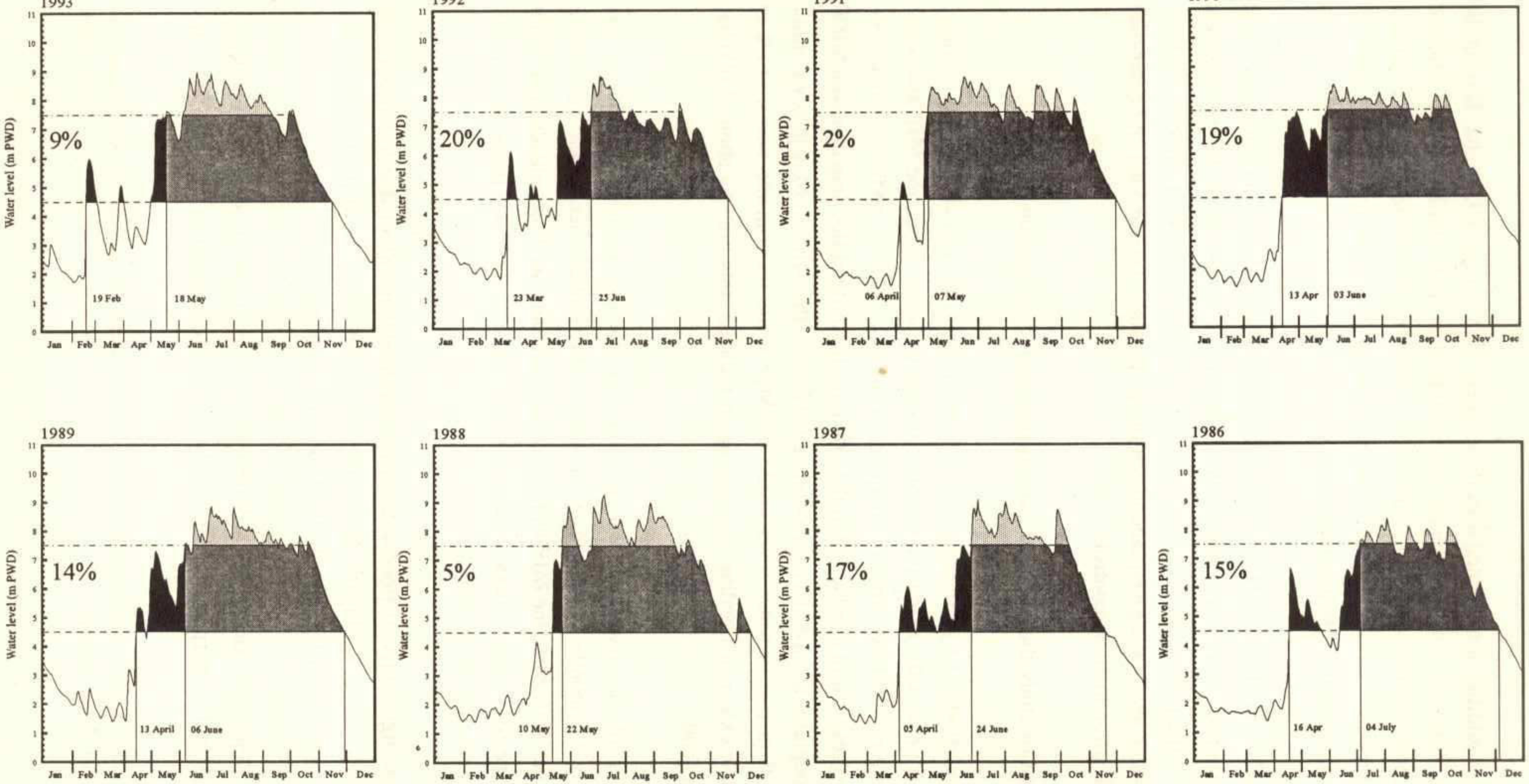
The objective of this type of project was to delay the entry of the first river flood until mid-May and thereby protect the *boro* harvest. Since its construction in 1985, the project achieved its objective in all years except 1991 when high river floods occurred during the first week of May (Fig. 2.7). In the year of study (1993) the submersible embankment around the *haor* prevented temporary river flooding on two occasions between February and April and delayed the onset of more permanent monsoon floods for about 19 days in May. The monsoon flood levels were unaffected due to overtopping of the submersible embankment.

Examination of annual flood indices based on the integration of flood depth and duration showed that in 1993 the flood was reduced by 9% compared with that on adjacent unregulated floodplains but in other years this ranged from 2% to 20%. The degree of flood reduction estimated from data in Figure 2.7 was a slight overestimate since the data could not take into account an extension of the flood season inside the SHP during the drawdown and early winter caused by drainage congestion. This resulted largely from blockage of the main drainage canal by a leaseholder to facilitate fishing with *ghori jal*.

Manu Irrigation Project (MIP)

Ever since its construction in 1983, the MIP failed to provide the level of flood control for which it was designed. In at least five years of high floods in the Manu River, cuts were made in its embankment by people living immediately outside it to relieve flooding of their homesteads. Flood levels in the Manu increased considerably in recent years as a result of confining floodwaters in the river channel by building flood control embankments and also because of increased local rainfall. Even during drier years, when no cuts were made in embankments, rainfall flooding inside the project was 1 to 2 m greater than the target design level of 7.15 m PWD. In drier years flood levels normally ranged from 8 to 9 m PWD despite pumping out of floodwaters by Kashimpur pump station which proved ineffective.

Figure 2.7 Seasonal flooding patterns inside and outside Shanghair Haor, 1986 - 1993



Notes:
1. ■ River flooding excluded by submersible embankments ■ Rainfall and river flooding on regulated and unregulated floodplains □ River flooding over submersible embankment
2. –·–·– Denotes the level at which submersible embankment in the SHP overtops by river flooding
3. - - - - Denotes the level at which river waters enter unregulated floodplains in Dekker Haor
4. Vertical lines identify a) date on entry of river floods on to unregulated floodplains b) date of first overspill of submersible embankments and c) date of the flood drawdown
5. Percentage values relate to the proportion of the total annual flood index (metre days) reduced by submersible embankments in the SHP
6. Flood levels were derived from water levels of the Surma River at Sunamganj

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This resulted in an additional inundated area of between 5,000 ha and 10,000 ha. During the year of study by FAP 17, cuts were made in embankments in June 1993. These allowed floodwaters to enter suddenly from the Manu River which reportedly resulted in extensive damage to rice crops but also allowed fish to enter the project. During the previous drier year of 1992 no cuts were made in embankments.

Since both the MIP and Hakaluki *Haor* drain into the Kushiyara River, flooding patterns in both were determined to a large extent by those of the river. Prior to embankment construction, flooding patterns in both areas were very similar. Because of slope of the river bed, however, water levels at a given land elevation in Hakaluki were about 1 m higher than those of the MIP prior to flood control.

During the period of study the MIP had the flowing impacts on flooding:-

i) Intermittent flooding by external rivers was prevented from 18 February until 8 June. Up to early May little extensive rainfall flooding occurred inside the MIP and water levels were reduced by 1 to 2 m compared with peak levels immediately outside the MIP. This resulted in a reduction in the extent of intermittent flooding on about 5,000 ha of floodplains immediately surrounding *beel* inside the MIP. In May heavy rainfall caused a 3 m rise in water level inside the MIP while that outside was up to 2 m higher. The extent of flooding was thus again reduced, this time by about 7,000 ha, on higher land.

ii) The timing of the first entry of river waters on to *beel* and low floodplains was delayed by 3.5 months (18 February - 8 June). After embankments were cut in June flooding patterns inside the MIP were essentially the same as those outside apart from two brief periods of peak flood in June and July when water levels inside were about 0.5 m higher than those outside.

iii) There was slight entry of floodwaters from the Kushiyara River due to leakage in a 3-vent sluice gate at Kushiyara. No major entry was possible, however, until late July when erosion caused breaches in the Kushiyara embankment.

iv) A 3-vent sluice gate constructed at Kashimpur was not included in the original design of the MIP and its purpose has apparently not been documented. The gate has a sill level of 1.4 m PWD which is considerably lower than the approved level of 4.1 m PWD on the adjacent 6-vent gate. The 3-vent sluice was opened in late December to drain out water remaining in Khorodari *Khal* and the connecting Patasinga *Beel* to levels below those recommended in the project design. This was done to facilitate fishing in leased *beel* and *khal*.

Chatla-Fukurhati Project (CFP)

The Chatla-Fukurhati Project was selected for study as a representative example of a partial flood control project. That the scheme did not provide the level of full flood control to which it was originally designed was due to inadequate maintenance and repair of regulators and embankments.

Andolir *Beel* was selected as a free-flooding control area. However, hydrological studies revealed that the area was less freely-flooded than floodplains within the FCD project and also more poorly drained. This was attributed to the development of a network of rural roads which provided unplanned partial flood control.

Since Andolir *Beel* did not function as a free-flooding control area, it was not possible to assess quantitative changes in flooding patterns within the project resulting from the construction of flood control embankments. However, several hydrological differences between sites inside and outside the FCD project were identified and these provided a rational basis for the interpretation of differences in fish populations between sites.

There was no difference in the timing of the first pre-monsoon rainfall floods or the start of the flood drawdown between sites inside and outside the FCD project. The magnitude of the pre-monsoon rainfall floods was about 0.5 metre lower than at sites outside the CFP because of a more efficient drainage system which also resulted in a more rapid flood drawdown in October. From mid-June to the end of November flood levels inside the CFP were 0.5 metre higher than those outside it due to a greater ingress of river floodwater. A greater proportion of the monsoon flood therefore originated from river flooding inside the FCD project. The duration of the flood was shortened by 2 to 4 weeks in December inside the CFP because of improved drainage.

Tangail Compartmentalization Pilot Project (CPP)

The peripheral embankment used in the Tangail CPP had no influence on flooding patterns within the project. There was a delay in entry of the first river waters into *beel* and floodplains of about 2 to 3 weeks inside the CPP, but this was caused by natural siltation at the mouth of the Lohajang River.

3 IMPACTS ON FISH

3.1 Objectives

Of the seven immediate objectives of FAP 17 listed in section 1.2, five directly concern the fisheries studies (Nos. 1, 4, 5, 6, 7). The training element of the study (objective No. 7) was addressed by on-the-job training of approximately 100 fisheries biologists during the course of the field programme. Training was also given to senior supervisory personnel who were responsible for the management and implementation of fisheries monitoring programmes. These members of staff were professors seconded from different universities in Bangladesh. The remaining objectives were addressed through computerised analyses of the enormous volume of fisheries data accumulated by the study to provide information upon which to base impact assessments (objectives 4 and 5) and recommendations relevant to possible future flood control developments (objectives 1 and 6).

3.2 Approach

In order to obtain quantitative assessments of the impacts of flood control on fisheries it was necessary to provide accurate detailed estimates of fish production (catch), densities, diversities and movements inside and outside various flood control projects which could then be used in a series of paired comparisons between similar habitat types. For such detailed quantification of multi-gear, multi-species fisheries it was considered essential to use direct enumeration methods. This approach involved the collection of fisheries catch information in defined and measured areas during the actual operation of different gear types ranging from the smallest gears such as *sip* (Appendix 1), used by children, to the large-scale gears such as *ber jal*, used by teams of professional fishermen. To do this, enumerators had to interview fishermen and measure catches on the water, whether on shallow floodplains or on very large rivers such as the Jamuna. This approach was highly labour intensive and required rigorous on-site supervision, but was the only method which could provide the level of quantitative and qualitative detail required to fulfil the specific objectives of the fisheries studies.

Initially, alternative approaches to fisheries assessment were considered. These included the use of the existing method of collecting fisheries statistics i.e. the Bangladesh Fisheries Resource Survey System (BFRSS) developed by the Department of Fisheries with assistance

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from FAO. Another possibility was demographic household and market surveys which have been used in other fisheries studies in Bangladesh, e.g. the Third Fisheries Project. These approaches, however, could not provide the level of quantitative detail of each gear type and each fish species which was required to produce a comprehensive set of baseline data.

The value of simple environmental indicators of fish production e.g. the morphoedaphic index* was also explored but found to be of little predictive value in describing floodplain fisheries in Bangladesh.

3.3 Study Areas

The methods and criteria for the selection of study areas are briefly summarised here. They have been fully documented previously in the FAP 17 Inception and Interim Reports and have been presented again with some additions as Appendix 3 of the Final Report.

The selection process involved a considerable amount of preparatory work in the form of desk studies and field surveys. Selections were made at four different geographical levels, which are listed below in descending order of size:

1. FAP region
2. Flood control project within FAP regions
3. Aquatic habitats within each project and its control area
4. Sampled sites within each habitat type.

Four of the five FAP regions were selected for study, i.e. the North Central (NC), North West (NW), North East (NE) and South West (SW) regions (Fig. 3.1). The South East Region could not be studied because of financial, logistical and manpower constraints. Within each region flood control projects were selected to ensure inclusion both of a range of different types which were of particular regional significance (Table 2.1). For example, in the North East Region there are many partial flood control projects based on submersible embankments, with construction of more planned for the future. There are also a number of full flood control projects and both types of project were therefore selected for study in this region.

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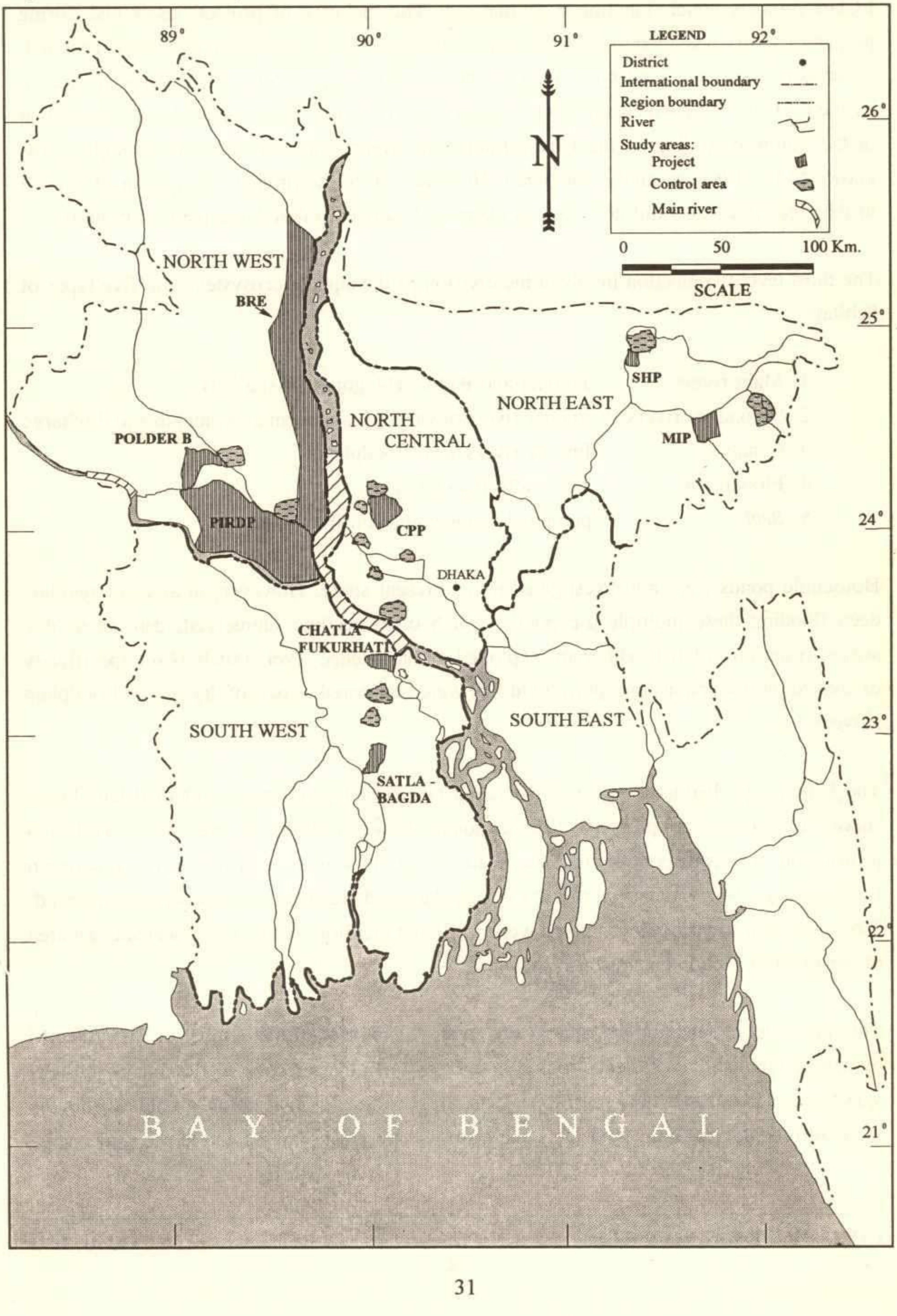
* MEI = Total dissolved solid concentration (mg/l) divided by mean water depth (metres).

Figure 3.1 FAP 17 study areas



The greatest constraint on the selection process at this geographical level was in finding FCD/I projects which functioned as planned. The majority of projects examined during preparatory surveys failed to offer the level of flood protection for which they were designed, invariably because of inadequate maintenance or repair. A similar conclusion was reached by the FAP 13 study which specifically addressed this issue[7]. This meant, for example, that in the South West Region the Chatla-Fukurhati Project was selected even though it was known to be at best partially functional. However, since the project was typical of several in the area which also did not work as planned, it was considered acceptable for study.

The third level of selection involved the division of the aquatic ecosystem into five types of habitat:

1. Main rivers	: Jamuna and Padma (Meghna not studied)
2. Secondary rivers	: smaller rivers of varying catchment area, length and discharge
3. Canals	: linking rivers with floodplain
4. Floodplain	: seasonally flooded land
5. *Beel*	: perennial water bodies on floodplain.

Household ponds were not investigated in the present study. However, in areas of regular, deep flooding these multiple use ponds, which often become submerged, can act as dry season reservoirs of fish which are exploited at subsistence level. Ponds (*kua*) specifically excavated on floodplains to capture wild fish were monitored as part of dry season floodplain surveys.

The Jamuna and Padma rivers were surveyed largely independently of regional land-based surveys of flood control projects. All other aquatic habitats, if they occurred within a selected project and its outside control area, were sampled at the same time. The distinction between floodplain and *beel* was fairly arbitrary during the flood season when both were submerged. Most perennial water bodies sampled were small and therefore within these *beel* sites an area of surrounding floodplain was also included.

The final level of selection was that at site level. A summary of the number of sites selected by habitat type is given for each region in Table 3.1. In the selection of floodplain and *beel* sites inside and outside flood control projects, areas were chosen as far as possible within the same agro-ecological unit, with the same historical flooding patterns and at the same range of land elevation. Wherever possible attempts were made to apply stratified random selection of sampling sites within the logistical constraints of the survey programme. The selection of floodplain and *beel* sites automatically determined the selection of canals and secondary rivers which linked with these areas (Fig. 3.2). Close spatial linkage between different types of habitat was needed to examine possible fish movements through the aquatic ecosystem and identify blockage to movements by flood control structures.

Table 3.1 Summary of the total number and size of sampling sites by habitat and region

Habitat	Size Unit	Region								All Regions	
		North Central		North East		North West		South West			
		Nos	Size	Nos	Size	Nos	Size	Nos	Size	Nos	Size
Main River (Jamuna and Padma)	km ha	4	34.8 5,665.4	0	-	3	19.3 3,288.0	1	8.2 1,256.5	8	62.3 10,209.9
Secondary River	km ha	7	90.1 856.5	5	51.91 516.4	9	96.7 593.9	3	29.3 477.0	24	267.9 2443.7
Canal	km ha	8	46.8 93.7	3	8.3 60.8	4	32.2 70.8	6	31.6 125.4	21	118.8 350.7
Floodplain/ *beel*	ha	12	1,562.7	13	2,457.1	14	3,572.6	12	1,710.1	51	9,302.5
Total		31		21		30		22		104	

Note: Size of site refers to length in km for kilometres and area in hectares for rivers and canals and area in hectares for floodplains/*beel*

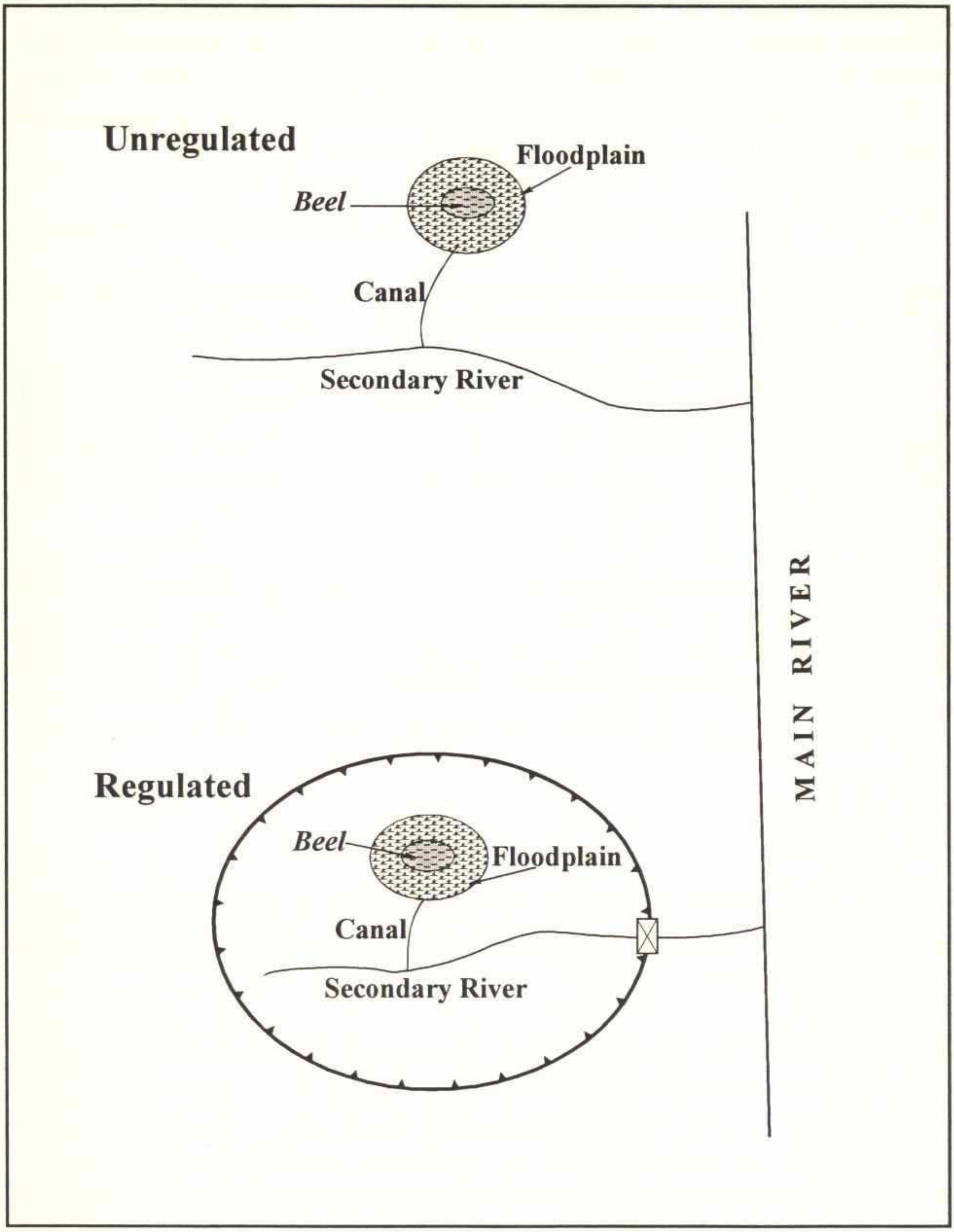
3.4 Methods

Methods used in fisheries surveys were described in detail in the Interim Report of FAP 17 and presented again with some additions in Appendix 3 of the Final Report. A brief summary of these is given below.

The formulation of the objectives of FAP 17 was based on the anticipation of several potentially harmful impacts of flood control on capture fisheries. These are discussed in detail in section 3 but the major impacts are also outlined here to place in context the objectives of the study and to clarify the reasons for the methods selected to achieve the project objectives. The main potential impacts on fisheries addressed by the biological component of the study are summarised below.

JB

Figure 3.2 Schematic site layout of sampling sites inside and outside flood control projects



i) Loss of flooded land

It was anticipated that by converting seasonal wetland to drier land flood control would reduce the area of flooded land and consequently the amount of fish on that land (objective no. 4). It was necessary therefore to estimate the fish production per unit area of land potentially lost to agriculture or to the construction of flood control infrastructure. To that end, a fish production study was established (see para 3.4.1).

ii) Reduced fish catch from remaining flooded land

In flood controlled areas it was expected that there might be a relative loss in catch compared to that from unregulated floodplains. This may result from several causes including reduced fish densities; reduced fishing effort or the opposite, by over-fishing; reduced recruitment; indirect effects of loss of adjacent flooded land, and deterioration in environmental conditions. The fish production study was designed address this issue (objective no. 4) by the comparison of fish yields inside and outside FCD/I projects (para 3.4.1).

iii) Reduced fish abundance

It was anticipated that fish abundance or densities might be reduced by flood control especially by blocking movements of migratory fish between rivers and floodplains. Statistical analyses of catch rates were used address this issue under objective no. 4 (see paras 3.4.2 and 3.4.9).

iv) Increased fishing pressure

In simple terms catches are determined primarily by fish abundance (catch rates) and the amount of fishing effort. It was expected that in flood controlled areas there may be more effort on a reduced flooded area which might have an adverse long-term impact on the sustainability of fish resources. The fish production study was designed address this issue (objective no. 4) and to provide estimates of fishing effort inside and outside FCD/I projects (para 3.4.3). In addition fish population studies were designed to provide information on fishing mortalities and exploitation rates in and out of projects areas (see para 3.4.7).

a9

v) Reduced biodiversity

It was expected that flood control would result in reductions in the diversity of fish species principally by blocking their movements between rivers and floodplains (objective no. 5). Estimation of numbers of species found in each habitat inside and outside FCD/I projects was therefore used as a measure of species diversity (see para 3.4.4).

vi) Reduction in migratory fish

One of the most obvious potential impacts of flood control was in blocking movements of migratory fish and prawns between floodplains and rivers (objective no. 5). Changes in catch composition were used to monitor potential reductions of migratory species in flood controlled areas (see para 3.4.5).

vii) Reduced recruitment

It was anticipated that flood control embankments and regulators would block movements of fish between rivers and floodplains at different stages in their life cycles (objective no. 5). This blockage to movement would result in reduced recruitment of fish in flood controlled areas and possibly result in reduced diversities, densities and catch. This issue was addressed through studies on movements of adult and juvenile fish and a separate study on hatchling drift (see para 3.4.6).

3.4.1 Fish production

This study relates to objective no. 4. The term fish production here refers to the total fish catch or yield from different types of fishing gears encountered during the study, not biological productivity. The aim of the production study was to provide quantitative estimates of fish catch by species of all gears operating on floodplains, *beel*, canals and rivers. This was achieved by the use of two types of survey: a catch assessment survey (CAS), which measured the catch rate of each gear type, and a fishing effort survey (FES) to estimate fishing effort in terms of number of units and duration of fishing by each gear type operating day and night. By applying the catch rates of each gear type to their individual total daily effort, an estimate of the total daily catch of each fish species was obtained. Surveys were undertaken twice per month, to provide an estimate of the total monthly catch of each species within a defined area of floodplain or length of river or canal. Monthly catch estimates were then converted to weight per unit area of floodplain or *beel* and per unit length of river and canal. Catches from rivers and canals were expressed as kg/ha or kg/km. However, since estimates of lengths were regarded as more accurate and reliable than area estimates derived from dry season satellite images and field measurements, catches are expressed more commonly as kg/km in this report.

Values of catch per unit area or catch per kilometre were then used to make comparisons between the same type of aquatic habitat i.e. floodplain/*beel*, canal, and river inside and outside areas of flood control. To compare catch estimates from larger areas inside and outside projects it was necessary first to extrapolate catch estimates from site level to these larger areas. On floodplains this was done by using area elevation curves of extrapolation areas and by applying catch rates from sites within a defined range of land elevation to appropriate areas obtained from the area elevation curve. For canals and rivers, total lengths were estimated within the extrapolation area and catch rates (kg/km) were applied to these to obtain total riverine and canal catches. These were then added to the total floodplain/*beel* catch to obtain the total catch from the extrapolation area which when divided by its own area provided an estimate of the integrated catch per unit area of floodplain. These estimates were than used for comparison between areas inside and outside FCD/I projects.

3.4.2 Fish densities

Statistical analyses of seasonally pooled catch rates of dominant gears used inside and outside flood control projects were undertaken. The underlying assumption of the method was that once differences in catchabilities between gears had been accounted for, any further differences in catch rates inside and outside FCD/I projects were due solely to differences in fish densities (see para 3.4.9).

3.4.3 Fishing effort

The model used in the statistical analysis of catch rates provided a standardisation of effort between different gears. The estimates of standardised gear effort in terms of gears hours of the selected standard gear were then used to compare sites inside and outside projects. In cases where the statistical model could not be fitted, comparisons were made of the effort by individual dominant gears in and out of FCD/I's.

3.4.4 Biodiversity

The term "species diversity" was used in this report in its simplest sense to denote the total number of different species of fish recorded at each site. The number of species recorded depended on the sampling effort deployed. No doubt more species would have been recorded had more sites or gear units been sampled more often using larger sum-samples of catches.

Two taxonomic guides were used for the identification of fish found in this study: Rahman (1989)[18] and Talwar and Jhingran 1991.[19] The more recent guide was used to provide a systematic listing of the scientific names of fish. The guide by Rahman, however, was used more widely by fisheries biologists and all Bengali names of fish used in the present report were derived from this source. The FAP 17 database also provides comprehensive lists of local names of fish recorded in each region.

3.4.5 Catch composition

Determination of monthly and annual percentage catch compositions by weight were used to assess the impact of flood control on fish community structure and, in particular, to evaluate the impact on migratory species. All species recorded were divided into three categories of habitat preference: riverine, migratory and floodplain residents based on distributions identified using the complete FAP 17 database. The categorisations should be regarded as provisional only. As more knowledge is gained of the ecology and behaviour of individual fish and prawn species in Bangladesh more accurate revisions to the list will be required.

3.4.6 Fish movement

Seasonal movements of adult and juvenile fish between spatially linked sites in different habitats were identified from changes in monthly catch compositions; temporal and spatial changes in the distributions of important individual species, and changes in monthly species numbers and catch contributions of riverine, migratory and floodplain resident fish. Where available, additional information on the average size (weight) of fish and their reproductive state were used to determine whether fish were adults or juveniles and whether movements were primarily for growth, breeding or both.

Investigations of downstream passive drift of fish hatchlings were carried out in all regions except the South West. The studies involved the collection of fish larvae in surface set drift nets of known area over measured time intervals and measured water velocities to provide quantitative estimates of supply rates and densities of different fish species under varying flow conditions. This information could then be used to assess the impact of flood control embankments on fish movement at a critical stage of their life cycle prior to recruitment into subsistence and commercial fisheries. The results also assisted in the formulation of proposed mitigation measures by improvements in regulator design and operation to allow the passage of hatchlings on to their nursery grounds on floodplains.

3.4.7 Population dynamics

Population dynamics studies were designed to supplement the main fish production studies by providing biological explanations for differences in catch inside and outside FCD/I projects in terms of differences in growth, mortality, recruitment or exploitation of selected fish populations. The study was based on fish stock assessment techniques using computerised length frequency analyses on a limited number of species representing different trophic levels and exhibiting different breeding behaviour.

3.4.8 Water quality and hydrology

Simple water quality measurements were taken at each site. These consisted of determination of water depth, transparency, temperature, conductivity, total dissolved solids concentration, pH and dissolved oxygen. These are aspects of water quality which, when considered together, provide a useful description of factors important for fish.

Methods used to describe flooding patterns inside and outside flood control projects were presented earlier in this report (section 2.2.3).

3.4.9 Statistical analyses

A detailed description of the statistical analyses employed as part of the impact assessment procedure is presented in Appendix 3 of the Final Report. To summarise briefly, the method was based on fisheries data collected using stratified random sampling from comparable sites inside and outside FCD/I projects for each identified habitat type. The aim of the statistical methodology was to allow valid comparisons of fish densities (as measured by catch rates) by habitat type, FCD/I projects and region at inside and outside groups of sites. Any differences detected were then interpreted in terms of their effect on the annual catch per unit area. This was achieved by comparing catches per unit area inside FCD projects with those that would be expected had fish densities at inside sites been the same as those at the comparable sites outside.

3.5 Fisheries Outside FCD/I Projects

3.5.1 Background

The FAP 17 fisheries studies surveyed 104 sites on floodplains, *beel*, canals and rivers in all FAP regions except the South East. During 19 months of field surveys 389 tonnes of fish were sampled, representing 11% of the total estimated catch from all sites (Table 3.2).

The observed catch comprised a total of 231 species of fish amounting to more than 90% of the total of 256 species recorded for Bangladesh, which gives some indication of the extensiveness of the surveys. A further indication of the scale of the surveys is provided in Table 3.1, from which it can be seen that almost 400 km of secondary rivers and canals were monitored directly together with about 10,000 hectares of the main rivers Jamuna and Padma and over 9,000 hectares of floodplain and *beel*. Taking each habitat in turn, the following discussion provides a brief summary description of the fish populations and fisheries in areas outside FCD/I projects and inter-relates those features most relevant to the Flood Action Plan.

3.5.2 Main rivers: Jamuna and Padma

Catch

The Jamuna and Padma rivers run for a combined length of about 570 km in Bangladesh before meeting the lower Meghna and discharging into the Bay of Bengal. Estimates of catch per unit area (CPUA) varied markedly within and between rivers and seasonally (Fig. 3.3) but much of the variation was due to the patchy distribution of fisheries exploiting the migratory *ilish*, (see Appendix 2 for local and scientific names of fish). This species contributed greatly to the catch of the lower Padma (393 kg/ha) but was relatively unimportant on the upper Padma (44 kg/ha) and on the Jamuna north of the Hurasagar confluence (Table 3.3).

Table 3.2 Summary description of catch assessment surveys

	Main rivers	North Central	North West	North East	South West	All regions
Total weight of fish sampled (tonnes)	4.50	26.19	47.50	248.91	61.91	389.01
Total number of fish sampled	14,09,113	30,52,623	1,03,34,567	3,06,03,000	59,58,508	5,13,57,811
After extrapolation these represent:						
Total weight of fish caught in sample sites	1,103.32	366.89	949.05	681.49	425.39	3,526.14
Total number of fish caught in sample sites	34,54,66,668	4,28,97,253	20,64,59,849	8,37,87,159	4,09,39,031	71,95,49,960
Percentage of sample weight to total weight	0.41	7.14	5.01	36.52	14.55	11.03
Number of different types of gear observed	48	34	36	47	29	71
Number of species recorded during whole study period	123	154	148	149	135	231
Number of species recorded during 12 month period (March 1993 - February 1994)	116	127	147	136	134	218
Number of species identified tentatively in hatchling study.		107	110	107		142

Figure 3.3 Annual and seasonal catches from the Jamuna and Padma rivers, March 1993 - February 1994

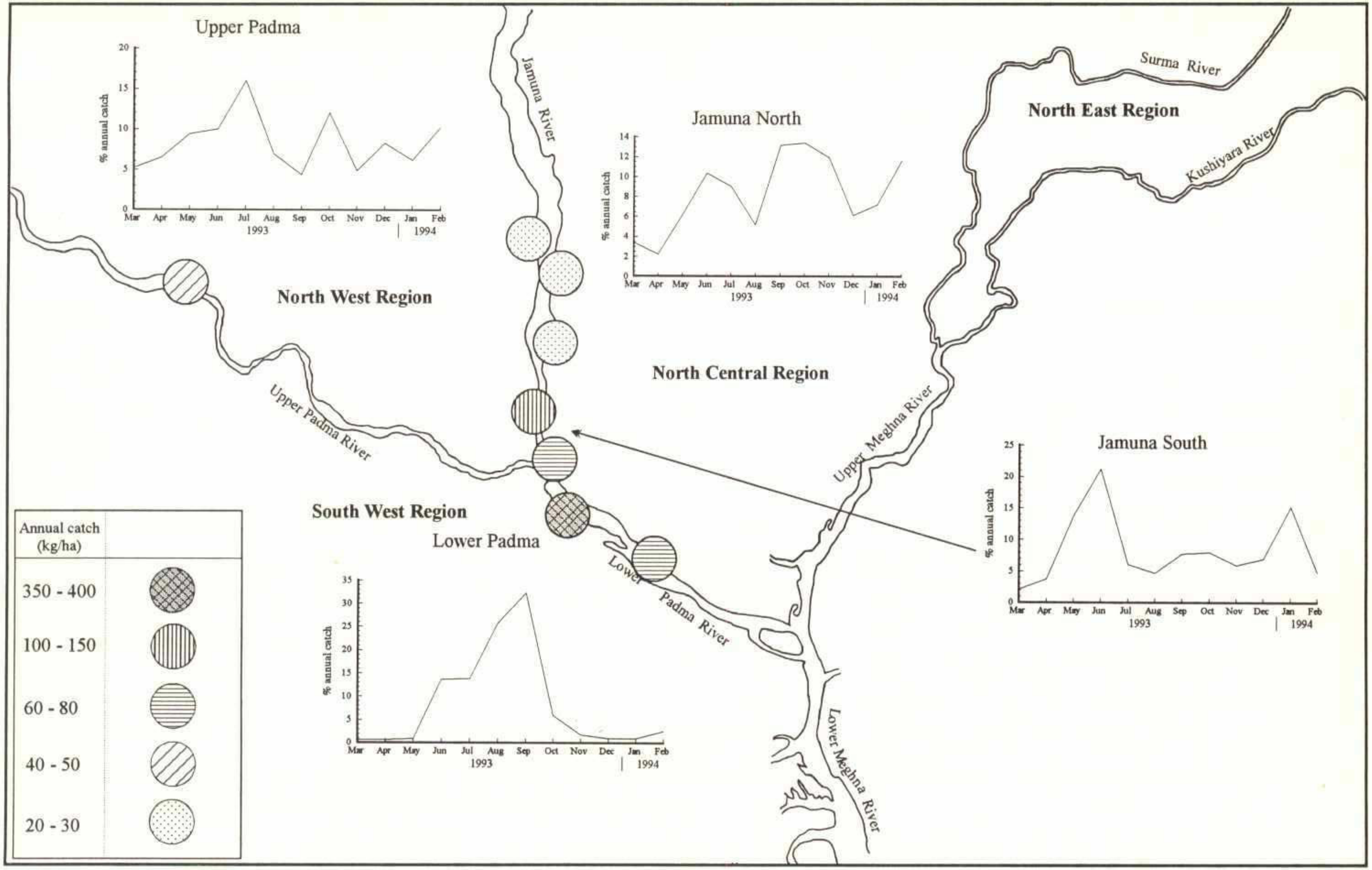


Table 3.3 Annual catch from sampling sites on the Jamuna and Padma rivers, March 1993 - February 1994

River	Site	Annual catch per site (tonnes)	Annual Catch per Unit Area (kg/ha)	
			Total catch	Without *ilish*
Jamuna	NW 01	35.529	21.53	19.82
	NC 01	48.037	29.63	21.26
	NC 20	41.997	22.14	16.71
Jamuna "North" Sub-total:		**125.563**	**24.22**	**18.85**
	NW 02	143.038	143.51	74.80
	NC 32	43.246	64.03	47.35
Jamuna "South" Sub-total:		**186.284**	**111.41**	**63.7**
Upper Padma	NW 24	28.323	44.17	42.96
Lower Padma	NC 33	571.883	392.91	55.15
	SW 01	88.751	70.63	33.27
Lower Padma Sub-total:		**660.634**	**243.51**	**45.00**

Omission of *ilish* from the analyses revealed similar values of CPUA on the upper and lower Padma (43 and 45 kg/ha respectively) which were more than double that on the Jamuna north of the Hurasagar (19 kg/ha) but less than that to the south of the Hurasagar (64 kg/ha). Here the higher yield was probably due to the proximity of the Jamuna and Padma confluence and the outfall of a large tributary from the North West Region, the Atrai River, which discharged into the Jamuna at the Hurasagar confluence. The combined catch of the Jamuna and Padma rivers was estimated to be about 10,000 tonnes for the period March 1993 to February 1994 (Table 3.4). This value lies within the range of published catch statistics (BFRSS) provided by the Department of Fisheries between 1983 (21,000 t) and 1993 (4,700 t). The published estimates show a marked progressive decline in catches during this period. The estimate from the present study is double that of the most recent published estimates. This estimate however, is for one year only and reveals nothing about long-term trends.

y4

Table 3.4 Estimated total annual catch of Jamuna and Padma rivers, March 1993 - February 1994

River	Annual Catch (tonnes)			% *ilish*
	Ilish	Other Species	Total	
Jamuna/Brahmaputra	1,407	3,637	5,044	28
Lower Padma	1,820	1,905	3,725	49
Upper Padma	33	1,167	1,200	3
Padma (total)	1,853	3,072	4,925	38

Ilish dominated the catch of the lower Padma (49% of annual catch) and Jamuna (28%) but was relatively unimportant on the upper Padma (Table 3.4). This fish is extremely important to Bangladesh, with an estimated total annual catch of 56,842 tonnes most of which is captured on the Meghna but according to published statistics represents about 75% of the total combined catch of the three principal rivers, the Padma, Jamuna and Meghna.[20] *Ilish* undertakes seasonal spawning migrations from sea to river, the most important of which historically was along the Padma into the Ganges of India. The estimated catch of 33 tonnes of *ilish* on the upper Padma is probably an underestimate since it is based on only one sampling site situated at Rajshahi, some 160 km upstream from the Jamuna confluence where higher densities occur. Since *ilish* is a riverine spawner, spending its life cycle between river and sea, it should be relatively unaffected by the impacts of most FCD developments. This was confirmed by FAP 17 studies on floodplain fisheries which showed that juvenile *ilish* (*jatka*) occurred in many floodplain areas but in very low numbers. In only one study area, the unregulated floodplains near Baghabari off the Baral River in the North West, did *jatka* form an important component of the floodplain catch. Here they comprised 6% of the annual catch and a peak monthly catch of 28% in August.[21] Though probably not greatly affected by flood control embankments, FAP 17 studies on the regulated Baral River at Charghat revealed clearly that Charghat regulator blocked movements of upstream migrating *ilish* which were migrating towards for the Padma River.[22] Even though regulator gates were open, fish movements were hindered by large water level differences across the structure which created turbulent flow and high water velocities.

The most important gears used on the Jamuna and Padma rivers are listed in Table 3.5 together with their percentage contributions to the total annual catch. Drifting gill nets predominated on both rivers; on the Padma, however, larger-meshed multifilament nets were more important. These targeted large catfish such as *pangas*, *baghair* and *rita* and also the major carps whereas smaller-meshed monofilament nets used on the Jamuna targeted *ilish*.

The other very important drifting net, the *shangla jal* which also specifically targeted *ilish*, was omitted from the percentage compositions given in Table 3.5 since this gear had a highly restricted distribution coinciding with some sampling sites which, if included, would have biased the general picture of fishing activities on the river and masked the catch of other gears. *Ber jal* and *moi jal* were important on both rivers particularly during the dry season when they exploited the shallow waters over *char*. Hook and line fisheries were more prevalent on the Jamuna where they targeted mainly *ghaura*.

Table 3.5 Percentage contributions made by dominant gears to the total annual catch from the Jamuna and Padma rivers, March 1993 - February 1994

Gear name	Jamuna	Padma
Ber jal	8.6	9.5
Moi jal	11.8	3.3
Satiber jal	2.2	–
Thella jal	5.8	–
Jhaki jal	3.9	2.1
Chandi jal	–	3.6
Current jal (Stationary)	5.8	–
Current jal (Drifting)	25.1	–
Par jal	1.1	27.5
Kajuli jal	1.9	2.0
Gai dasem	–	33.8
Veshal	–	2.4
Sip	3.8	–
Tana barsi	5.0	–
Daun	8.2	–
Doiar trap	7.4	5.9
Total	90.6	90.1

Note: Dominant gears are defined as those which when ranked in order of abundance comprised at least 90% of the catch in each river.

LEGEND

dark	>10%
light	5–9.9%
none	1–4.9%

59

Biodiversity

A total of 120 species was recorded between August 1992 and February 1994, of which 107 were found on the Padma and 90 on the Jamuna. That a higher number of species was found on the Padma despite a lower sampling effort (only three sites compared with five on the Jamuna) indicates that the river supports a more diverse fish fauna than the Jamuna. This difference can also be seen between individual sites on the rivers during the annual cycle from March 1993 to February 1994 (Fig. 3.4). Major seasonal changes in species diversity were generally similar at all sites with two periods of increase. The first was between June and July and the second, and higher, between September and October, coinciding with the flood drawdown when many species migrate from the drying floodplains to seek the shelter of rivers. Increases in species number observed during July and October resulted mainly from the influx of juveniles of floodplain species. The initial rise in July probably resulted from localised overbank spillage of river water on to adjacent low-lying land but may also have resulted from the downstream drift of hatchlings of floodplain species during rainfall runoff from floodplain to river during May prior to the reversal of current direction in June when river water first reached floodplains.

In Table 3.6 species are divided into three categories of habitat preference based on spatial distributions derived from the FAP 17 fisheries database covering four FAP regions and the main rivers. These categories are defined below.

a) Riverine

Species which are usually confined to rivers and estuaries (or sea in the case of *ilish*) throughout their life cycle with no direct dependence on floodplains, although some species can be found on more extensive floodplains, particularly in the North East Region.

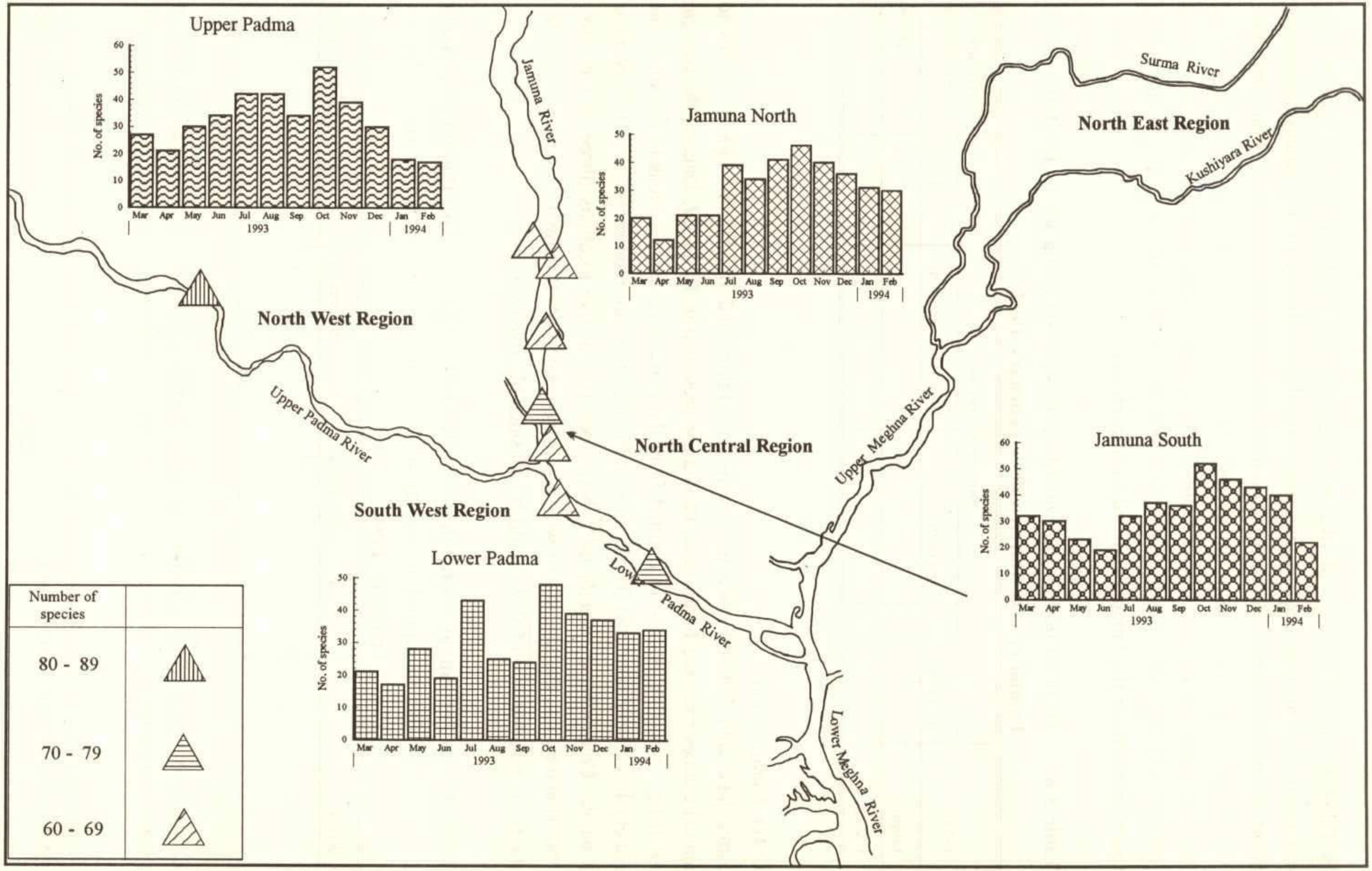
b) Migratory

Species which move between river and floodplain during different stages of their life cycle and therefore have some dependence on floodplains for growth and/or reproduction.

c) Floodplain resident

Species which are capable of surviving in perennial waters of the floodplain throughout the year and are largely dependent upon them for growth and reproduction. Many of these species occupy a variety of habitats, including large rivers.

Figure 3.4 Biodiversity: Annual total number of fish species in the Jamuna and Padma rivers, March 1993 - February 1994



In Table 3.6 annual numbers of riverine, migratory and floodplain resident species were calculated as an average per sampling site to avoid the influence of differences in sampling effort on species diversity i.e. in this case differences in the numbers of sites on each river. The results showed that while the average numbers of migratory species were identical between rivers, the Padma supported slightly more riverine and floodplain resident species. Riverine and migratory species comprised 58% and 57% of the total annual number of species per site on the Jamuna and Padma respectively.

Table 3.6 Mean annual number of fish species per sampling site on the Jamuna and Padma rivers, March 1993 - February 1994

River	Number of species				% riverine + migratory
	Riverine	Migratory	Floodplain resident	Total	
Jamuna	22	18	28	68	59
Padma	25	18	32	75	57

Catch Composition

Percentage contributions made by riverine, migratory and floodplain resident species to annual catches from the Jamuna and Padma are presented in Table 3.7. Data on the *shangla jal* fishery targeting *ilish* were omitted from the percentage species breakdowns since this fishery has a very restricted distribution and is therefore not representative of the rivers as a whole. Concentrated *shangla jal* fisheries occurred at five locations (three on the lower Padma and two on the Jamuna) of which four were sampled. If these data had been included the relative abundance of *ilish* would be considerably overestimated.

Table 3.7 Percentage contributions by riverine, migratory and floodplain resident fish to annual catches from the Jamuna and the Padma rivers, March 1993 - February 1994

River	Riverine	Migratory	Floodplain resident
Jamuna	60	13	13
Padma	73	10	6

Catches from both rivers were dominated by riverine species which accounted for 60% of the catch from the Jamuna and 73% from the Padma. Migratory and floodplain resident fish were equally abundant on the Jamuna comprising 13% each of the catch while on the Padma floodplain resident fish were less abundant (61%).

Percentage catch contributions of individual dominant species showed that *ilish* dominated catches from both rivers but was relatively more abundant on the Padma where it accounted for 47% of the annual catch than on the Jamuna (31%) (Table 3.8). Of the other important riverine species, *ghaura*, *shangus*, *piali* and *gang tengra* were more abundant on the Jamuna while *pangas*, *baghair*, *rita* and *kachki* were more abundant on the Padma.

On the Jamuna there was 5 dominant migratory species, *boal*, *guizza*, *katari*, *kabashi* and *bata* compared with two on the Padma, *catla* and *rui*. None of these species comprised more than 4% of annual catches. Only 3 floodplain resident species were listed as dominant. Of these *boal* was the most important providing about 4% of the annual catch from each river. The others, *puti* and *canchan puti*, together accounted for about 3% of the Jamuna catch only. Prawns were important in both rivers accounting for 9% of the annual catch from the Padma and 14% from the Jamuna.

During the course of the Flood Action Plan, one of the key questions which has been raised relates to the role of large rivers such as the Jamuna and Padma as dry season reservoirs of floodplain fish and important sources of recruitment to floodplain populations during the monsoon season. The extensive list of floodplain species found in rivers throughout the year confirms that these rivers do indeed provide shelter during the dry season for a wide range of species classified as floodplain residents which contributed 13% of the winter catch in each river. Even though only three of these species, *bailla*, *tengra* and *puti* made significant contributions to the riverine catch during winter, the fact that a further 22 species were also present highlights the importance of the extensive areas of these large rivers during a critical period in the hydrological cycle when the area of perennial water on the floodplain is at a minimum.

Table 3.8 Percentage contribution (by weight) by dominant species to the total annual catch from the Jamuna and Padma rivers, March 1993 – February 1994

Haitat Preference	Species name: Scientific	Species name: Bengali	Jamuna: Annual	Jamuna: Winter	Padma: Annual	Padma: Winter
Riverine	*Rita rita*	*Rita*	–	–	2.3	(6.0)
	Aspidoparia morar	*Piali*	3.2	(7.3)	–	(2.1)
	Crossocheilus latius	*Kalabata*	1.1	(1.7)	–	–
	Hilsa ilisha	*Ilish*	31.4	(7.8)	47.2	(4.1)
	Corica soborna	*Kachki*	–	–	1.9	(8.6)
	Apocryptes bato	*Chiring*	–	–	–	(3.3)
	Rhinomugil corsula	*Khorsula*	2.6	(1.9)	3.7	(11.1)
	Ailia coila	*Kajuli*	2.8	(3.9)	2.3	(7.8)
	Clupisoma garua	*Ghaura*	8.2	(5.9)	1.6	(2.7)
	Silonia silondia	*Shillong*	–	–	–	(1.2)
	Bagarius bagarius	*Baghair*	1.2	–	4.1	(1.7)
	Gagata nangra	*Gang tengra*	–	(1.5)	–	–
	Gagata youssoufi	*Gang tengra*	2.8	(6.5)	–	(1.6)
	Pangasius pangasius	*Pangas*	–	–	8.7	–
	Himantura sp	*Shangus*	4.2	(12.2)	–	–
Subtotal			57.4	(48.7)	71.8	(50.3)
Migratory	*Aorichthys aor*	*Ayre*	–	–	–	(2.0)
	Aorichthys seenghala	*Guizza*	2.8	(8.1)	–	–
	Mystus bleekeri	*Golsha tengra*	–	(1.1)	–	–
	Mystus cavasius	*Kabashi*	1.3	(1.1)	–	–
	Catla catla	*Catla*	–	–	3.9	(2.3)
	Labeo bata	*Bata*	1.1	–	–	–
	Labeo calbasu	*Kalbaus*	–	–	–	(1.9)
	Labeo rohita	*Rui*	–	–	1.6	–
	Salmostoma bacaila	*Katari*	1.4	(1.4)	–	(1.9)
	Salmostoma phulo	*Fulchela*	–	–	–	(1.7)
	Gudusia chapra	*Chapila*	–	–	–	(2.8)
	Wallagu attu	*Boal*	2.9	(4.1)	–	–
Subtotal			9.5	(15.7)	5.5	(12.5)
Floodplain Resident	*Mystus vittatus*	*Tengra*	–	(1.5)	–	–
	Puntius conchonius	*Canchan puti*	1.5	–	–	–
	Puntius sophore	*Puti*	2.9	(3.4)	–	–
	Glossogobius giurus	*Bailla*	3.6	(6.2)	3.9	(11.9)
Subtotal			8.0	(11.1)	3.9	(11.9)
Other	Prawn spp.	*Chingri/icha*	14.1	(16.5)	8.9	(18.1)
Subtotal			14.1	(16.5)	8.9	(18.1)
Grand total			89.0	(92.0)	90.2	(92.9)

Notes: 1. Values in parentheses relate to catches made during the winter period, March. April and December 1993 and January – February 1994
2. Dominant species are defined as those species which comprised 1% or more of the total annual catch
3. Shaded values highlight to most important species (>4%)
4. See text for definitions of habitat preference categories
5. Shangla jal catch omitted from analyses (see text)

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3.5.3 Secondary rivers

Catch

Annual catches varied considerably between regions, with highest catches recorded in the North East and North West (Fig. 3.5). Tropical riverine catches are normally directly related to differences in the size of river systems, with larger rivers generally supporting greater catches.[23] In the present study, however, regional differences greatly outweighed any influence that may have been attributable to size. For example, small rivers of the North East (Mahasingh and Old Surma) and North West (Karatoya) produced much higher catches than significantly larger rivers in the North Central (Dhaleswari) and South West (Arial Khan). These regional variations in annual catch were related to differences in seasonal patterns of catch (Fig. 3.5). In the North East and North West a larger proportion of the catch was taken during the winter period, following the flood recession, whereas in the other regions a high proportion of the catch was taken in a short period during the flood drawdown. In some cases the seasonal patterns in catch can be explained in terms of the seasonality of river flow e.g. on the Bhubaneswar of the South West almost the entire annual catch was captured during the short drawdown period of October and November, after which the river dried up completely. The annual catch in this river greatly exceeded those of adjacent perennial rivers, one of which, the Arial Khan, was substantially larger. In the case of the Bhubaneswar the high annual catch could be attributed to the very high fishing pressure placed on fish which had migrated from floodplains and concentrated in rapidly decreasing areas of isolated riverine pools, where their susceptibility to capture was greatly increased.

In contrast, some equally highly seasonal rivers in the North Central Region e.g. the Gazikhali near Saturia, supported very low annual catches compared to other small rivers in the region. It therefore seems that despite the overall regional differences in riverine catch revealed in this study, there remains a high degree of variability between rivers within most regions which makes it difficult to generalize within the range of catch values recorded. Any future assessment of potential loss would therefore depend upon extrapolating from the results of specific sites used in this study or would require additional site-specific surveys in areas not covered here.

The most important gears used on secondary rivers in terms of their contribution to the total annual catch are presented in Table 3.9. *Ber jal* predominated in all regions, but were especially important in the North East where they captured 30% of the catch. *Veshal* were

Figure 3.5 Annual and seasonal catches from secondary rivers, March 1993 - February 1994

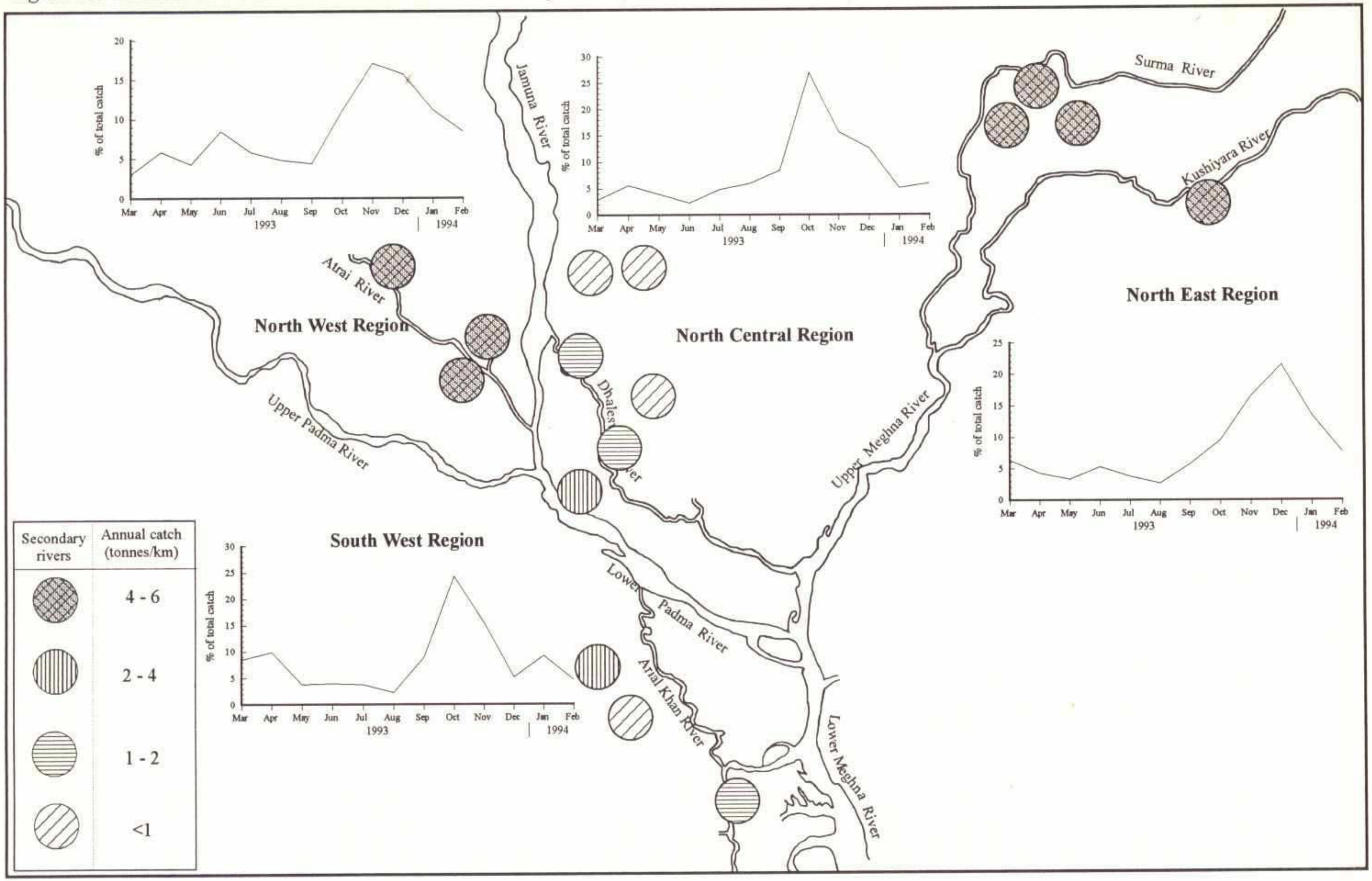

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Table 3.9 Percentage contribution made by dominant gears to the annual catch from secondary rivers, March 1993 – February 1994

	Region			
Gear name	North East	South West	North West	North Central
Ber jal	29.7	14.5	11.6	16.6
Moi jal	–	7.3	6.1	2.7
Satiber jal	–	–	–	2.0
Baoli jal	–	–	5.5	–
Dora jal	4.2	–	–	–
Uttar jal	6.7	–	–	–
Afa/Hat bauli	3.6	–	–	–
Chandi jal	2.5	–	–	–
Current jal (Stationary)	–	–	–	3.2
Current jal (Drifting)	3.0	–	12.0	–
Veshal	11.9	22.4	2.5	20.1
Suti jal	–	–	2.6	–
Shangla jal	–	4.7	–	–
Sip	9.1	3.1	6.1	3.5
Tana Barsi	6.1	–	1.5	6.7
Daun	4.0	5.7	1.5	–
Doiar trap	–	6.4	5.0	7.3
Katha	4.9	4.0	24.2	13.0
Jhaki jal	–	9.7	9.8	6.9
Thella jal	4.6	9.0	–	5.7
Hand fishing	–	5.8	–	3.8
Nimbaich	–	–	1.9	–
Total	90.2	92.6	90.2	91.5

Note: Dominant gears are defined as those which when ranked in order of abundance comprised at least 90% of the catch in each river

LEGEND

(dark shading)	>10%
(light shading)	5–9.9
(no shading)	1–4.9%

the most important gear in the North Central and South West, taking 20-22% of the catch, but captured only 12% of the catch in the others regions. Other important, widely used gears included *jhaki jal*, *thella jal* and small *doiar* traps. Hook fisheries were more prevalent in the North East probably because of the greater abundance of large catfish species. Dry season gears such as *katha* were more important in the North West and North Central than in other regions.

Studies carried out by FAP 17[24] and FAP 6[2] in the North East Region demonstrated the great importance of river *duar* (scour holes) as winter refuges for large species of fish, particularly catfish and major carps. *Duar* are presently included in riverine *jalmahal* where they are intensively fished by leaseholders during the dry season. FAP 6 recommended the prohibition of fishing *duar* during the dry season and the establishment of river patrols by DoF to enforce protective fisheries regulations. FAP 17 results supported this measure as a means of conserving important overwintering broodstock of high value species which form the basis of both riverine and floodplain fisheries.

Biodiversity

The number of species found in rivers varied regionally, with highest numbers (94-99 per annum) recorded in the North East and North West (Fig. 3.6). This regional pattern follows that of fish production. It therefore appears that rivers of the North East and North West supported not only the greatest fish diversities but also the greatest catches of all regions studied. Of the remaining regions, the South West rivers supported the lowest number of species. This is rather surprising in view of the higher diversity found on the Padma, which feeds these rivers, than on the Jamuna system feeding the North Central rivers. The low diversity is even more surprising given the proximity of the rich waters of the lower Meghna system which lie a short distance to the east. Seasonal changes in species diversity were most noticeable in the South West where a clear peak coincided with the timing of the flood drawdown when fish moved off the drying floodplains and returned to the shelter of rivers. Peaks in diversities were also seen during the drawdown in other regions but these were less marked than in the South West.

Examination of the diversities of different categories of fish showed that those of riverine and migratory species were higher in the North West and North East regions than in other areas (Table 3.10). This was attributed to greater flooded areas in these regions which were located immediately adjacent to relatively large river systems.

Figure 3.6 Biodiversity: Annual total number of fish species in secondary rivers, March 1993 - February 1994

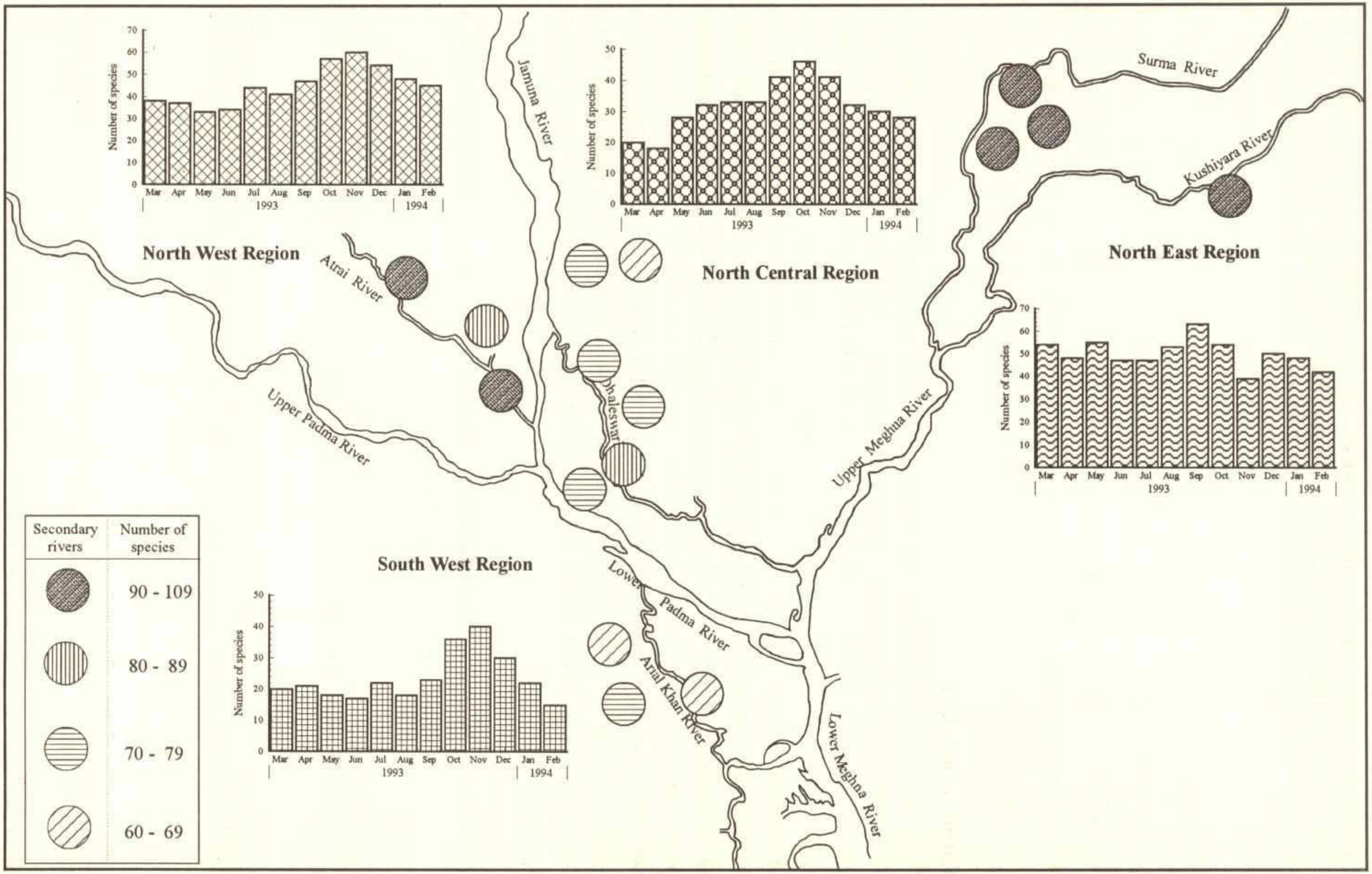


Table 3.10 Mean annual number of fish species per sampling site on secondary rivers in different regions, March 1993 - February 1994

Region	Number of species				% riverine + migratory
	Riverine	Migratory	Floodplain resident	Total	
North West	33	22	39	94	59
North Central	21	18	37	76	51
South West	18	16	33	67	51
North East	30	25	44	99	56

Catch Composition

Percentage catch contributions by riverine, migratory and floodplain resident species to annual catches from rivers in each region are presented in Table 3.11. The results identified several important regional differences. In the North Central Region riverine species accounted for only 9% of the catch compared with 21-26% in other regions. Reasons for the low abundance of this group of fish in North Central rivers remain unclear and this is an area which requires further investigation. Migratory species comprised the highest share of the catch (54%) in the North East where, as mentioned earlier, the greatest areas of open water occur which favour many migratory species. This group of fish was least abundant in the South West where it accounted for 15% of the catch. Floodplain resident fish formed a significant component of the catch in all regions but were particularly important in the North Central and South West where they accounted for 51% and 40% of annual catches respectively.

Table 3.11 Percentage contributions by riverine, migratory and floodplain resident fish to annual catches from secondary rivers, March 1993 - February 1994

Region	Riverine	Migratory	Floodplain resident
North West	26	35	27
North Central	9	30	51
South West	21	15	40
North East	23	54	15

Examination of catch compositions showed that of the dominant riverine species, *ilish* predominated in all regions except the North Central (Table 3.12). In the latter region, only 3 riverine species, *ghaura*, *kajuli* and *piali*, comprised more than 1% of the annual catch. The second most important riverine species was *kachki* which accounted for 5-6% of catches from the North East and South West but was uncommon in other regions. The compositions of dominant migratory species varied between regions but those of the North East and North West showed the closest similarities although the relative abundance of individual species differed. For example, *chapila*, *kalbaus* and the large catfish *guizza* were more abundant in the North East whereas smaller catfish species such as *golsha tengra* and *kabashi* predominated in the North West.

There were also considerable inter-regional variations in the relative abundance of floodplain resident species. In the North East only 4 dominant species were recorded and none formed more than 3% of the annual catch. In contrast, species such as *canchan puti*, *puti*, *bailla*, *baral baim* and *kaikka* made significant contributions to catches in other regions. Prawns were also important in all regions where their catch contributions ranged from 8% in the North East to 24% in the South West. The greater significance of prawns in the South West may be attributed to the proximity of brackish waters to the south which possible favoured some species.

Table 3.12 Percentage contribution (by weight) by dominant species to the annual catch from secondary rivers, March 1993 – February 1994

Habitat	Species name		Region			
Preference	Scientific	Bengali	North East	South West	North West	North Central
Riverine	*Rita rita*	*Rita*	1.8	1.3	–	–
	Aspidoparia morar	*Piali*	–	–	–	1.3
	Botia dario	*Rani*	1.4	–	–	–
	Hilsa ilisha	*Ilish*	5.7	6.8	12.2	–
	Corica soborna	*Kachki*	4.6	6.0	–	–
	Rhinomugil corsula	*Khorsula*	–	1.5	–	–
	Ailia coila	*Kajuli*	1.9	–	3.3	1.3
	Clupisoma garua	*Ghaura*	2.6	1.4	3.4	2.2
	Gagata youssoufi	*Gang tengra*	1.4	–	1.4	–
	Johnius coitor	*Koitor*	–	–	1.1	–
	Pangasius pangasius	*Pangas*	–	1.4	–	–
Subtotal			19.5	18.4	21.3	4.8
Migratory	*Aorichthys aor*	*Ayre*	3.2	2.1	–	1.8
	Aorichthys seenghala	*Guizza*	9.7	–	–	–
	Mystus bleekeri	*Golsha tengra*	1.8	–	6.3	2.0
	Mystus cavasius	*Kabashi*	4.9	–	9.7	1.1
	Catla catla	*Catla*	–	1.9	–	2.0
	Cirrhinus mrigala	*Mrigel*	–	–	–	2.3
	Cirrhinus reba	*Raik*	1.6	3.7	1.1	4.1
	Labeo calbasu	*Kalbaus*	6.4	–	2.3	2.0
	Labeo rohita	*Rui*	3.9	2.0	1.3	2.5
	Salmostoma phulo	*Fulchela*	2.2	–	–	2.1
	Gudusia chapra	*Chapila*	8.6	–	1.3	–
	Eutropiichthys vacha	*Bacha*	1.1	–	1.0	–
	Pseudeutropius atherinoide	*Batasi*	–	–	1.9	–
	Wallagu attu	*Boal*	4.2	–	7.3	7.4
	Notopterus chitala	*Chital*	3.1	–	–	–
Subtotal			50.7	9.7	32.3	27.2
Floodplain Resident	*Mystus vittatus*	*Tengra*	–	2.0	2.7	2.9
	Xenentodon cancila	*Kaikka*	–	4.3	1.3	2.7
	Puntius conchonius	*Canchan puti*	1.0	1.0	2.3	8.9
	Puntius sophore	*Puti*	–	3.6	2.6	7.1
	Puntius ticto	*Tit puti*	–	1.0	–	–
	Glossogobius giurus	*Bailla*	1.7	14.2	4.5	7.4
	Channa marulius	*Gajar*	–	1.4	–	–
	Channa punctatus	*Taki*	–	3.0	1.1	3.8
	Macrognathus pancalus	*Guchi*	–	2.2	1.6	2.8
	Mastacembelus armatus	*Baral baim*	2.5	1.2	5.7	5.7
	Chanda baculis	*Chanda*	1.7	–	–	–
Subtotal			6.9	33.9	21.8	41.4
Other	Prawn spp.	*Chingri/icha*	7.7	23.0	11.7	9.2
Subtotal			7.7	23.0	11.7	9.2
Grand total			84.8	84.9	87.1	82.6

Notes:
1. Dominant species are defined as those species which comprised 1% or more of the total annual catch
2. Shaded values highlight the most important species (>4%)
3. See text for definitions of habitat preference categories (section 3.5.2)

3.5.4 Canals

Catch

Values of catch per unit length of canals varied regionally (Fig. 3.7). Highest catches (3-4 tonnes/km) were recorded in the North East and South West regions, whilst lowest catches were observed in the North Central Region. However, the number of canals sampled in the North East and North West was very low, and therefore generalizations about catches in these regions should be treated with caution. More canals were sampled in the other regions and the results clearly reveal higher catches in the South West than in the North Central Region. The catch of canals depends, amongst other things, upon their size and location. The relationship between catch and size was examined using canal width as an index of size, since discharge data were lacking and catchment areas difficult to define in some cases. The relationship for catches from the North Central and North West regions is shown in Figure 3.8. For these regions there was a highly significant positive relationship between catch (kg/km) and canal width (m). However, when data from other regions were added the pattern was confused and no significant relationship was observed. This could be attributed to the influence of location on canal catches. In the South West, small canals directly draining floodplains and *beel* were heavily fished and produced higher catches than larger canals in other areas which served largely as conduits between river systems. For future fisheries assessments, especially in areas outside the North Central and North West regions, it is difficult to generalize within the range of catch values recorded in this study and therefore any assessments of potential loss would depend upon extrapolating from results of specific sites or would require additional site-specific surveys.

Seasonal changes in catch were generally similar between regions, with peak catches taken during or immediately following the flood drawdown (Fig. 3.7). In the South West and North West a major part of the catch (46% and 66% respectively) was taken from November to December, while in the North Central 54% of the annual catch was captured a month earlier, between October and November, reflecting the slightly earlier drawdown in this region. In the North East the pattern was more confused, probably because the sampled site drained not only an extensive *haor* (Hakaluki) but also connected with a small river system. Therefore this site exhibited features characteristic of both river and canal.

Percentage contributions made by dominant gears to the annual catch from canals in each region are presented in Table 3.13. The North East differed from other regions in that 50%

Figure 3.7 Annual and seasonal catches from canals, March 1993 - February 1994

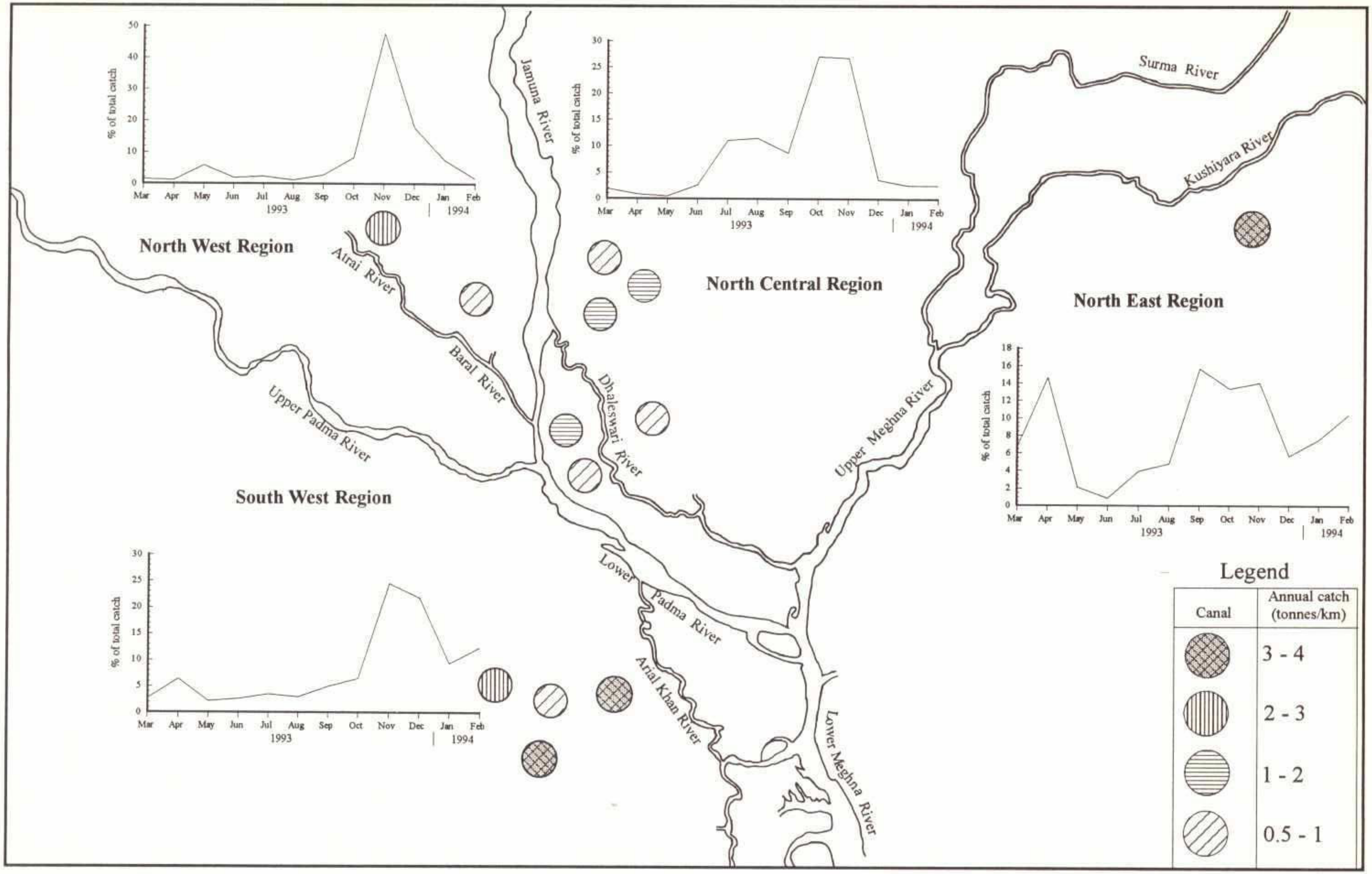


Figure 3.8 **Relatioship between total annual catch from canals and canal width in the North Central and North West regions, March 1993 - February 1994**

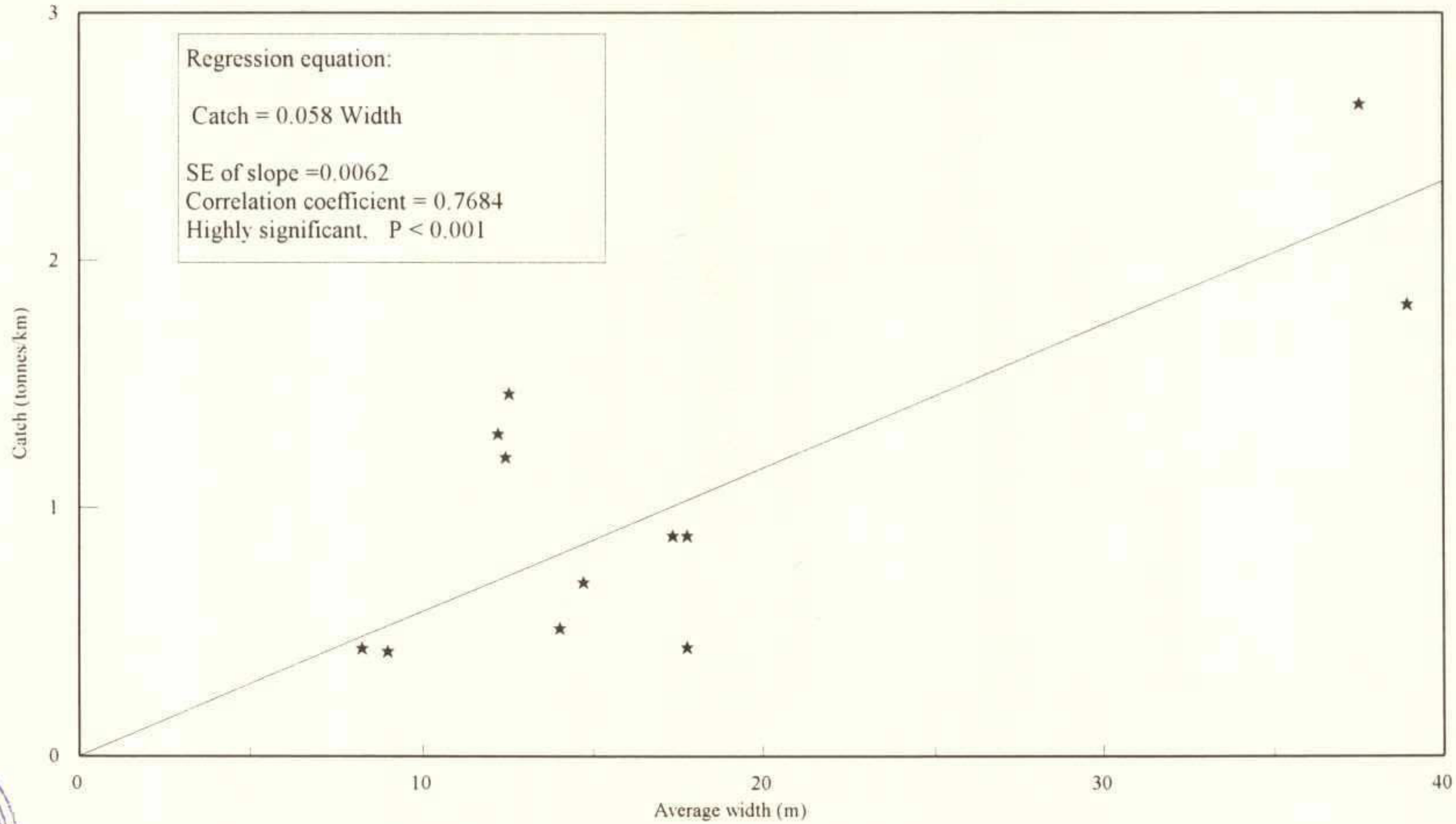


Table 3.13 Percentage contributions (by weight) made by dominant gears to the annual catch from canals, March 1993 – February 1994

	Region			
Gear name	North East	South West	North West	North Central
Ber jal	22.6	4.0	–	3.7
Dhor jal	–	3.8	4.6	–
Moi jal	–	3.1	3.5	–
Baoli jal	–	–	8.1	–
Uttar jal	27.3	–	–	–
Ucha	–	–	–	3.4
Tukri	–	9.4	–	–
Dharma jal	–	–	–	13.6
Veshal	14.0	12.8	3.3	29.2
Suti jal	–	–	41.5	–
Sip	2.2	2.4	–	1.8
Daun	–	3.7	–	–
Doiar trap	–	9.1	6.8	5.4
Katha	14.4	16.0	3.6	6.3
Kua	–	–	–	3.4
Jhaki jal	6.8	14.7	12.2	10.0
Juti	–	2.5	–	–
Thella jal	4.7	7.1	–	8.3
Urani	–	–	–	2.0
Akra	–	–	2.9	–
Hand fishing	–	2.2	4.8	3.9
Total	92.0	90.8	91.3	91.1

Note: Dominant gears are defined as those which when ranked in order of abundance comprised at least 90% of the catch in each canal

LEGEND

(dark shading)	>10%
(light shading)	5–9.9%
(no shading)	1–4.9%

of the catch was taken by two gears, *ber jal* and *uttar jal*. In other regions, *jhaki jal* was important, whilst lift nets (*veshal* or *dharma jal*) were important in all regions except the North West, where they were replaced by *suti jal* (bag nets). Other important gears which were widely used included *thella jal* and *doiar traps*. *Katha* were particularly important in the South West, which probably resulted from the more perennial nature of the sampled sites.

Biodiversity

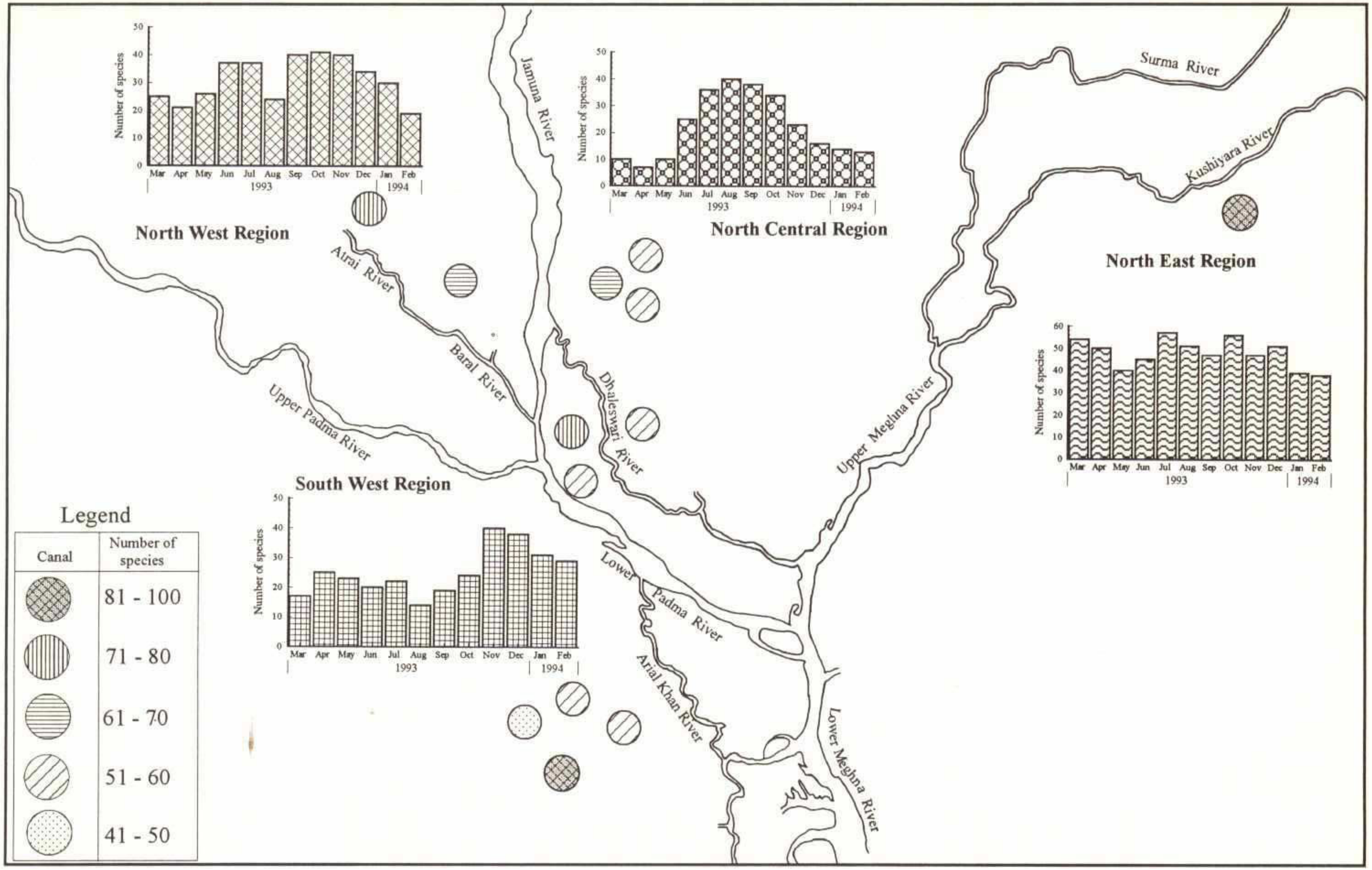
Regional differences in species diversity were not clear. Highest numbers of species were recorded from one site in the North East and in one canal, Satla-Bagda *Khal* in the South West (Fig. 3.9). Three other canals in the South West supported few species despite high annual catches. Numbers of species in the North West and North Central overlapped in range and appeared to be slightly higher than those in the South West, excluding Satla-Bagda *Khal*.

Seasonal changes in species diversity varied regionally. In the North Central Region, numbers increased to a single peak during August and September, coinciding with the start of the flood drawdown, when fish migrated from the adjacent floodplains and concentrated in canals. In the North West and South West highest numbers of species were again recorded during months of the drawdown (October - November) but these peaks were less noticeable than that observed in the North Central canals (Fig. 3.9). Seasonal patterns were less clear in the North East, possibly resulting from the more riverine nature of the main drainage channel of Hakaluki *Haor*. When catches were divided into different categories of fish, clear differences in diversities between regions were apparent (Table 3.14). Lowest diversities of riverine and migratory species were seen in the North Central and South West regions where these groups accounted for 39% and 37% of the total annual number of species per site. The riverine group of fish was particularly impoverished in the South West. Highest numbers of both riverine and migratory species were found on the one sampled site in the North East.

Table 3.14 Mean annual number of fish species per sampling site on canals in different areas, March 1993 - February 1994

Region	Number of species				% Riverine + Migratory
	Riverine	Migratory	Floodplain resident	Total	
North West	14	16	39	69	43
North Central	10	14	37	61	39
South West	7	15	38	60	37
North East	28	22	45	95	53

Figure 3.9 Biodiversity: Annual total number of fish species in canals, March 1993 - February 1994



Catch Composition

Percentage contributions by riverine, migratory and floodplain resident species to annual catches from canals in each region are presented in Table 3.15. Riverine species made little contribution to canal catches in any region. In the North Central Region they were of negligible significance providing only 1% of the catch. In the North West and South West they provided 4% of the catch and in the North East 10%. Migratory species were considerably more important, accounting for between 40-43% in the North East and North West but less in the North Central (22%) and South West (13%) where floodplain resident species dominated catches (60-66%). The most important individual migratory species included mainly catfish and carp (Table 3.16). In the North East two catfish were particularly important, *boal* and *kabashi*. These same species were also important in the North West where a third catfish species, *golsha tengra*, was particularly important. The major carps, *rui*, *catla*, and *mrigel* formed 16% of the total annual canal catch in the North Central Region. Of these, *rui* and *catla* were the most abundant species. In all other regions, including even the North East, major carps were relatively unimportant. In the North East, *kalbaus* comprised about 5% of the catch and *mrigel*, about 2%, but *rui* and *catla* were uncommon and did not appear amongst dominant species from the one site sampled. Prawns formed an important component of the catch in all regions, ranging from 8% in the North East to 23% in the South West.

Table 3.15 Percentage contributions by riverine, migratory and floodplain resident fish to annual catches from canals, March 1993 - February 1994

Region	Riverine	Migratory	Floodplain resident
North West	4	43	44
North Central	1	22	66
South West	4	13	60
North East	10	40	36

Table 3.16 Percentage contribution (by weight) by dominant species to the annual catch from canals, March 1993 – February 1994

Habitat Preference	Species name: Scientific	Species name: Bengali	Region: North East	Region: South West	Region: North West	Region: North Central
Riverine	*Somileptes gongota*	*Gharpoia*	–	–	1.1	–
	Botia dario	*Rani*	1.2	–	–	–
	Hilsa ilisha	*Ilish*	1.1	–	–	–
	Ailia coila	*Kajuli*	1.4	–	–	–
Subtotal			3.7	–	1.1	–
Migratory	*Aorichthys aor*	*Ayre*	2.0	3.4	1.1	–
	Aorichthys seenghala	*Guizza*	3.1	–	–	–
	Mystus bleekeri	*Golsha tengra*	3.1	–	12.6	–
	Mystus cavasius	*Kabashi*	10.9	–	5.7	–
	Catla catla	*Catla*	–	–	–	5.9
	Cirrhinus mrigala	*Mrigel*	1.7	–	–	3.4
	Cirrhinus reba	*Raik*	–	–	3.4	1.5
	Labeo calbasu	*Kalbaus*	5.2	–	–	–
	Labeo rohita	*Rui*	–	1.5	–	7.5
	Salmostoma bacaila	*Katari*	–	–	1.8	–
	Gudusia chapra	*Chapila*	1.2	–	–	–
	Pseudeutropius atherinoides	*Batasi*	–	–	4.2	1.0
	Wallagu attu	*Boal*	8.2	5.2	11.7	–
Subtotal			35.4	10.1	40.5	19.2
Floodplain Resident	*Anabas testudineus*	*Koi*	–	–	–	1.4
	Mystus tengara	*Bajari tengra*	–	1.1	–	1.0
	Mystus vittatus	*Tengra*	2.4	4.3	3.6	2.1
	Colisa fasciatus	*Khalisha*	–	1.8	1.4	3.1
	Colisa lalia	*Lal khalisha*	–	1.0	–	–
	Xenentodon cancila	*Kaikka*	–	4.6	–	2.1
	Cyprinus carpio	*Karfu*	–	–	–	1.1
	Puntius chola	*Chala puti*	1.6	–	–	–
	Puntius conchonius	*Canchan puti*	2.3	2.0	3.4	3.0
	Puntius sophore	*Puti*	–	10.8	9.2	17.5
	Puntius ticto	*Tit puti*	–	3.4	–	2.5
	Rasbora daniconius	*Darkina*	–	1.7	–	–
	Glossogobius giurus	*Bailla*	4.2	4.3	3.3	3.2
	Hypophthalmichthys molitrix	*Silver carp*	5.1	–	–	–
	Lepidocephalus guntea	*Gutum*	–	2.1	2.2	2.3
	Channa marulius	*Gajar*	–	–	–	1.0
	Channa punctatus	*Taki*	–	2.9	4.2	9.2
	Channa striatus	*Shol*	–	1.2	–	2.4
	Heteropneustes fossilis	*Shingi*	–	1.0	–	1.0
	Macrognathus pancalus	*Guchi*	2.8	5.7	5.3	3.4
	Mastacembelus armatus	*Baral baim*	8.3	1.4	3.8	1.2
	Nandus nandus	*Bheda*	–	2.8	–	–
	Notopterus notopterus	*Foli*	1.5	–	–	–
	Tetraodon cutcutia	*Potka*	–	1.7	–	–
	Chanda baculis	*Chanda*	2.4	–	–	–
	Chanda ranga	*Lal chanda*	–	–	–	1.1
Subtotal			30.3	53.9	36.2	58.5
Others	*Macrobrachium rosenbergii*	*Golda*	–	1.2	–	–
	Prawn spp.	*Chingri/icha*	8.6	21.2	8.4	11.2
	Turtle	*Dur kasim*	4.8	–	–	–
Subtotal			13.5	22.5	8.4	11.2
Grand total			82.8	86.4	86.2	89.0

Notes: 1. Dominant species are defined as those species which comprised 1% or more of the annual catch

2. Shaded values highlight the most abundant species (>4%)

3. See text for definitions of habitat preference categories (section 3.5.2)

3.5.5 Floodplains and *beel*

Catch

Estimates of catch per unit area (CPUA) from floodplain sites outside FCD/I projects are summarised in Fig. 3.10. The results showed that there was variation between regions, with generally highest values in the South West followed by the North East. Substantial variations between sites were recorded in the North Central Region, where small *baor*-like *beel* supported highest yields, but considerably lower values were found on the more typical depression-like *beel* and seasonal floodplain. For each FCD/I project studied, the results from a number of unregulated floodplain and *beel* sites were combined to give an estimate for flooded areas as a single floodland system (Table 3.18). In five projects estimates were made of the total catch from larger areas of floodplain outside and inside FCD/I projects. In four cases (PIRDP, SBP, MIP, SHP) the inside areas comprised the total area of the project while the size of outside study areas ranged from 2,800 ha in Dekker *Haor* (SHP) to a maximum of 23,000 ha in Hakaluki *Haor* (MIP). Catches from these areas were derived from the extrapolation of catch estimates from floodplains, *beel* and canal sites following the procedure outline in section 3.4.1. Catches from main and secondary rivers were not included in integrated estimates of CPUA shown in Table 3.17.

Table 3.17 Annual catch from unregulated floodplain/*beel* sites outside selected flood control projects, March 1993 - February 1994

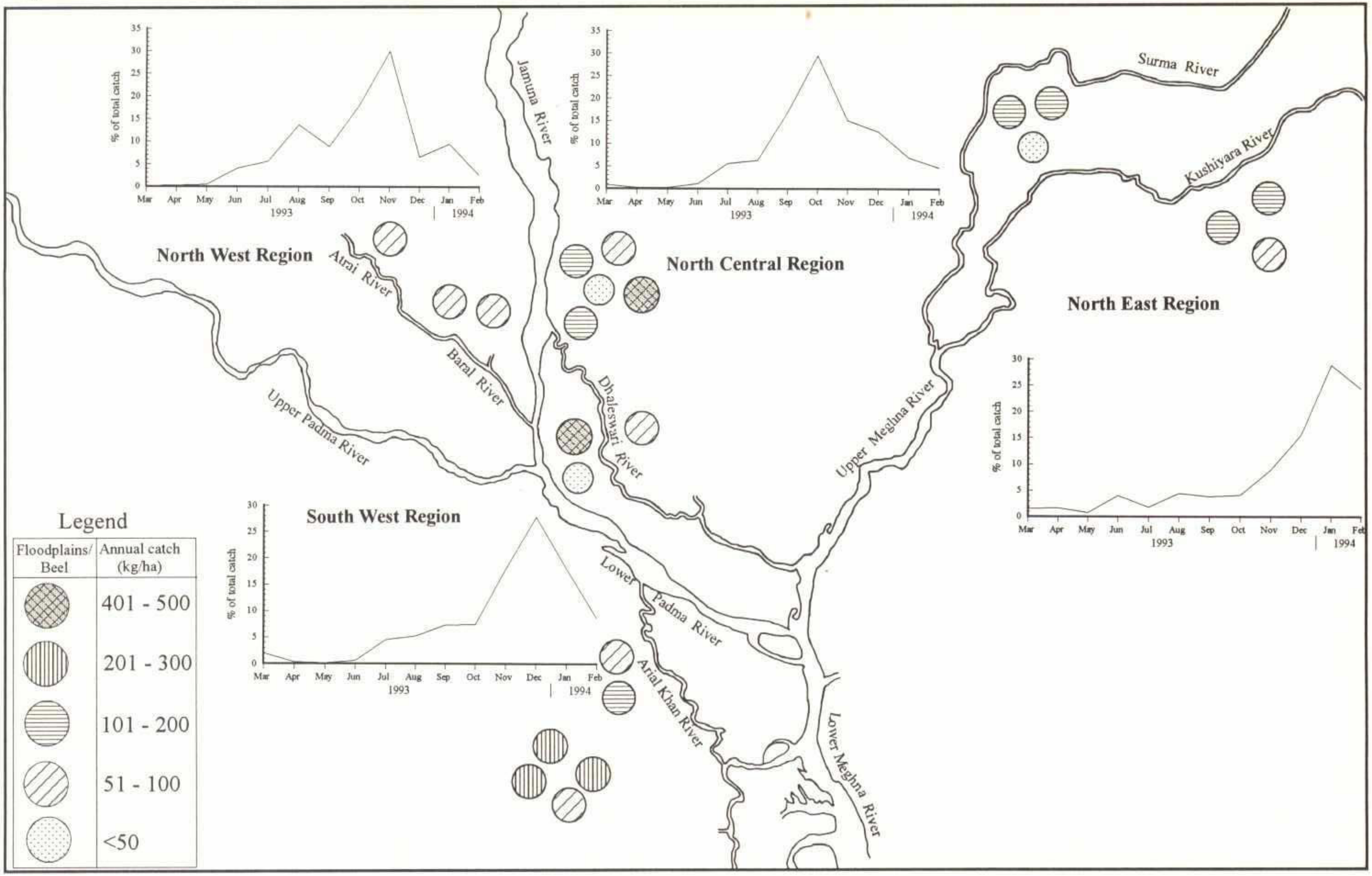
Region	Project	Location of unregulated floodplain/*beel*	Catch (kg/ha)
North Central	BRE	Anahula *Beel*, Tangail⇓	43
North Central	CPP	Gazaria/Mailjani *Beel*, Tangail	107
North West	PIRDP	Potajia↓	94
North West	CBP	Chalan *Beel*↓	68
North East	MIP	Hakaluki *Haor*↓	142
North East	SHP	Dekker *Haor*↓	107
South West	CFP	Andolir *Beel*	111
South West	SBP	Bagihar *Beel*↓	202

Notes:

↓. Estimates of annual yield were derived from the integration of catches from floodplain, *beel*, canal and river to obtain a total CPUA (see section 3.4.1)

⇓. Although the BRE is in the North West Region, the "outside" reference site was across the Jamuna River in the North Central Region

Figure 3.10 Annual and seasonal catches from floodplains and beel, March 1993 - February 1994



The results again revealed variation in fish yields between and within regions. Values of CPUA ranged from 43 kg/ha in the North Central Region to 202 kg/ha in the South West. Values were generally higher in the South West and North East than in other regions. There was, however, considerable variation within regions which in the North Central and South West could be attributed to differences in flooding patterns. The Anahula floodplains in the North Central Region supported an annual catch of 43 kg/ha compared with 107 kg/ha on nearby floodplains at Gazaria and Mailjani. The Anahula floodplains were on higher land where the magnitude, extent and duration of flooding was less than that at Gazaria and Mailjani. Given the relationship between flood extent and catch found in other parts of the world[25, 26], a lower catch would be expected from Anahula. In the South West Region, higher catches were recorded from Bagihar *Beel* than Andolir *Beel* which was located on slightly higher ground where flooding was reduced compared to that on Bagihar *Beel*. Again, higher catches would be predicted from the lower, more heavily flooded sites on Bagihar *Beel*.

In comparison with estimates of catch per unit area from floodplains in other parts of the world the current estimates indicate that Bangladesh is more productive than most (Table 3.18).

Table 3.18 Comparison of annual floodplain catch from other countries

Location	Catch (kg/ha)
Lower Mekong, Asia	41
Niger, Africa	30-75
Orinoco, South America	44
Tropical floodplains	40-60

Source: Welcomme (1985)[23]

Seasonal changes in catch varied regionally. In the North East, dramatic increases occurred during the winter from December 1993 to February 1994 when large leased *beel* fisheries were fished out. In the North Central and North West catches reached a maximum during and immediately following the flood drawdown when fish were concentrated in decreasing areas and volumes of water and therefore easier to catch. In the South West peak catches were observed slightly later in the season, two months after the onset of the drawdown.

Major regional differences were seen in the pattern of gears used (Table 3.19). In the North East *ber jal* captured more than half (59%) the annual catch. This gear was used widely

Table 3.19 **Percentage contribution made by dominant gears to the annual catch from floodplains and beel, March 1993 – February 1994**

Gear name	Region			
	North East	South West	North West	North Central
Ber jal	58.5	–	23.8	8.6
Dhor jal	–	–	2.0	2.7
Moi jal	–	–	8.4	–
Horhori	–	–	5.1	–
Baoli jal	–	–	4.6	–
Dora jal	3.8	–	–	–
Ucha	–	–	–	3.9
Current jal (Stationary)	–	23.9	10.5	5.5
Koi jal	–	4.4	2.2	–
Dharma jal	–	–	–	4.3
Veshal	–	7.6	–	4.9
Suti jal	–	–	6.2	–
Ghori jal	3.0	–	–	–
Sip	–	5.4	–	–
Daun	–	–	5.5	–
Nol barsi	–	8.9	–	–
Doiar trap	–	6.8	6.4	–
Polo	–	2.9	–	–
Patar savar	–	6.3	–	–
Katha	5.7	–	8.6	2.3
Kua	–	23.4	2.4	13.0
Jhaki jal	–	–	2.4	9.0
Thella jal	14.9	2.7	–	32.6
Hand fishing	4.5	–	2.5	3.4
Total	90.4	92.2	90.4	90.2

Note: Dominant gears are defined as those which when ranked in order of abundance comprised at least 90% of the catch

LEGEND

(dark shading)	>10%
(light shading)	5–9.9%
(no shading)	<5%

during the dry season fishing of leased *beel* but also used in the shallower waters of the open *haor* during the monsoon season. Other prominent gears such as *katha*, hand-fishing, dewatering and *ghori jal* were to a large extent under the control of leaseholders. *Thella jal* was the second most important gear and contributed 17% of the total catch. This gear was used widely during the rising and full-flood periods on the periphery of *haor* by subsistence and semi-commercial fishermen to catch mainly prawns. It was also allowed to fish leased *beel* during the dry season but then fishermen had to share the catch with the leaseholder.

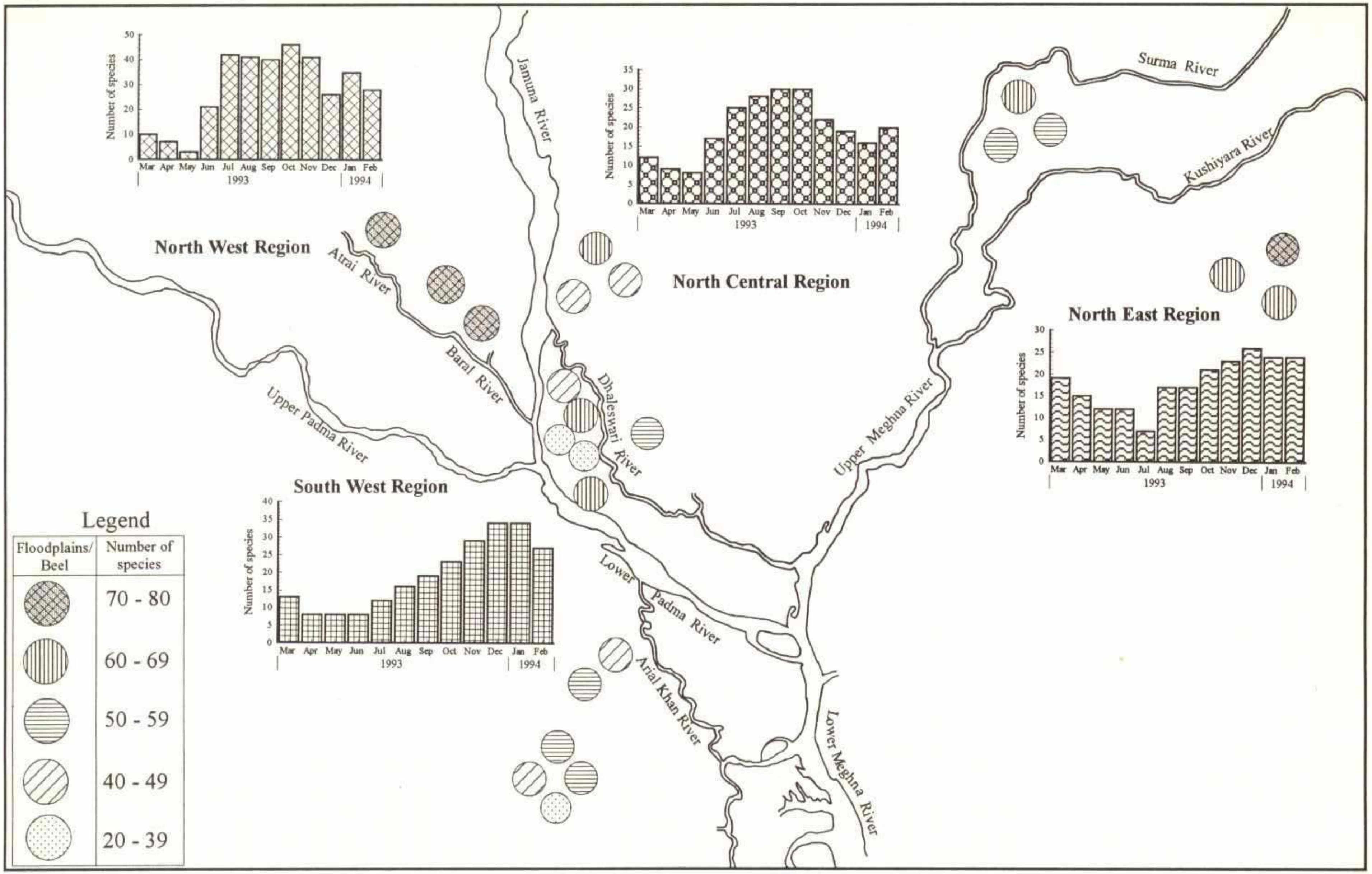
In the North West Region *ber jal* was again the most important gear contributing 24% of the catch but in the North Central it was less important (9%) and in the South West hardly used at all possibly because of the extensive cover of water hyacinth on the sites surveyed. In this region and the North Central, small-scale gears such as *thella jal* or *current jal* were more important together with dry season *kua*.

Biodiversity

Highest species diversities from individual floodplain and *beel* sites were observed in the North West and North East regions (Fig. 3.11). This pattern is almost the same as that recorded in rivers, but the number of species occurring on floodplains was substantially lower in all regions than in their respective rivers. Seasonal changes in species numbers varied somewhat between regions but a feature common to all was that lowest diversities were recorded during the pre-monsoon months around April and May when catches were also at their lowest. In the North Central Region there was a distinct peak in diversity during the monsoon and flood drawdown (July-October) and a secondary peak in February when *kua* were fished out. A similar pattern was seen in the North West but here a peak in diversity extended from July to November probably as a result of the longer flood season in that region. In the North East, peaks were less clearly defined but highest diversities were observed between October and February with a slight peak in December. Diversities followed a different seasonal pattern is the South West. Here, a gradual increase was seen from July to January which reflected the greater importance of catches taken later in the year, reaching a peak in December.

When catches were divided into categories of riverine, migratory and floodplain resident fish, clear differences between regions emerged (Table 3.20). In the South West and North Central regions very few riverine species entered floodplains and *beel* and migratory species wee also fewer in number than those in the North West and North East. Taken together riverine and

Figure 3.11 Biodiversity: Annual total number of fish species in floodplains and beel, March 1993 - February 1994



migratory species comprised 51% and 38% of the total number of species recorded per site from the North West and North East compared with 30% and 19% from the North Central and South West.

Table 3.20 Mean annual number of fish species per sampling site on floodplains/*beel* in different regions, March 1993 - February 1994

Region	Number of species				% Riverine + migratory
	Riverine	Migratory	Floodplain resident	Total	
North West	20	19	38	77	51
North Central	4	11	35	50	30
South West	1	8	39	48	19
North East	10	14	40	64	38

Catch Composition

Contributions made by different categories of fish to annual catches varied greatly between regions (Table 3.21). Riverine species accounted for 8% of the catch in the North West compared with 1% or less in other regions. The low contribution found in the North East is surprising given its large area of open waters and the fact that migratory species comprised 41% of the catch in this region. In the North West migratory species provided 27% of the catch whereas in the North Central and South West, this group of fish accounted for only 9% and 2% of the catch respectively. The reasons for such a scarcity of riverine and migratory species on unregulated floodplains in the South West remain unclear. In one study area, outside the Chatla-Fukurhati Project, the development of rural roads acted as unintentional flood control embankments and hindered the ingress of both river floodwaters and migratory fish on to floodplains. However, in the second study area on Bagihar *Beel*, floodplains received floodwaters from the Kumar River via canal systems along which migratory fish could move freely.

In addition, commercial savar fisheries operated on the Kumar River to collect major carp hatchlings but catch assessment surveys revealed little evidence of their recruitment on to floodplain and *beel*. Further work is needed in this region to elucidate the movements of adult and juvenile fish and fish hatchlings between rivers and floodplains. Floodplain resident species provided almost the total catch (96%) from the South West Region and also the bulk of catch (69%) from the North Central Region. In the North West and North East catch contributions by floodplain residents were considerably lower (50% and 38%) largely because of the greater ingress of migratory species.

Table 3.21 Percentage contributions by riverine, migratory and floodplain resident fish to annual catches from floodplains/*beel*, March 1993 - February 1994

Region	Riverine	Migratory	Floodplain resident
North West	8	27	50
North Central	<1	9	69
South West	<1	2	96
North East	1	41	38

Examination of the composition of dominant species found on floodplains and *beel* revealed considerable differences between regions (Table 3.22). The most abundant migratory species found on the *haor* of the North East included the large catfish, *guizza*, the schooling clupeid, *chapila* and the smaller catfish, *kabashi*. Apart from *mrigel*, which formed 1% of the catch, other major carps were uncommon and did not appear in the list of dominant species. In the North West the most abundant migratory species were the catfish, *boal*, *golsha tengra*, *batasi* and *kabashi*. The clupeid, *chapila* formed 3% of the total catch as did *ilish*, mainly as juveniles swept in from the neighbouring Atrai River where spawning occurred.

In the North Central Region only two migratory species appeared as dominant; these were the major carps *rui* and *catla* which together formed about 5% of the catch. The value of 5% is the highest contribution made by major carps to floodplain catches in any of the four regions surveyed. Their relative abundance in this region can be attributed to the natural supply of hatchlings from the Brahmaputra/Jamuna system. A similar contribution to floodplain catches of the North West Region would be expected in the absence of the Brahmaputra Right Embankment. The contributions of major carp to floodplain catches of the North Central are much lower than those of canals in this region. This difference may be caused by the differential migration rates between species from the floodplain, with a higher proportion of major carp escaping from the rapidly drying flood lands which are unable to provide adequate areas of perennial waters.

The most important and widespread floodplain resident species included *puti* which comprised 10-17% of catches outside the North East Region, *taki*, *guchi baim*, *bailla*, *kaikka* and

Table 3.22 Percentage contributions (by weight) by dominant species to the annual catch from floodplains/beel, March 1993 – February 1994

Habitat Preference	Species name		Region			
	Scientific	Bengali	North East	South West	North West	North Central
Riverine	*Hilsa ilisha*	*Ilish*	–	–	4.3	–
Subtotal			–	–	4.3	–
Migratory	*Aorichthys aor*	*Ayre*	1.1	–	1.0	–
	Aorichthys seenghala	*Guizza*	15.6	–	–	–
	Mystus bleekeri	*Golsha tengra*	–	–	4.3	–
	Mystus cavasius	*Kabashi*	4.2	–	3.3	–
	Catla catla	*Catla*	–	–	–	1.9
	Cirrhinus mrigala	*Mrigel*	1.2	–	–	–
	Labeo rohita	*Rui*	–	–	–	2.8
	Salmostoma bacaila	*Katari*	1.1	–		–
	Salmostoma phulo	*Fulchela*	1.2	–	1.4	–
	Gudusia chapra	*Chapila*	12.8	–	3.1	–
	Pseudeutropius atherinoides	*Batasi*	–	–	3.7	–
	Wallagu attu	*Boal*	–	1.2	7.3	–
Subtotal			37.1	1.2	24.1	4.7
Floodplain Resident	*Anabas testudineus*	*Koi*	–	13.6	–	2.8
	Mystus vittatus	*Tengra*	1.7	1.3	3.8	1.4
	Colisa fasciatus	*Khalisha*	–	13.8	–	3.7
	Colisa lalia	*Lal khalisha*	–	1.1	–	1.8
	Xenentodon cancila	*Kaikka*	2.2	1.4	–	3.1
	Cyprinus carpio	*Karfu*	–	–	2.3	–
	Osteobrama cotio cotio	*Keti*	3.6	–	–	–
	Puntius conchonius	*Canchan puti*	2.0	1.7	2.3	2.3
	Puntius sophore	*Puti*	1.1	16.8	10.7	12.6
	Puntius ticto	*Tit puti*	–	1.3	–	–
	Glossogobius giurus	*Bailla*	3.3	–	4.5	2.2
	Lepidocephalus guntea	*Gutum*	–	–	1.5	3.0
	Channa marulius	*Gajar*	1.7	–		–
	Channa punctatus	*Taki*	–	14.1	2.9	12.1
	Channa striatus	*Shol*	–	7.9	–	2.2
	Clarias batrachus	*Magur*	–	1.1	–	–
	Heteropneustes fossilis	*Shingi*	–	10.0	–	3.0
	Macrognathus aculeatus	*Tara baim*	–	–	3.4	1.9
	Macrognathus pancalus	*Guchi*	2.6	1.2	5.1	5.7
	Mastacembelus armatus	*Baral baim*	2.1	–	3.3	1.3
	Nandus nandus	*Bheda*	–	2.4	–	–
	Ompok bimaculatus	*Kani pabda*	2.6	–	–	–
	Notopterus notopterus	*Foli*	2.7	2.2	–	–
	Chanda baculis	*Chanda*	2.7	–	1.1	–
	Chanda nama	*Nama chanda*	1.2	–	2.7	–
	Chanda ranga	*Lal chanda*	–	–	1.1	2.2
Subtotal			29.3	89.8	44.6	61.3
Other	Prawn spp.	*Chingri/icha*	19.4	2.0	14.2	21.8
Subtotal			19.4	2.0	14.2	21.8
Grand total			85.7	93.0	87.3	87.8

Notes: 1. Dominant species are defined as those species which comprised 1% or more of the total annual catch

2. Shaded values highlight the most abundant species (>4%)

3. See text for definitions of habitat preference categories (section 3.5.2)

canchan puti. Some species such as *koi*, *shingi* and *khalisha* were very abundant only in the South West which suggests that environmental conditions may have been different here from those in other regions. No evidence for this was found during the water quality monitoring programme, however. Prawns were important in all regions except the South West where they comprised only 2% of the catch. In the North East and North Central they formed 19% and 22% of the catch respectively and in the North West Region 14%. The relative scarcity of prawns on the floodplains of the South West is surprising given their important contribution to catches from canals (21%) and rivers (23%) of that region. In the North East, prawns formed the basis of extremely important subsistence and semi-commercial fisheries located on the shallow peripheral water of *haor* during rising and full flood seasons.

3.6 Fisheries Inside FCD/I Project

3.6.1 Background

Assessments of the impact of flood control on capture fisheries were first carried out in Bangladesh between 1976 and 1982 as part of the Irrigation Fisheries Development Project (IFDP).[27] A few years later the Master Plan Organisation (now known as WARPO) reviewed the impact of flood control, drainage and irrigation on fisheries.[28] These studies identified several potential adverse impacts which in later reviews were reported to have been partly responsible for a general decline in the capture fisheries of Bangladesh. [29,30,31] These problems were raised again as important issues to be addressed during the course of the Flood Action Plan. The reported decline in fish production from inland capture fisheries was of particular concern when faced with the prospect of further large-scale flood control under the Flood Action Plan which, if successful, could cause considerable harm to fisheries and further accelerate the reported decline in production. Other factors which were perceived to have been responsible for the decrease in capture fisheries included the expansion of agrochemical pollution which was related to increased irrigated rice production; increased incidence and severity of fish disease; siltation, and over-fishing.

3.6.2 Potential impacts of flood control on fisheries

The potential impacts of flood control on capture fisheries were based on the general perception that full flood control projects were functional and that natural flooding patterns on floodplains had been radically altered. Outside the North East Region, the principal objective of flood control was to increase rice production by replacing deepwater *b. aman* with HYV *t. aman* which requires shallow water during the monsoon. Under the scenario of full flood control for HYV *t. aman* production some of the more important potential adverse impacts on fisheries are listed below.

i) Loss of flooded habitat during the monsoon resulting in a loss of fish production.

ii) Blockage to the movements of fish (adults, juveniles and hatchlings) between external rivers and floodplains.

iii) Reduced diversity of fish by preventing migratory species entering floodplains.

iv) Increased fishing pressure on smaller areas of water during the monsoon resulting in damage to the long-term sustainability of fisheries.

v) Reduced dry season habitat resulting in higher fishing pressure and increased catchability of overwintering fish broodstock. The increased abstraction of water from *beel* to irrigate surrounding rice fields was of particular concern.

vi) Reduced groundwater recharge resulting in a lower water table in the dry season which in turn could lead to a reduction in the area of perennial *beel*. Dry season rice production dependent on tubewell irrigation was also thought to be at risk from lowered groundwater levels as well as increasing the problems for drinking water supplies.

vii) Loss of high value migratory species such as major carps and catfish by preventing migrations between rivers and floodplains and thereby interfering with their life cycles.

viii) Increased fish disease by the creation of adverse environmental conditions such as stagnation of standing waters which could trigger disease outbreaks in already stressed and modified fish communities.

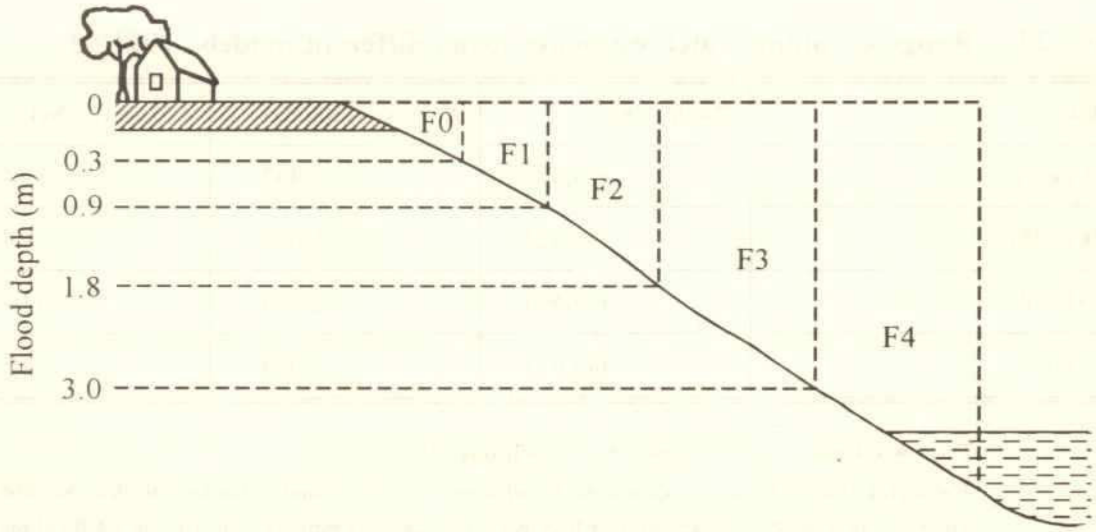
Although many potential harmful impacts of flood control on fisheries were identified there was no systematic method of including them in quantitative economic analyses of proposed flood control developments. The early study by the IFDP[27] stressed the need for further detailed long-term studies to understand the complex relationship between floodplain fisheries and the biological, environmental and socioeconomic factors which influence fish populations. As flood control developments expanded rapidly in the 1980s, the MPO[29] recognised the increasing need to formulate a method by which fisheries assessments could be integrated into economic analyses of the costs and benefits of flood control projects. This is discussed further in the following section.

3.6.3 Methods of assessment of the impact of flood control on fisheries

The MPO used the results of earlier studies of IFDP to identify the various potential impacts of flood control. These, however, could only provide an indication of the effect of a small number of projects in the South East Region on fisheries during a short period in the early 1980s. What was needed was a system which could provide more up-to-date and extensive quantitative estimates of fish production. The only data available at that time were the annual fisheries statistics collected by the Department of Fisheries through its Fisheries Resource Survey System (BFRSS). The MPO used the data to provide estimates of annual catch per hectare of floodplain (Table 3.23). This was done in two ways to provide low and high estimates of annual CPUA. The low estimate was obtained simply by dividing the total fish production from floodplains by the estimated area of floodplain. The high estimate also included the annual catch from *beel*, rivers and estuaries excluding riverine species such as *ilish* which were considered to be unaffected by flood control. The high estimate was based on the assumption that, in terms of fisheries, different habitats should be considered as a single integrated aquatic system through which fish move, feed, grow and reproduce. A physical change to one part of the system e.g. by flood control on floodplains, would therefore have an impact on fisheries in other parts.

In a complementary study, the MPO also devised a method to classify land types according to maximum flood levels expected during an average flood year with a return period of 2.33 years. This is known as the mean annual flood (Fig. 3.12). The divisions between each category or flood phase were based largely on crop suitability patterns.[32] The changes in area of different flood phases could then be used to assess the benefits of flood control in terms of changes in cropping patterns and associated predicted increased rice production. For fisheries assessments, the estimates of annual CPUA were assumed to be derived from land ranging from F1 to F4. Estimates published by the Department of Fisheries differ in that

Figure 3.12 Classification of flood depths



Flood Phase	Flood depth (m)
F0	0 - 0.3
F1	0.3 - 0.9
F2	0.9 - 1.8
F3	1.8 - 3.0
F4	>3.0

Source: Based on data adapted from MPO (1987)[32]

Note: The classification of flood depths was based on the maximum flood depth that has a recurrence interval of 2.33 years and a duration of one day. The 2.33 year flood is known as the mean annual flood.

e.g. F2 flood phase is that land on which the maximum depth on any given day reached 1.8 m and was not less than 0.9 m under flood conditions equivalent to the mean annual flood.

these assume floodplain fish production is derived largely from the more deeply flooded land ranging from F2 to F4. The application of the different areas to catches results in considerable differences in estimates of CPUA, those from DoF being almost twice those of MPO. The findings from the present FAP 17 study support more closely the use of the areas used by DoF than those used by MPO. Data in Table 3.23 show that of the two methods used to estimate annual catches, the "high" estimate was actually lower than the "low" estimate of DoF. This was caused by lower yields from rivers and estuaries which when combined with floodplain catches, reduced the overall estimate.

Table 3.23 Range of annual catch estimates using different models, 1991/92

Method	Catch (tonnes)	Area[3] (million ha)	CPUA (kg/ha)
MPO (low)[1]	329,573	5.487	60
MPO (high)[2]	446,623	6.633	67
DoF (low)[1]	329,573	2.833	116
DoF (high)[2]	446,623	3.979	112

Notes:
1. The low estimates include catches from floodplains only
2. The high estimates include catches from floodplains, *beel*, rivers and estuaries with *ilish* deducted
3. MPO use an estimate of 5.487 million hectares for floodplains ranging from F1 and F4 flood phases DoF use an estimate of 2.833 million hectares for floodplains ranging from F2 to F4 flood phases (see Fig. 3.12 for definitions of flood phases)

3.6.4 Identified impacts

In the analyses and interpretations of results which follow, fisheries inside eight selected flood control projects are compared with those of unregulated floodplains in pairs, following the method outlined in sections 3.3 and 3.4. The selected projects were divided into three broad categories based on the degree of flood control provided during the study period. The categories were a) full flood control, b) controlled flooding for deepwater *aman* and c) partial flood control (see section 2.3.2). The three categories provided a framework for the following discussion on various impacts of flood control on fisheries.

1. Loss of catch through lost habitat

Whenever flood control projects reduce the area of flooded land there will be a loss of habitat for fish production. The annual fish yield or catch per unit area from this lost habitat varied geographically between regions and between different land heights (Table 3.17). In the North East Region annual combined catches from unregulated floodplains, *beel* and canals ranged from 107 kg/ha to 142 kg/ha. In the North West they ranged from 68 kg/ha to 94 kg/ha, in the North Central from 43 kg/ha to 107 kg/ha and in the South West from 111 kg/ha to 202 kg/ha.

In view of the wide variation in values of CPUA between regions, it is recommended that each region be treated separately when applying these values to future flood control projects. The low value of 43 kg/ha from the North Central Region relates to more shallowly flooded land equivalent to F1 (see Fig. 3.12). Other values relate to varying proportions of land between F2 and F4 and can be used as indices covering this range of flood depths. Given the variability in CPUA values within regions, it is also recommended that those values from the project nearest the proposed development should be used in future analyses.

The CPUA values obtained in this study relate to a certain set of hydrological conditions found in each region in 1993 and it is important to realise that under different natural flooding conditions changes in annual fish yield would be expected. Analyses of longer-term flooding patterns on floodplains showed wide inter-annual variations (e.g. Figs 2.1 and 2.2). Studies in other parts of the world have shown a direct positive relationship between the catch from floodplain fisheries and annual variations in the flood extent. [25, 26] It is to be expected therefore that there should be wide variations in annual catch if there are large yearly changes in flood magnitude and extent.

The only fisheries catch data which provide a time series are those of the Government statistics (BFRSS). Unfortunately, these show no direct relationship to variations in flooding patterns between years. The present study does, however, provide an indication of the degree of variation in catches to be found in two hydrological years in the North Central and North West regions where survey periods covered 19 and 17 months respectively. This provided an opportunity to compare catches made during two flood recessions and winters when the bulk of the annual catches was taken (Figs 3.13 and 3.14). Catches from floodplains, canals and rivers were lower in both regions during 1992 when flood magnitude, extent and

Figure 3.13 Comparison of catches from the North Central Region in 1992/3 and 1993/4

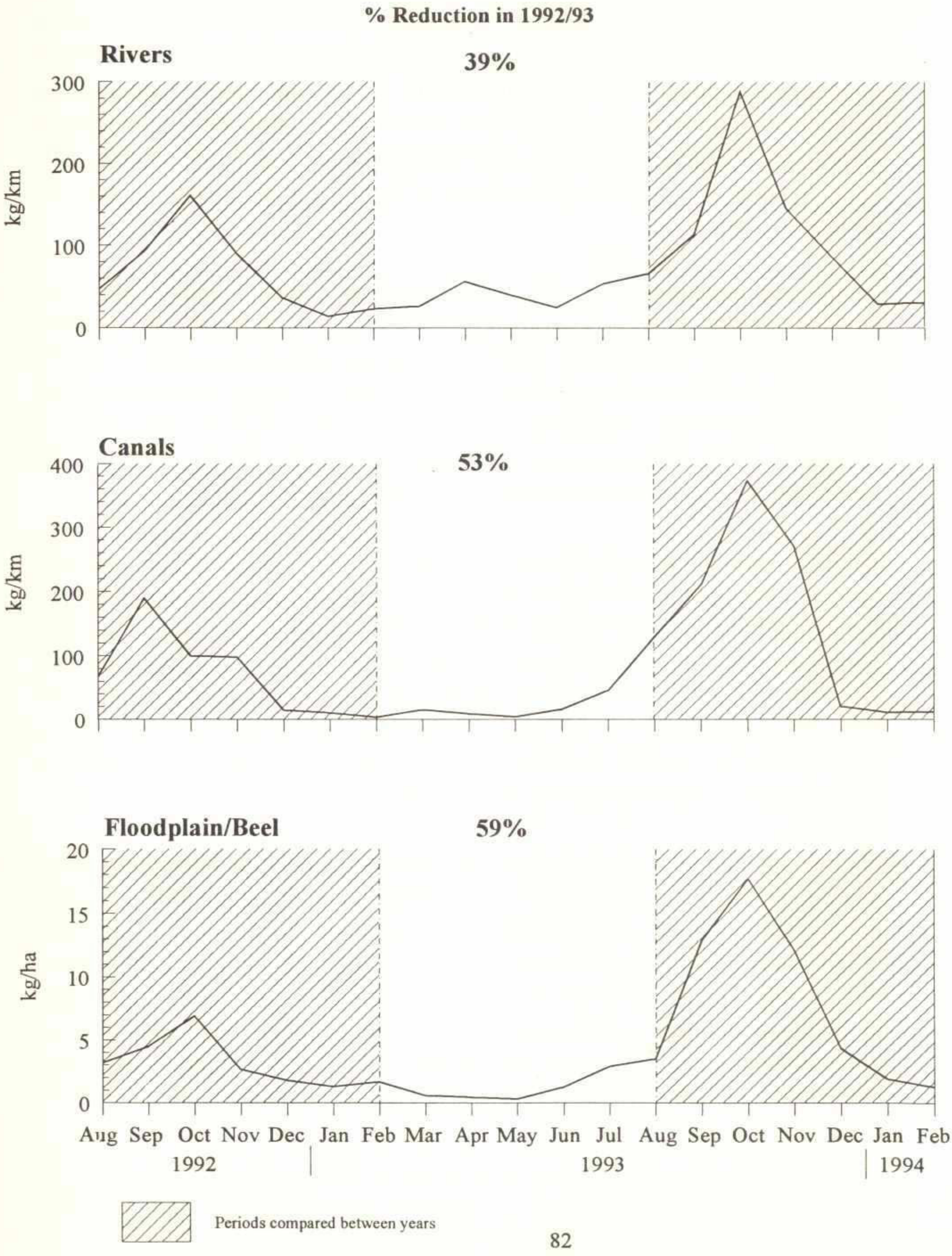
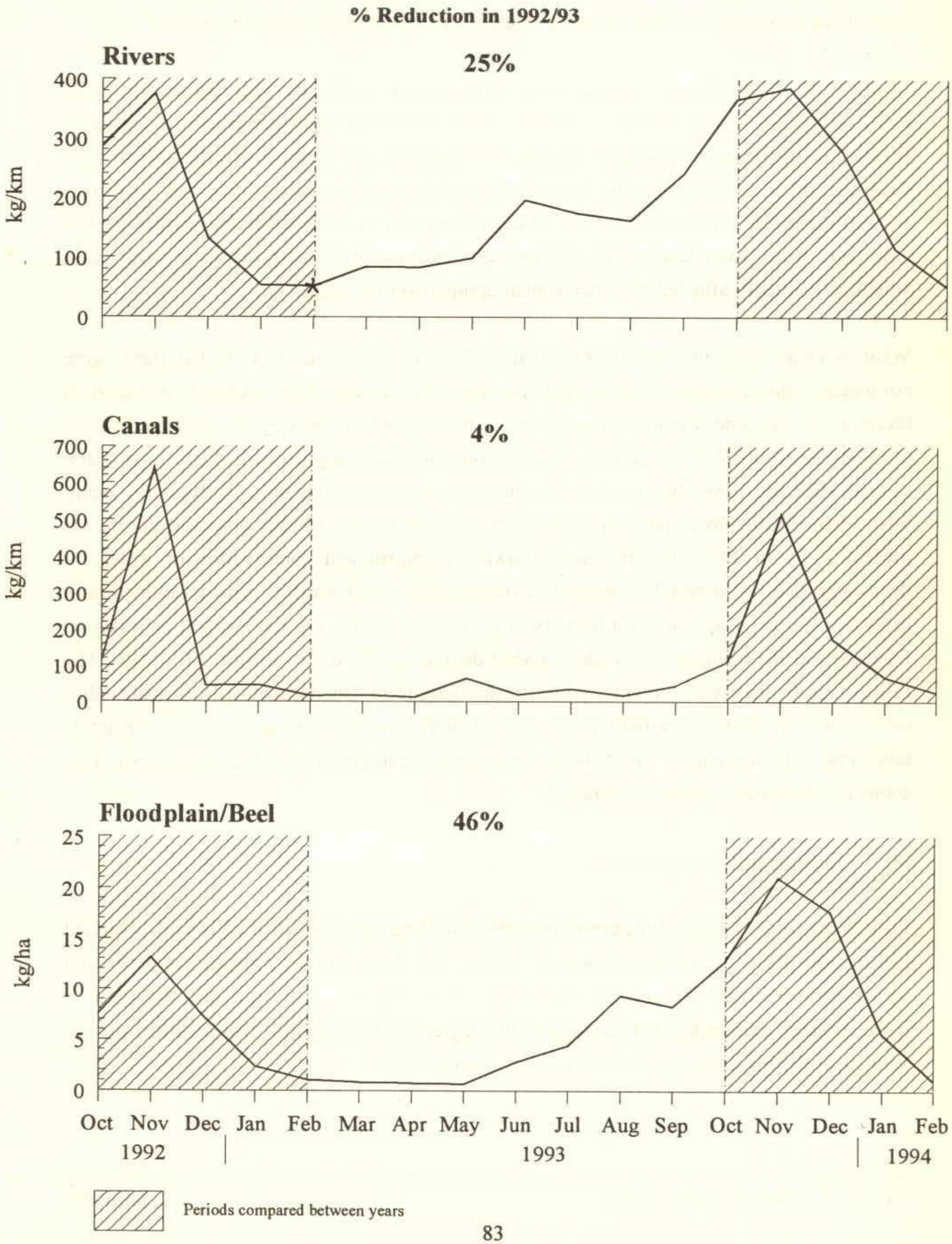


Figure 3.14 Comparison of catches from the North West Region in 1992/3 and 1993/4



duration were substantially lower than those in 1993. The greater reduction in floodplain catches than rivers was attributed to the higher proportion of floodplain resident fish which were more dependent on inter-annual variations in flooding than riverine species.

In the North West Region, catches were reduced less in the dry year inside one FCDI project, the PIRDP, than outside it. The difference was attributed to the greater reduction in flooding on unregulated floodplains during 1992 than the more stable controlled flooding for deepwater rice cultivation inside the PIRDP. A study of Chalan *Beel* Polder B, however, showed the reverse trend with larger reductions in catch in 1992 inside the project. In this case there were major changes in fishing gears and possibly fishing access between years which undoubtedly affected the inter-annual comparison of catches.

What is clear from the results presented in Figures 3.13 and 3.14 is that there were consistent major changes in catches between years of different flood levels. It is important therefore to take into account annual flooding patterns when applying the estimated values of CPUA from the FAP 17 study to future flood control developments. In high flood years, such as 1987 and 1988, the extent of flooding in those projects remaining structurally secure would have been substantially reduced compared with the differences observed during the present study in 1993. In drier years however, control and conservation of water for deepwater rice could result in greater flooding inside FCD projects which would benefit capture fisheries. The long-term impacts of these rarer high flood and drought episodes on fisheries and their interactions under varying degrees of flood control are not known. The results thus emphasise the urgent need for further long-term fisheries and hydrological studies on which to develop a quantitative floodplain fisheries model that can used as a predictive tool to provide future advice on fisheries management and development in Bangladesh. This subject is discussed further in section 5.

2. Reduction in relative catch

Prior to the FAP 17 study, the general perception in Bangladesh was that FCD/I development had reduced fish catches through loss of habitat (No. 1 above) and reduced catch per unit area from the remaining regulated floodplains. The FAP 17 results revealed, however, a more complex relationship between catch, the degree of flood control, fish densities and the amount of fishing effort applied to fisheries (Table 3.24).

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Table 3.24 Comparison of annual catches from floodplains inside and outside flood control projects, March 1993 - February 1994

Type of flood control	Project	Region	Annual catch[1] (kg/ha)		Percentage change inside	Fish Density[2]	Fishing Effort
			Outside	Inside			
Full Flood Control	BRE	NW	43	8	- 81	-	Out > In
Controlled Flooding	PIRDP*	NW	94	143	+ 52	Out > In	In > Out
	Chalan Polder*	NW	68	189	+ 178	NS	In > Out
	Satla-Bagda*	SW	202	128	- 37	Out > In	Out > In
Partial Flood Control	SHP*	NE	107	103	- 4	NS	In > Out
	MIP*	NE	142	113	- 20	Out > In	In > Out
	CFP	SW	111	142	+ 28	NS	In > Out
	CPP	NC	107	109	+ 2	-	-

Notes: 1. In five project marked with an asterisk, annual catches were based on the integration of total catches from large areas of floodplains, *beel* and canals (see section 3.5.5)
2. Statistical difference in fish densities are shown with the direction of the difference. NS denotes not significant and - denotes notes not tested

In the one and only full flood control project which operated as planned, the BRE, the catch from floodplains and *beel* was 81% lower than that from regulated floodplains. This was the only project where flooding was substantially reduced. In three other full flood control projects which remained structurally secure, catches were higher inside two (PIRDP and CBP) and lower in the third (SBP). All three operated for the production of deepwater rice rather than HYV *t. aman* and consequently sluice gates were opened intermittently to provide controlled river flooding during the monsoon which also allowed fish to enter the systems. In Chalan *Beel* Polder B, where the greatest increase in regulated catch was found, controlled flooding for deepwater rice resulted in an increase in flooding of 18% compared with that on unregulated floodplains and which would therefore favour a higher catch. In the PIRDP, peak fluctuations in flood levels were reduced and a more predictable, controlled flood level along village shorelines resulted in a considerable increase in fishing effort by shallow-water subsistence fisheries using *thella jal* and *doiar* traps which in turn led to a higher catch inside than out. In Satla-Bagda Polder 1, peak flood levels were again reduced but in this case fishing effort and fish density were also lower inside the project which resulted in a lower catch.

The only other project which functioned as planned, apart from the BRE, was the Shanghair *Haor* Project which provided partial flood control using submersible embankments that overtopped in May. The delay in major pre-monsoon river flooding of 19 days made no significant impact of the annual CPUA. The three remaining projects, the Tangail CPP, the MIP and the Chatla-Fukurhati Project, provided no protection from river flooding during the monsoon. Values of annual CPUA inside and outside the Tangail CPP were very similar while higher catches were observed outside the MIP and inside the Chatla-Fukurhati Project respectively. The lower catches outside the Chatla-Fukurhati Project could be attributed to rural road construction which reduced the ingress of river floodwaters thus serving unintentionly as flood control embankments. Lower catches inside the MIP were attributed to reduced entry of migratory species from external rivers despite public cuts in embankments.

Catches from canals and rivers inside and outside flood control projects followed the same general trend as floodplain catches (Table 3.25). The greatest reduction in catch from regulated canals was observed in the full flood control project (BRE) in which the catch was 70% lower than that from an unregulated canal. In two projects which provided controlled flooding, reductions in catch were lower than in the BRE. Inside the PIRDP a reduction in catch of 51% was found. This contrasts with a catch increase found on regulated floodplains of this project. Reasons for the difference in results between habitats remain unclear. In both Chalan *Beel* Polder B and Satla-Bagda Polder 1, submerged main drainage canals were sampled as part of the floodplain. These gates were closed temporarily or canals dammed during the early winter to concentrate fish migrating from floodplains. This effectively lengthened the flood season by 2 to 4 weeks and increased the catchability of fish which had access to fewer drainage channels than did those on regulated floodplains.

Catches from regulated rivers of the PIRDP varied considerably; the lowest was found in the most highly regulated river which served as the main irrigation channel of the project, while the highest catch was from a river which drained the lowest land with the longest flood duration where winter *katha* fisheries predominated.

Table 3.25 Comparison of annual catches from canals and rivers inside and outside flood control projects, March 1993 - February 1994

Type of flood control	Project	Habitat	Annual Catch (kg/km)		Percentage change inside	Fish Density	Fishing Effort
			Outside	Inside			
Full Flood Control	BRE (NW)	Canal	1461	434	- 70	NS	Out > In
		River	438	1501	+ 243	NS	In > Out
Controlled Flooding	PIRDP (NW)	Canal	889	436	- 51	NS	Out > In
		River	4003	1292-8155	-	-	-
	SBP (SW)	Canal	2975	2182	- 27	-	
Partial Flood control	MIP (NE)	Canal	2726	4069	+ 49	NS	In > Out
	CFP (SW)	Canal	3022	4124	+ 36	NS	In > Out
	CPP (NC)	Canal	1052	955	- 9	-	
		River	551	748	+ 36	-	

In those projects which provided only partial flood control, canal catches were generally higher than those from unregulated canals. In one of these, the MIP in the North East Region, sluice gates were closed temporarily in early winter, to concentrate fish migrating from floodplains, and later opened to facilitate intensive fishing by leaseholders. Similar operations were observed in Shanghair *Haor* on a submerged drainage canal sampled as part of the floodplain which was temporarily dammed by the leaseholder of the fishery, again to concentrate fish prior to heavy fishing.

3. <u>Reduction in fish densities</u>

Statistical comparisons of seasonally pooled catch rates of dominant gears used on floodplains and *beel* inside and outside FCD/I projects revealed that of the four projects which were structurally secure and provided full flood control or controlled flooding, fish densities were significantly lower on regulated floodplains inside two of them, the PIRDP and Satla-Bagda (Table 3.24). In the PIRDP, however, the fit of the statistical model was poor; the difference between densities was not therefore demonstrated conclusively. In the other two projects no significant difference in fish abundance was detected inside and outside embankments. In both projects it was not possible to use the selected statistical model because of large differences in the types of gears used on inside and outside sites. An alternative analysis was therefore applied on a few individual dominant gears. This was considered to be a less robust method since only part of the total annual catch was examined.

No significant differences in fish densities were detected in the project which was designed to offer partial flood protection (Shanghair *Haor*) or in the project which did not prevent river flooding because of poor maintenance (Chatla-Fukurhati). In the MIP, significantly lower fish densities were recorded prior to embankment cuts and significantly higher densities later in the year following several cuts. The significantly lower densities found early in the year followed a previously drier year when embankments were not cut and fish were effectively prevented from entering the project. Analyses carried out on canal catches in several projects revealed no significant differences in fish densities at inside and outside sites (Table 3.25). Overall, the results from floodplains/*beel* provide some evidence that flood control can result in a significant reduction in biological productivity by decreasing fish abundance even though some access through sluice gates was provided during the monsoon season.

4. Increased fishing effort

When full flood control projects worked as planned, as in the case of the BRE, reduced flooding substantially decreased the opportunities for fishing compared with those on unregulated floodplains resulting in a reduction in fishing effort and thus catch (Table 3.24). In two other structurally secure full flood control projects in the North West, fishing effort increased on regulated floodplains. In the PIRDP, controlled river flooding for deepwater rice provided a stable and predictable flooding pattern (see Figs 2.5 and 2.6). This allowed small-scale subsistence fisheries (*doiar* traps and *thella jal*) to operate for longer periods along the shoreline of villages immediately adjacent to households. In contrast, on unregulated floodplains water depths and flood extent fluctuated considerably during the monsoon providing a less stable hydrological environment for the operation of shallow-water gears. A similar trend was seen in Chalan *Beel* Polder B although not as clearly as in the PIRDP. In Satla-Bagda Polder 1, a greater amount of fishing effort was recorded on unregulated floodplain/*beel* by isolated households located on low-lying land and totally surrounded by floodwaters. This situation was atypical of most floodplain sites and was considered to be the main cause of the very high fishing effort observed in this area.

In three other projects (SHP, MIP and CFP) which provided only partial flood protection, fishing effort inside embankments was also higher than that outside. In total, increased fishing effort by small-scale gears occurred on floodplain and *beel* in five projects and in three of these (PIRDP, CBP, CFP) it was the main cause for higher catches recorded. In addition, fishing effort was also found to be higher inside three of the five projects where canal/river comparisons were made (Table 3.25.). It is not known at present what effect such an increase in fishing effort may have on the long-term sustainability of the fish and prawns stocks upon which these fisheries are based.

5. Reduction in diversity

In the one project which provided full flood control (the BRE) there was a 33% reduction in species diversity on its floodplain/*beel* compared with that outside (Table 3.26). In projects where monsoon river floodwaters were allowed to enter floodplains for the production of deepwater rice, species diversities were reduced to a lesser extent, between 19% and 25% in the North West Region and 4% in Satla-Bagda Polder 1 in the South West. In projects which provided partial or no flood control species diversities on floodplain/*beel* were not generally adversely affected. A similar trend was also seen in diversities recorded in regulated canals and rivers (Table 3.27).

Examination of different groups of fish revealed that the diversities of riverine and migratory species were more greatly reduced than floodplain resident species (Table 3.28). This was not unexpected since the principal cause of reduced diversity was blockage to fish movements between rivers and floodplains by flood control structures. Again the greatest adverse impact was seen in the BRE where there was a 95% reduction in the number of riverine and migratory species compared with 15% increase in the diversity of floodplain resident species. In Chalan *Beel* Polder B and the PIRDP riverine and migratory species numbers were reduced by 29% and 45% and floodplains residents by 8% and 5%. These results demonstrate clearly the mitigating effect on species diversity of controlled flooding for *b. aman* compared with the impact of full flood control for HYV *t. aman*.

In Satla-Bagda Polder 1 in the South West Region, the reduction in diversity of riverine and migratory species was less than that seen in the PIRDP and Polder B. This was attributed not to differences in the functioning of the polder but to the lower overall diversity of these groups of fish on both regulated and unregulated floodplain in this part of the South West Region (see section 3.5.5).

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Table 3.26 Annual number of species recorded from floodplains and *beel* inside and outside FCD/I projects, March 1993 - February 1994

Type of flood control	Project	Number of species		Percentage difference inside
		Outside	Inside	
Full Flood Control	Brahmaputra Right Embankment (NW)	46	31	- 33
Controlled Flooding	Pabna Irrigation and Rural Development Project (NW)	76	57	- 25
	Chalan *Beel* Polder B (NW)	80	65	- 19
	Satla Bagda Polder 1 (SW)	48	46	- 4
Partial Flood Control	Shanghair *Haor* Project (NE)	58	64	+ 10
	Manu Irrigation Project and Hakaluki *Haor* (NE)	70	68	- 3
	Chatla-Fukurhati Project (SW)	52	72	+ 38
	Compartmentalization Pilot Project (NC)	59	64	+ 8

Notes: 1. Annual species numbers are arithmetic mean numbers per sampling site where there are more than one site per project
2. + and - denote increase and decrease in numbers respectively

Table 3.27 Annual number of species recorded from canals and rivers inside and outside FCD/I projects, March 1993 - February 1994

Type of flood control	Project	Habitat	Number of species		Percentage difference inside
			Outside	Inside	
Full Flood Control	Brahmaputra Right Embankment (NW)	River	78	60	- 23
		Canal	59	34	- 42
Controlled Flooding	Pabna Irrigation and Rural Development Project (NW)	River	88	73	- 17
		Canal	63	56	- 11
	Satla Bagda Polder 1 (SW)	Canal	46	51	+ 11
Partial Flood Control	Manu Irrigation Project and Hakaluki *Haor* (NE)	Canal	95	81	+ 15
	Chatla-Fukurhati Project (SW)	Canal	59	63	+ 7
	Compartmentalization Pilot Project (NC)	River	74	80	+ 8
		Canal	58	60	+ 3

Notes: 1. Annual species numbers are arithmetic mean numbers per sampling site where there are more than one site per habitat
2. + and - denote increase and decrease in numbers respectively

Table 3.28 Annual numbers of migratory and floodplain resident species recorded on floodplains/*beel* inside and outside FCD/I projects, March 1993 - February 1994

Type of flood control	Project	Outside		Inside		% change inside	
		Migratory	Floodplain resident	Migratory	Floodplain resident	Migratory	Floodplain resident
Full Flood Control	BRE (NW)	20	26	1	30	- 95	+ 15
Controlled Flooding	PIRDP (NW)	38	38	21	36	- 45	- 5
	CBP (NW)	42	38	30	35	- 29	- 8
	SBP (SW)	10	38	9	37	- 10	- 3
Partial Flood Control	SHP (NE)	17	41	22	42	+ 29	+ 2
	MIP (NE)	31	39	27	41	- 13	+ 5
	CFP (SW)	10	42	31	41	+ 210	- 2
	CPP (NC)	18	41	19	45	+ 6	+ 10

Notes: 1. The migratory group of fish includes both riverine and migratory species
2. + and - denote increase and decrease in percentage respectively

The partial flood control project of Shanghair *Haor* had no adverse effect on species diversity. Indeed, 29% more riverine and migratory species were recorded inside than outside the project. In contrast, in the MIP the diversity of these groups was reduced by 13% despite cuts made in embankments in early June, three weeks after the submersible embankments of Shanghair *Haor* overtopped. In the poorly functioning Chatla-Fukurhati Project of the South West Region, diversities of riverine and migratory species were considerably lower outside the project. This unusual result was attributed to the unplanned development of rural village roads which blocked river flooding and fish movements on floodplains with no formal flood protection. Diversities of floodplain resident fish were largely unaffected in projects providing partial or little flood control.

Similar trends were seen in diversities of different groups of fish from regulated canals and rivers (Table 3.29). Greatest reductions in diversities of migratory species were observed under conditions of full flood control and least impact occurred under partial flood control. Diversities of floodplain resident fish were also reduced by full flood control but less so by controlled and partial flood control. That the diversity of this group is reduced at all suggests that there is blockage to seasonal movements of some species between rivers and floodplains.

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Table 3.29 Annual numbers of migratory and floodplain resident species recorded on canals and rivers inside and outside FCD/I projects, March 1993 - February 1994

Types of flood control	Project	Habitat	Outside		Inside		% change inside	
			Migratory	Floodplain resident	Migratory	Floodplain resident	Migratory	Floodplain resident
Full Flood Control	BRE (NW)	River	43	35	26	34	- 40	- 3
		Canal	27	32	7	27	- 74	- 16
Controlled Flooding	PIRDP (NW)	River	54	34	33	40	- 39	+ 18
		Canal	24	39	19	37	- 21	- 5
	SBP (SW)	Canal	10	36	11	40	+ 10	+ 11
Partial Flood Control	MIP (NE)	Canal	50	45	36	45	- 28	0
	CFP (SW)	Canal	18	41	27	36	+ 50	- 12
	CPP (NC)	River	39	35	40	40	+ 3	+ 14
		Canal	25	33	20	40	- 20	+ 21

Notes: 1. The migratory group of fish includes both riverine and migratory species
2. + and - denote increase and decrease in percentage respectively

6. Reduction in migratory fish

Under full flood control inside the BRE, the contribution to the annual catch made by riverine and migratory species was negligible (<1%) compared with that on unregulated floodplains (26%). Under controlled flooding for deepwater rice in the PIRDP and Chalan *Beel* Polder B a similar scale of reduction was found (26%-30%) but in these projects, riverine and migratory species still contributed between 6% and 10% of the catch (Table 3.30). In Satla-Bagda Polder 1 in the South West Region, riverine and migratory species made negligible catch contributions (<2%) on both regulated and unregulated floodplains.

Of the four projects which provided partial or little control over flooding the percentage catch contributions of riverine and migratory species increased inside two (SHP and CFP) and decreased in the others (MIP and CPP) compared with contributions from respective unregulated floodplains. Annual percentage catches of riverine and migratory fish ranged from 6% to 36% on regulated floodplains in these four projects. This was substantially higher than the range of 0.1% to 10% from the four structurally secure projects which provided a greater degree of flood control. The results showed that as the degree of flood control increased, catches were increasingly dependent on a relatively small number of floodplain resident species.

Migratory and riverine groups of fish included several large and higher value species such as major carps and certain catfish. Reductions in these fisheries therefore resulted in a lower overall value of the catch from flood controlled areas.

Table 3.30 Percentage contributions by migratory and floodplain resident fish to catches from floodplains and *beel* inside and outside FCD/I projects, March 1993 - February 1994

Type of flood control	Project	Migratory		Floodplain Resident	
		Outside	Inside	Outside	Inside
Full Flood Control	BRE (NW)	26	<1	59	93
Controlled Flooding	PIRDP (NW)	36	10	50	63
	CBP (NW)	35	7	52	77
	SBP (SW)	2	2	96	91
Partial Flood Control	SHP (NE)	10	19	66	58
	MIP (NE)	55	36	27	39
	CFP (SW)	3	14	94	70
	CPP (NC)	11	6	65	70

Note: The migratory group of fish includes both riverine and migratory species

Under full flood control, the contribution made by migratory species to the canal catch was 35% lower than that on the regulated canal whereas on the regulated river, migratory species contributed 19% more (Table 3.31). The difference was attributed to an influx of fish from the lower reaches of the regulated river which opened on to the unregulated Baral River. Most migratory fish appeared in the river during the drawdown and moved upstream towards the Jamuna where they were blocked by Bauitara regulator and captured by gears such as *urani* set on the structure itself and by *dharma* and *deal* traps set immediately downstream. Under controlled flooding conditions in the PIRDP, the scale of reduction in migratory fish catches in canals and rivers was lower than that found on floodplains and contributions were generally higher.

Table 3.31 Percentage contributions by migratory and floodplain resident fish to catches from rivers and canals inside and outside FCD/I projects, March 1993 - February 1994

Type of Flood Control	Project	Habitat	Migratory		Floodplain Resident	
			Outside	Inside	Outside	Inside
Full Flood Control	BRE (NW)	River	31	50	57	43
		Canal	42	7	46	85
Controlled Flooding	PIRDP (NW)	River	49	32	36	56
		Canal	15	9	67	81
	SBP (SW)	Canal	3	4	94	84
Partial Flood Control	MIP (NE)	Canal	50	51	36	36
	CFP (SW)	Canal	5	11	91	86
	CPP (NC)	River	32	26	59	62
		Canal	44	8	45	77

Note: The migratory group of fish includes both riverine and migratory species

7. Disruption of fish community structure

Results from analyses of catch compositions revealed that fish community structure in flood controlled areas was disrupted not only by a loss of riverine and migratory species but also by major changes in the composition of the remaining floodplain resident species (Table 3.32). As the degree of flood control increased there was an increasing loss in community heterogeneity and catches were increasingly dependent on a relatively small number of abundant floodplain resident species. Under these conditions there is a danger that the capability of fish stocks to sustain increased fishing pressure may be impaired and that disease outbreaks may be more frequent and damaging. At present it is not known how serious these potential problems may be.

In Table 3.32 percentage contributions made by dominant species to annual catches were combined across regions for projects providing different types of flood control. The results showed clearly the gradation in impact of the increasing degree of flood control. Under partial flood control, 6 dominant migratory species provided 20% of the annual catch. These species comprised large catfish *ayre* and *boal*, major carps, *rui*, *catla* and *mrigel* and the

Table 3.32 Percentage contributions by dominant species to catches from floodplains/beel outside and inside flood control projects, March 1993 – February 1994

Habitat Preference	Species name: Scientific	Species name: Bengali	Outside: Full Flood Control	Outside: Controlled Flooding	Outside: Partial Flood Control	Inside: Full Flood Control	Inside: Controlled Flooding	Inside: Partial Flood Control
Riverine	*Aspidoparia morar*	*Piali*	3.9	–	–	–	–	–
	Hilsa ilisha	*Ilish*	–	1.9	–	–	–	–
Subtotal			3.9	1.9	–	–	–	–
Migratory	*Aorichthys aor*	*Ayre*	–	–	–	–	–	7.1
	Aorichthys seenghala	*Guizza*	–	–	10.9	–	–	–
	Mystus bleekeri	*Golsha tengra*	–	1.9	–	–	–	–
	Mystus cavasius	*Kabashi*	–	1.5	3.0	–	–	–
	Catla catla	*Catla*	–	–	–	–	–	1.4
	Cirrhinus mrigala	*Mrigel*	1.5	–	–	–	–	1.3
	Labeo rohita	*Rui*	3.7	–	1.1	–	1.5	3.5
	Salmostoma phulo	*Fulchela*	7.5	–	–	–	1.8	–
	Gudusia chapra	*Chapila*	1.7	1.3	9.0	–	–	5.3
	Pseudeutropius atherinoides	*Batasi*	–	1.6	–	–	–	–
	Wallagu attu	*Boal*	1.7	3.9	–	–	–	1.8
Subtotal			16.1	10.2	24.1	–	3.2	20.4
Floodplain Resident	*Anabas testudineus*	*Koi*	–	8.2	1.7	2.3	1.1	1.1
	Mystus tengara	*Bajari tengra*	–	–	–	–	1.6	–
	Mystus vittatus	*Tengra*	1.1	2.3	1.7	–	1.6	1.8
	Colisa fasciatus	*Khalisha*	2.7	9.1	1.5	27.3	2.1	1.5
	Colisa lalia	*Lal Khalisha*	2.7	–	–	–	–	–
	Colisa sota	*Khalisha*	–	–	–	5.3		–
	Xenentodon cancila	*Kaikka*	–	1.2	1.9	–	5.7	2.0
	Cyprinus carpio	*Karfu*		–	–	–	–	3.0
	Osteobrama cotio cotio	*Keti*	–	–	2.5		–	–
	Puntius chola	*Chala puti*	–	–	–		–	1.3
	Puntius conchonius	*Canchan puti*	6.1	1.9	2.1	–	3.6	–
	Puntius phutunio	*Phutani puti*	–	–	–	1.9		–
	Puntius sophore	*Puti*	10.7	14.3	5.0	10.1	13.8	7.1
	Puntius ticto	*Tit puti*	1.1	–	–	–	–	–
	Amblypharyngodon mola	*Mola*	1.0	–	–	1.5	–	–
	Esomus danricus	*Darkina*	1.7	–	–	1.2	–	–
	Glossogobius giurus	*Bailla*	2.6	2.0	2.8	–	3.3	2.1
	Lepidocephalus guntea	*Gutum*	1.4	–	1.3	2.4	1.3	–
	Channa marulius	*Gajar*	–	–	1.6	–	1.3	2.1
	Channa punctatus	*Taki*	5.5	8.9	4.5	19.6	11.6	5.8
	Channa striatus	*Shol*	–	3.6	2.5	2.4	2.7	1.3
	Clarias batrachus	*Magur*	–	–	–	1.9	–	–
	Heteropneustes fossilis	*Shingi*	–	6.7	1.8	7.0	2.8	1.9
	Macrognathus aculeatus	*Tara baim*	1.3	1.5	1.0	–	1.1	–
	Macrognathus pancalus	*Guchi*	6.2	2.9	3.0	2.0	4.3	2.1
	Mastacembelus armatus	*Baral baim*	–	1.5	1.8	–	1.2	–
	Nandus nandus	*Bheda*	–	–	1.2	–	–	1.0
	Ompok bimaculatus	*Kani pabda*	–	–	1.8	–	–	–
	Notopterus notopterus	*Foli*	–	1.6	2.0	–	–	4.1
	Tetraodon cutcutia	*Potka*	–	–	–	–	1.1	–
	Chanda baculis	*Chanda*	–	–	1.9	–	–	2.1
	Chanda nama	*Nama Chanda*	4.6	1.3	–	–	1.8	1.1
	Chanda ranga	*Lal chanda*	7.2	–	–	2.8	2.7	–
Subtotal			55.9	67.0	43.4	87.7	64.7	41.5
Other	Prawn spp.	*Chingri/icha*	15.3	7.1	17.5	7.0	21.0	23.3
Total			91.2	86.1	85.0	94.7	89.0	85.2

Notes:
1. Dominant species are defined as those species which comprised 1% or more of the total annual catch
1. Shaded values highlight the most abundant species (>4%)
2. See text for definitions of habitat preference categories (section 3.5.2)

clupeid, *chapila*. Under controlled flooding conditions only two migratory species were dominant, *rui* and *fulchela*, which together accounted for only 3% of the catch. Under full flood control conditions no migratory species were listed as dominant.

The reverse trend was seen in catches of floodplain fish. In partial control projects, 17 species provided 41% of the catch; under controlled flooding, 19 species comprised 65% and under full flood control 14 species accounted for 88% of the catch. The most equitable distribution of the catch between species was found under partial control and the least under full flood control. A total of 7 species was found in all 3 types of flood control project of which 5 were particularly abundant in one or more types. These comprised *khalisha*, *puti*, *taki*, *shingi* and *guchi baim*. Under full flood control, two species, *khalisha* and *taki* were particularly abundant, comprising 27% and 20% of the annual catch respectively. The latter species together with *shingi*, *koi* and *magur* were more abundant on the regulated floodplains inside the BRE. These species are especially adapted to harsh conditions where low oxygen levels may prevail, suggesting that environmental conditions may have been worse under full flood control but went undetected during the water quality monitoring survey.

In Table 3.32 a list has been compiled of those floodplain resident species dominating catches on both regulated and unregulated floodplains. The species listed in this group are of immense significance in Bangladesh. It is virtually certain, for example, that this small group of species provides a large proportion of the category "other inland fish" recorded in the national fisheries statistics of 1991/92 as contributing almost 200,000 t from floodplains and *beel*.[33] Most are small species, maturing within one year. Many of them are related to each other and therefore probably share a number of life history and population characteristics. This could simplify the prospect of estimating sustainable yield from these species once their population dynamics are understood. At present there is insufficient information to allow this to be done.

A further common characteristic of catches was the importance of prawns. The results in Table 3.32 indicate a decrease in abundance as the degree of flood control increased. In all areas however they formed an important component of the catch. In some areas of the North East Region they supported very important subsistence and semi-commercial fisheries during the pre-monsoon and monsoon periods. For example, in the MIP and the unregulated Hakaluki *Haor* the annual catch of prawns in 1993 was estimated at 918 t and 1645 t respectively. Unfortunately, because of taxonomic difficulties, prawns were rarely identified in the field. However, results from samples sent to the Marine Science Institute at Chittagong indicated that all species belonged to the genus *Macrobrachium*. This genus is regarded as a typical estuarine spawner which makes migrations into freshwaters at an early stage in its life cycle. FAP 17 studies on the movements of fish hatchlings using fine-meshed drift nets have shown, however, that juvenile prawns formed an important component of the catch in the North East Region and in other parts of the country, which suggests widespread spawning inland by some species.

8. Reduced fish migrations

Under full flood control on the BRE, sluice gate closures from June to September effectively blocked the entry of 17 riverine and migratory species which entered unregulated floodplains via the Northern Dhaleswari on the left bank of the Jamuna. All species were juveniles, the most abundant of which were *piali*, *fulchela*, *rui*, *mrigel*, *chapila*, *katari* and *bhangan*. During the drawdown several migratory species moved up the regulated Old Hurasagar towards the Jamuna. These fish were blocked by Bauitara regulator and captured by gears set on or near the structure. The main species captured included juvenile migratory species such as *rui*, *kalbaus*, *raik*, *kalabata*, *katari* and *bata*, and the floodplain resident, *taki*.

On the regulated Baral River, a distributary of the Padma River, Charghat regulator also blocked the upstream migrations of fish moving into the Padma despite the fact that gates were partially open during the monsoon. Water level differences across the regulator ranging from 0.5 m to 2.0 m were sufficient to create turbulence and high enough water velocities to form a barrier to upstream movements of fish and increase their susceptibility to capture. On the downstream walls of the regulator, hand-held scoop nets, *hat tana*, captured a total of 41 species of fish moving upstream, of which 33 were migratory. The principal target species was adult *ilish* moving upstream on a spawning migration. Other relatively abundant species blocked and captured at the regulator were *rui*, *catla*, *mrigel*, *raik*, *boal* and *shillong*.

In projects which provided controlled flooding for deepwater *aman*, flood control structures reduced fish migrations in two ways. First, by reducing the number of entry points on to floodplains and thereby concentrating fish in fewer channels where they were more susceptible to capture. Secondly, by closing the gates of regulators for extended periods during the pre-monsoon and monsoon. These projects did, however, offer greater opportunity for fish to enter floodplains than under full flood control conditions seen on the BRE since gates were opened intermittently to allow the entry of river waters for the cultivation of deepwater *aman*.

In the PIRDP, migrations of fish from external rivers to regulated rivers inside the project were delayed up to one or two months by intermittent gate closures. There was also a lower dispersal of riverine and migratory species, notably *ilish*, *kabashi*, *boal*, *kajuli*, *ghaura*, *phasa*, *shillong*, *chital*, *rui* and *raik*, on to regulated floodplains than on unregulated floodplains. In Chalan *Beel* Polder B, sluice gates were closed in May, a month earlier than those of the PIRDP but opened again in June and July to provide gradual flooding for deepwater rice production. Several migratory species were blocked from entering at this time but appeared in catches on regulated floodplains later in the year (August-September) when sluice gates were closed to conserve inside water levels. These species could only have entered in June and July in such low numbers that they were not detected in floodplain catches at the time. Both riverine and migratory species moved off the regulated floodplains of Polder B in October and November, one to two months earlier than those on unregulated floodplains. In the PIRDP, riverine species also migrated off the floodplains quickly during the drawdown but several migratory species remained and were captured later in winter by *kua* and *katha*.

In those projects which provided partial flood control there was, not surprisingly, less impact on fish migrations. In the Shanghair *Haor* Project, submersible embankments delayed the main rise in pre-monsoon flooding by about 3 weeks in May. The only impact this had on adult and juvenile fish monitored during catch assessment surveys was to delay the entry of three migratory species, *rui*, *kalbaus* and *chapila*. These species together accounted for about 50% of the catch from unregulated floodplains in May but comprised only 2% of the catch inside the project.

In the MIP in the North East Region, preliminary surveys undertaken in January 1993 found only one migratory species and no riverine species on regulated floodplains. During the next month 6 riverine and migratory species accounted for 3% of the monthly catch. These species entered through sluice gates which were opened to drain canals and *beel*. In comparison, during January 1994, 22 riverine and migratory species accounted for 47% of the catch and in the following month 18 species contributed 28%. The difference between years was due to the absence of cuts in embankments in the drier year of 1992 and therefore entry of external river waters and fish was prevented whereas in June 1993 embankments were cut to relieve high outside flood levels thereby allowing migratory fish to enter the project.

Independent but closely related investigations of downstream movements of fish hatchlings in the Jamuna River and its distributaries showed that their passive drift on water currents was blocked by closures of sluice gates in the PIRDP and BRE. Blockage to movements was particularly harmful during the first large rise in river levels in June when densities and supply rates of major carp hatchlings were high. Other studies in the Padma system revealed that, even when gates were open, densities and supply rates of hatchlings were significantly reduced in regulated rivers when waters level differences across regulatory structures exceeded about 1 metre. In the North East Region, the prevention of river flooding until mid-May using submersible embankments was shown to prevent the entry of hatchlings of several species but the first appearance of major carp hatchlings (19 May) coincided with the time of over-spillage of embankments and the entry of river waters on to floodplains.

9. Population dynamics

Studies on the population dynamics of selected fish species were carried out to complement catch assessment studies and aimed to provide possible explanations for differences in fish catches inside and outside flood control projects. Length frequency analyses were used to examine differences in growth, mortality and recruitment. Although a large amount of data was collected, analyses were restricted to two projects in the North West Region, the PIRDP and Chalan *Beel* Polder B. Within these two projects, illustrative analyses were undertaken on two dominant floodplain resident species *puti* and *bailla*.

Quantitative methods for fitting growth curves were attempted but these did not produce reliable results due to small sample sizes in some months; qualitative methods were therefore used. The analyses revealed no significant differences in growth or mortality rates of fish populations inside and outside the flood control projects. While the results indicated that there was little evidence that stocks inside flood control areas were more threatened by the higher fishing effort observed there, mortality rates were very high both on regulated and unregulated floodplains. The analyses revealed that very few fish survived into their second year, so that spawning and survival of the populations were highly dependent on each year's offspring. The stocks of these species were therefore regarded as being highly vulnerable to over-exploitation and collapse.

10. Water quality

Seasonal variations in water temperature, pH, dissolved oxygen concentration, conductivity, total dissolved solids and transparency were monitored on floodplains, *beel*, canals and rivers. No major differences were detected on sites inside and outside flood control projects apart from a general greater clarity of waters inside projects which provided a degree of flood control at some times of the year. This was attributed to the limited contribution of river water to flooding on floodplains and possibly the deposition of silts in front of sluice gates and on first entry on to flooded land. The increased clarity of floodwaters on regulated floodplains would be expected to encourage macrophytic and algal growth, and increased phytoplankton and zooplankton populations which serve as food for many juvenile and some adult fish and thus possibly result in increased fish production.

4 SOCIAL AND ECONOMIC STUDIES

4.1 Background

Plans put forward under the Bangladesh Flood Action Plan (FAP) aim to greatly increase the area of the country where the natural hydrological regime has been modified. The types of mechanism envisaged for achieving a solution to the problems caused by flooding have, to some extent, developed during the course of the regional and special studies initiated under the *aegis* of the FAP but, with some exceptions, the proposals continue to be dominated by infrastructural programmes aimed at altering hydrological patterns in order to minimize flood risks.

The FAP 17 socioeconomic research programme has therefore attempted to analyse the relative importance of fisheries in the livelihoods of rural households in a random selection of floodplain communities. The fisheries issue in flood control is usually seen in terms of trade-offs: will overall benefits to agriculture and other sectors exceed the disbenefits suffered by fisheries and those dependent on them? This approach ignores many serious issues regarding distribution and what constitutes a benefit for different groups within the population. However it offers a starting point for making sense of the complexities of rural livelihoods. Benefits from fisheries, whether in the form of income earned or food obtained, have to be seen in the context of the alternatives open to the household and way in which one source of livelihood is balanced with another through the year.

Originally, the FAP 17 study intended to isolate flood control impacts by looking at communities inside and outside flood control projects. However, the difficulties encountered in identifying, on the one hand, fully functioning flood control projects and, on the other, control areas which have not been impacted by some kind of intervention which mimics flood control (roads, paths, homesteads) limit the usefulness of these direct comparisons taken in isolation. The levels of variability between communities with apparently similar resource bases further complicates the question.

As a result, an understanding of the historical dimension of the community; the changes which have taken place in the surrounding environment, the shifts in patterns of agriculture, employment, settlement and community structure, the development of new arrangements for control of access to resources, including fisheries; all these processes need to be accurately understood in order to determine whether the current levels of dependence on fisheries are the result of flood control or other changes taking place irrespective of embankments or water regulation.

In most of the cases studied, flood control is only one of a complex series of changes which are impacting on the fisheries resource and on the way in which that resource is exploited and it has not proved possible to identify, quantitatively, the impacts of flood control *per se* on communities dependent on fisheries. However, the FAP 17 social and economic studies do provide qualified descriptions of these communities and the levels of their dependence on the fisheries resource which can be used as a baseline for monitoring future flood control interventions.

4.2 Methods and Definitions

The analyses below are based principally on data derived from the fish catch assessment survey (FCA) conducted by the fisheries team of FAP 17, and the socioeconomic household monitoring surveys, conducted by the socioeconomic team. In addition information has been used from a series of *ad hoc* surveys on issues such as fisheries access and fish marketing.

The methodology used for the FCA surveys has already been described in the Interim Report of FAP 17. The further processing of this data to allow socioeconomic analysis is described below, as is the data collection process for the various surveys undertaken by the socioeconomic team.

Processing of the FCA Data

The FCA data was used to look at two principal issues: the value of the catch and its distribution between different groups.

Value of the catch

The FCA estimates of species distribution of catch by site, location, month and gear were used to calculate corresponding catch values. This was achieved by multiplying species weights by estimated species prices, collected in the course of the fish marketing survey (see below).

Monthly price data were collected at four primary markets in each region on each species, when available, for the year 1993. Price trends were followed on 17 indicator species that were widespread, relatively common but sufficiently heterogeneous to cover the spectrum of inland fish types. All other major species were linked to an indicator species, on the advice of experienced market respondents (mainly *aratdars*) as to similarities in their seasonal price movements. Some of the minor species were either not familiar to or differentiated by the market respondents; these were assigned to groups on the basis of scientific species groupings. Differences within groups were allowed for by a markup factor, also derived from interview data. Thus the estimated price of *mrigel*, on which continuous price data were not collected, was that of *rui*, its indicator species, multiplied by 0.69, its markup factor.

The value of catch was estimated by multiplying the estimated catch of each species for each gear in each month on each site by its estimated price. This was then reduced by a marketing margin of 40% for the sites in the North East and 30% elsewhere. These reduction factors were derived from information gathered on fish trading households covered in the socioeconomic village monitoring. The greater margin in the North East is consistent with the much longer carrying distances there.

Classification of fishermen

The CAO1 forms contained questions relating to the respondents' ranking of different income sources for their household. These were used as a starting point for determining which gears were used by different categories of fishermen and, ultimately, how catch was distributed between them.

The categorization of households according to their dependence on fishing involves the division of a spectrum that extends from those where fishing is the only significant source of income to those where catching fish is a minor seasonal activity - perhaps only undertaken by small boys - and contributes to household

Table 4.1 Household fishing categories

Household Fishing Category	Criteria
HFC1	No other major source of income ranked
HFC2	Primary source of income - other sources ranked
HFC3	Other sources of income ranked higher than fishing
HFC4	Fishing primarily for subsistence - not ranked as a source of income

subsistence, not income. The categories used by FAP 17, which are broadly based on those used by FAO, are given in Table 4.1.

Income rankings were used to differentiate between households where fishing was the single (HFC1), the principal (HFC2) and a minor (HFC3) source of income and those where it contributes principally to household consumption (HFC4).

Households at either end of this spectrum are clearly differentiated, and can be classified with little difficulty; however, the boundaries between the intermediate categories were not always clear, particularly those between HFC2 and HFC3: in which where a household ranks fishing as a source of annual income can depend on when they are interviewed, a problem also noted by FAP 6.

Because of the stress laid upon the distributional impact of the FAP by many commentators, further analyses were also undertaken of the first ranked source of income where this was not fishing (i.e. for HFC3 and HFC4 households). In particular a distinction was drawn between households reporting farming as their primary source of income and those giving labour, trade or other.

The users of each gear were classified according to the above criteria, using the four household fishing categories, with an additional breakdown of HFC3 and HFC4 between farmers and non-farmers. For the detailed analyses, gear users were classified by habitat type, flood period and flood control status.

Socioeconomic surveys

The procedures for the collection of socioeconomic data were discussed in some detail in the FAP 17 Interim Report. This section provides a brief review and update of the material contained there.

The principal focus of the socioeconomic studies was the role of fisheries in the livelihood strategies of different social and occupational groups in floodplain communities and how this has been affected by flood control measures. To investigate this, communities inside and outside existing flood control projects, but located in areas with comparable agro-ecological characteristics, were selected for detailed study.

Near each randomly selected village, one or more specialised fishing communities were identified which exploited local fisheries resources. Each of these groupings of agricultural village (usually principally agricultural) and near-by fishing communities was regarded as a "village cluster." In each of these clusters, a quantitative survey of a stratified sample of households was carried out over a one-year period, looking at labour, income and consumption. This was supported by an appraisal looking at the historical and social processes affecting fisheries around the village cluster.

Selection of flood control projects

The only existing flood control project in the North Central Region was the Tangail CPP. As this small area had already been studied in very considerable detail by FAP 20 and FAP 16, it was felt that respondent fatigue would preclude any further monitoring there by FAP 17. North Central Region was therefore taken as an outside area. Elsewhere the choice of projects was similar to that for the fisheries studies: in the North West studies included Pabna Irrigation Project and Chalan *Beel* Polder B; in the North East, Kai Project and Manu Irrigation Project; in the South West, Satla-Bagda Polder 1 and Chatla-Fukurhati project.

Village selection

The main agricultural villages that were to be compared were selected on the basis of similarities in their Agro-Ecological Units (AEUs), as defined by the Bangladesh Land Resources Inventory on the basis of soil types and flood depths (to which flood duration is strongly correlated). Within a particular AEU, a broadly similar historical distribution of soil types, land height and agricultural capability can be assumed. As these AEUs are based on the Soil Reconnaissance Surveys conducted in the 1960s and early 1970s, they are indicative of conditions prior to the construction of the principal embankments in most areas: similarities in AEU therefore correspond to similarities in pre-flood control conditions.

This procedure was able to keep constant only those features of the community resource base that affect agricultural livelihood strategies at a macro level. In practice, levels and patterns of income were also significantly influenced by numerous micro level variations in factors such as land holding patterns, proximity of sources of alternative livelihood opportunities, NGO activity, *jalmahal* control etc. Indeed the effect of these factors was sufficiently strong to rule out any hope of measuring flood control impacts though community comparisons.

The village clusters that were selected as the outcome of this process are shown in Figure 4.1.

Village census

A census survey of all the households in the main agricultural villages and the fishing households in the fishing villages gathered information on numbers of family members, education and age of household head, principal sources of household income, fishing involvement and ownership of land, ponds, fishing gears and boats. In supporting volumes (village studies) the villages are referred to as main villages and satellite villages but in this report they are referred to as agricultural and fishing villages respectively.

Households were then classified. In the agricultural villages this was on the basis of landholding category; in the fishing villages on the basis of fishing categories. Landholding categories were defined in relation to total land owned as follows: Large >7.5 acres; Medium 2.5 - 7.49 acres; Small 0.5-2.49 acres and Landless <0.5 acres. Fishing categories were defined as in Table 4.1 above.

Household baseline survey

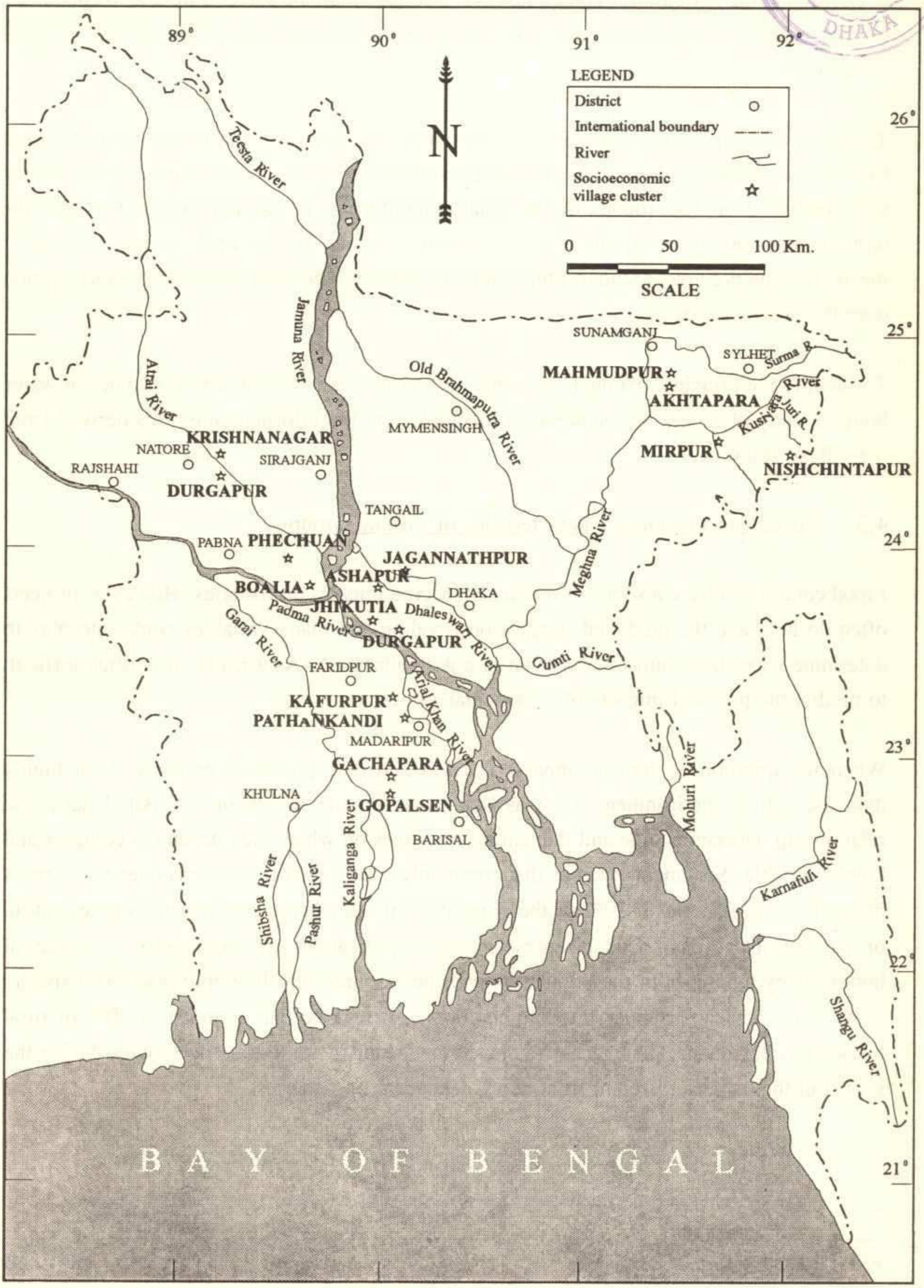
A stratified random sample was then taken, using this classification, and a baseline questionnaire administered. This covered: family composition, education, employment and occupation; migration history; land type, use, and ownership status. Information was also gathered on ownership of assets - such as agricultural equipment, livestock, transport etc - and on poverty indicators - food deficit months, clothing and indebtedness periods.

Household monitoring

Household monitoring of all the baseline survey respondents was then carried out, through repeat surveys over one year (1993-4), covering the Bengali months *Magh* (January-February) to *Poush* (December-January).

The principal focus of this survey was on household livelihood strategies, to gain a greater understanding of the sources and magnitude of income flows (in both cash and kind) into and out of the household through the year, so that the significance of the contribution of fisheries could be gauged more accurately. Accordingly, monthly information was gathered on income, expenditure and labour absorption of eleven different categories of enterprise: agricultural, livestock, agricultural labour, non-agricultural labour, food-for-work, self-employment, gear-making, fish trading, fishing, fish culture, and expenditure saving activities.

Figure 4.1
Location of agricultural villages surveyed by the FAP 17 socioeconomic studies



Ad hoc surveys

In addition to the agricultural village surveys, a series of *ad hoc* surveys were also conducted on consumption, fisheries access, fish marketing and target group approaches to pond aquaculture.

To assess the nutritional significance of fish within the diet of different groups in different time periods (during the peak fishing season and in the dry season), a consumption survey was conducted on two rounds of the village monitoring. It was administered to half the participating households by the female research assistants and covered the composition of meals over the previous 48-hours; the source of fish; and the frequency of fish consumption over the previous week.

To identify the principal parameters mediating access to fisheries on different types of water body, a study of access was undertaken to supplement the information on this derived from the village studies.

4.3 Social and Economic Characteristics of Fishing Groups

Flood control can have a series of relatively specific impacts on fisheries. However, projects often do not have the predicted impacts on flooding and many variables come into play to determine what those impacts might be in a particular case. As a result, it is often difficult to predict the physical impacts of a particular project.

When the question of human impacts is addressed, the problems multiply. In a highly dynamic natural environment, such as that found on the floodplains of Bangladesh, the relationship between people and the natural resources on which they depend is complex and highly variable. Statements such as that commonly used to justify concerns over the impacts of the FAP on fisheries ("80% of the population of Bangladesh depend on fisheries for all or part of their livelihoods") represent oversimplifications as they imply a degree of homogeneity among both the population and the resource which simply does not exist. In some years, under particular flooding conditions, it may be that as much as 80% of rural households have some members who engage in fishing at some time or another during the year, but this is very different from being dependent on fisheries.

Discussion of the real impacts on people of changes in fisheries due to flood control must therefore start from a better understanding of patterns of dependence on fisheries, irrespective of flood control.

4.3.1 Who fishes?

The widespread perception that fishing constitutes an important seasonal source of food and income for many of the poorest of the poor in rural areas is understandable given the intense fishing activity which can be observed at certain times of the year in floodplains all over the country. The numbers of people involved in fishing, the variety of techniques employed and the apparent heterogeneity of the people involved obviously encourage this impression.

Most attempts to categorise this varied and heterogeneous fishing population end up identifying three groups: "professional" or full-time fishermen; seasonal or part-time fishermen, and "subsistence" fishermen. At first sight, these categories appear arbitrary. It is true that, at least in the past, "professional" fishermen in Bangladesh have been a clearly circumscribed group, defined socially by their profession and, at least in part, by religion, caste and social status. Given the widespread diffusion of the fisheries resource which occurs during the floods, however, extensive fisheries involvement among the rest of population can be expected. Logically such involvement would depend, above all, on factors such as distance from suitable water bodies, availability of alternatives and seasonal or annual variations in flood extent.

Through the more precise measurement of income from different sources among a large sample of rural households, the FAP 17 social and economic studies aimed to provide a more precise picture of the different levels of fisheries involvement and dependence among different groups of the rural population and develop a more accurate framework for discussing different levels of fishing involvement.

The findings of the studies indicate however that the commonly used categorisations of fishing households-professional, seasonal and subsistence-hold up quite well to more detailed analysis of relative levels of fisheries dependence although certain points regarding definition need to be kept in mind. Given the degree of variation noted above between regions, areas, villages and years, there are obviously many groups and areas which will fall outside any attempt at categorisation at any given moment; increasingly many "seasonal" fishermen are becoming "professional" and most "subsistence" fishermen are also "seasonal" (Fig. 4.2). The definitions and variations within these three groups are therefore discussed below in some detail. The terms "professional," "seasonal" and "subsistence" will continue to be used throughout the report but the inevitable inadequacies of these categories need to be kept in mind and they should not be interpreted in a rigid fashion.

Table 4.2 gives the regional breakdown of the proportion of households in the main (non-fishing) villages studied by FAP 17 involved in seasonal (for income) and subsistence (for consumption) fishing respectively. As the dividing line between "seasonal" and "subsistence" fishermen is inevitably vague, a breakdown between "fishing" and "non-fishing" population in these villages is also given.

Table 4.3 uses data from the FAP 17 fish catch assessment surveys, carried out on the fishing grounds as opposed to in the villages, to show the distribution of catch, by value, among different categories of fishermen. This data is broken down by region and by type of fisheries habitat. There were slight differences in the ways in which the categories outlined above were interpreted in this survey, but the correspondence is sufficiently close to make these data and those obtained from the village studies comparable.

4.3.2 Subsistence fishermen

The term "subsistence" fishermen is normally used for those households where most catch is consumed in the household rather than converted into income. In practice, the term tends to be as a catch-all for everyone engaged in fishing who does not regard it as an "occupation." Alternative terms for this group might be "opportunistic" fishermen or "non-fishermen who fish." Although the latter term seems contradictory, it expresses well the social importance of not being regarded as a "fishermen" (*jele*) even if someone spends a considerable amount of time fishing.

Subsistence fishing gears

Many rural people fish regularly throughout the flood season and drawdown, but at low levels of intensity (a few hours at a time). They use small, flexible gears on generally shallow and peripheral water bodies or flooded areas which yield small amounts of fish. Others might only fish once or twice during the year under very particular circumstances (for example during the pre-monsoon *ozaya maatsch* fishery in the *haor* of the North East Region or during the dewatering of ponds and ditches during the drawdown period).

Figure 4.2 Categories of fisheries involvement in Bangladesh

Degree of fisheries involvement	Main fishing categories	Social and occupational groups involved in fishing	Types of fisheries involvement and gears used
Occasional	Subsistence	**Opportunistic fishers (for food):** **-labourers** **-traders and artisans** **-small farmers** **-medium farmers** **Children (play and for food)** **Women (rarely for food)** **Vulnerable groups (old people, widows, disaster victims)**	**Occasional fishing, limited to particular seasons.** **Mostly on shallow water bodies (floodplains, canals, ponds and ditches).** **Mostly small, low investment gears (push nets, traps, cast nets, spears, dewatering).** **Most gears replaced after one season.**
Part-time	Subsistence / Seasonal	**Opportunistic fishers (for income and food):** **-labourers** **-traders and artisans** **-small farmers** **-medium farmers** **Children (for food and for income)** **Women (rarely for food and income)** **Vulnerable groups (old people, widows, disaster victims)**	**As above**
	Seasonal	**Seasonal (for income)** **- small farmers** **- labourers** **- medium farmers** **- traders and artisans**	**Seasonal fishing on a more regular basis.** **On wide range of water bodies, including *beel* and major rivers.** **Small, low- investment gears (push nets, traps, cast nets, spears, dewatering) and small gill nets (current jal).**
	Seasonal / Professional	**Non-traditional full-time fishers**	**Practically year-round fishing.** **Wide range of water bodies.** **Wide range of gears including gill nets and seine nets.**
Full-time	Professional	**Traditional fishers**	**Year-round fishing.** **Mostly deeper water bodies.** **Large gears supplemented smaller gears in some periods.**

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Table 4.2
Seasonal and subsistence fishing in agricultural villages : proportion of households involved (% by landholding category)

Landholding categories1	Regions											
	North Central			North West			North East			South West		
	Seas.2	Subst.3	NFish.4	Seas.	Subst.	NFish.	Seas.	Subst.	NFish.	Seas.	Subst.	NFish.
Medium farmers	6.0	79.0	14.0	11.0	34.0	11.6	2.0	64.0	34.0	15.0	60.0	24.0
Small farmers	10.0	63.0	23.0	12.0	31.0	10.1	3.0	58.0	28.0	26.0	48.0	33.0
Landless	15.0	48.0	37.0	18.0	28.0	24.9	10.0	49.0	41.0	32.0	29.0	27.0
Village total	12.0	61.0	27.0	15.0	32.0	13.4	6.0	57.0	37.0	27.0	44.0	29.0
Total fish./non-fish.	73.0		27.0	47.0		53.0	63.0		37.0	71.0		29.0

Source : FAP 17 Village Census and Supplementary Surveys

Notes :

1 Landholding categories are defined in relation to total land owners as follows:
medium - 2.5-7.49 acres : small - 0.5-2.49 acres : landless < 0.49 acres

2 Seasonal fishermen - reporting some income from fishing during the year

3 Subsistence fishermen - reporting fishing / owning gear but not reporting income from fishing

4 Non-fishing - no fishing activity reported and no gear owned

Table 4.3
Distribution of catch by value (%) on different fisheries habitats among different categories of fish catchers in four regions

Fisheries habitat	Fishing categories by region											
	North Central			North West			North East			South West		
	Prof.	Seas.	Subst.	Prof.	Seas.	Subst.	Prof.	Seas.	Subst.	Prof.	Seas.	Subst.
Main Rivers	53.7	34.5	11.7	72.0	16.5	11.6	-	-	-	46.6	47.1	6.2
Secondary Rivers	47.5	15.5	37.0	54.9	35	10.1	80.4	9.0	10.2	61.7	15.2	23
Khal	42.3	13.8	44.1	37.9	37.2	24.9	55.9	25.5	14.6	41.4	31.7	27.4
Floodplains	22.4	15.6	61.7	47.9	38.9	13.4	57.5	23.1	19.6	41.0	45.6	19.3
Beel	15.7	22.2	62.1	66.5	27.5	6.1	84.6	7.2	8.3	35.2	51.1	14.1

Source : FAP 17 Fisheries Studies

Households engaged in fishing activities of this sort might not own any fishing gear as such, but rely on their hands, baskets and other implements which are not primarily destined for use in fisheries. Those gears which are owned are generally cheap and frequently can be constructed with materials readily available in and around the village. Table 4.4 shows the gears in each region which are predominantly operated by fishermen who fish "primarily for consumption." It also shows the principal source of income reported by people using those gears.

While some regional variations are clear, there are a group of gears which can safely be defined as "subsistence" fishing gears in that they are overwhelmingly operated by this group. These are:

- *deol* : a length of fine mesh netting strung between two vertical poles and pulled through the water by two people; also called *dhor jal* (North Central and North West) and *lathi jal* or *manipuri jal* (North East)
- *dharma jal* : a square lift net of various sizes hung from a bamboo poles and usually operated from the banks of rivers and *khal*
- *ucha* : a woven bamboo scoop pulled along the bottom of streams and flooded areas
- *doiar* or *deal* : different types of bamboo trap
- *sip* and *tana barsi* : a simple hook and line with or without a float
- *jhaki jal* : a circular cast net of various dimensions
- *thella jal* : a triangular push net on a bamboo or wooden frame
- hand fishing : usually associated with the dewatering of residual water bodies as the floods recede.

Children in subsistence fishing

In many areas these opportunistic fisheries are dominated by children who can account for well over 50% of fishing effort using some of the most important "subsistence" gears such as *thella jal* (push net) and *ucha* (scoop net). It is particularly in this extremely important group of children involved in fisheries that problems of categorisation become most difficult. Some children undoubtedly make a significant contribution both to household income and consumption through their fishing activity. For children, even from "non-fishing" families, fishing can be a seasonal "job" taking up 10-12 hours of the day even though parents may be reluctant to regard it as a significant source of income. In the eyes of adults, and even from the point of view of many children, fishing is a form of play rather than a productive activity. In fact, for pre-adolescent children, fishing clearly plays an important social and educational role as well as augmenting family food availability.

Table 4.4
Social and economic characteristics of subsistence gear users in different regions

NORTH CENTRAL REGION

Gear category (English)	Gear name (Bengali)1	Religion of gear users (%)		Fishing categories of gear users (%)			Gear users' first ranked source of income (%)				
		Hindu	Muslim	Prof.	Seas.	Subst.	Fishing	Farming	Labour	Trade	Other
Gill net	*current jal*	6.0	94.0	19.2	40.5	40.4	19.1	16.8	50.6	8.0	5.5
Seine net	*deol*	1.7	98.3	2.6	7.6	89.8	2.6	49.0	28.5	7.5	12.4
Lift net	*dharma jal*	3.8	96.2	2.6	10.0	87.4	2.6	33.5	37.6	12.8	13.6
Scoop net	*ucha*	2.9	97.1	1.5	2.3	96.2	1.5	34.3	45.3	14.0	5.0
Trap	*doiar*	5.3	94.7	24.5	33.7	41.8	24.5	13.8	45.4	10.4	5.8
Hook/ lines	*sip*	12.7	87.3	3.1	9.8	87.2	3.1	24.7	40.2	16.3	15.7
	daun	8.3	91.7	33.0	44.7	22.3	33.1	10.7	49.0	4.7	2.5
	tana barsi	16.4	83.6	38.4	8.1	53.4	38.5	11.4	26.6	13.8	9.8
Cast net	*jhaki jal*	54.6	45.4	55.6	4.3	40.0	55.7	17.3	15.0	8.4	3.7
Push net	*thella jal*	2.8	97.2	1.7	3.9	94.4	1.7	29.3	50.2	10.5	8.3
Miscellaneous	hand fishing	5.9	94.1	3.3	0.3	96.4	3.2	22.8	52.4	9.2	12.4

NORTH WEST REGION

Gear category (English)	Gear name (Bengali)1	Religion of gear users (%)		Fishing categories of gear users (%)			Gear users' first ranked source of income (%)				
		Hindu	Muslim	Prof.	Seas.	Subst.	Fishing	Farming	Labour	Trade	Other
Seine net	*deol*	3.4	96.6	6.2	34.2	59.5	6.3	62.2	24.5	1.7	3.2
Lift net	*dharma jal*	1.4	98.6	7.8	67.8	24.5	7.7	43.0	26.8	12.1	10.4
Trap	*deal*	1.2	98.8	6.0	52.7	41.1	6.1	32.3	43.5	10.7	7.4
Hook/ lines	*sip*	2.7	97.3	7.7	33.3	59.1	7.6	34.8	32.6	11.7	13.4
	tana barsi	27.4	72.6	24.6	22.6	52.7	24.6	15.4	13.6	25.4	20.9
Cast net	*jhaki jal*	21.6	78.4	48.5	29.7	21.8	48.5	17.7	21.9	5.5	6.4
Push net	*thella jal*	1.6	98.4	11.0	44.0	44.9	11.1	36.5	38.2	6.0	8.2
Miscellaneous	hand fishing	1.9	98.1	4.4	27.7	67.9	4.4	48.0	32.5	5.3	9.7

NORTH EAST REGION

Gear category (English)	Gear name (Bengali)1	Religion of gear users (%)		Fishing categories of gear users (%)			Gear users' first ranked source of income (%)				
		Hindu	Muslim	Prof.	Seas.	Subst.	Fishing	Farming	Labour	Trade	Other
Seine net	*deol*	22.9	77.1	19.5	28.9	51.9	19.6	53	18.2	-	3.2
Scoop net	*ucha*	8.0	92.0	6.2	18.0	75.8	6.3	73.4	15.6	-	2.6
Hook/ lines	*tana barsi*	10.5	89.5	60.5	18.7	20.7	60.5	27	8.3	-	2.6
Push net	*thella jal*	16.6	83.4	33.1	20.9	46.1	33.1	38.2	20.1	1.1	7.4
Miscellaneous	dewatering	4.4	95.6	34.0	7.2	58.8	34	52.2	6.9	-	7.7
	hand fishing	8.3	91.7	5.2	10.0	84.8	5.2	68.1	16.6	1	6.7

SOUTH WEST REGION

Gear category (English)	Gear name (Bengali)1	Religion of gear users (%)		Fishing categories of gear users (%)			Gear users' first ranked source of income (%)				
		Hindu	Muslim	Prof.	Seas.	Subst.	Fishing	Farming	Labour	Trade	Other
Scoop net	*ucha*	2.6	97.4	5.2	19.5	75.3	5.2	29.2	39.6	15.6	10.4
	tukri	38.9	61.1	8.2	12.2	79.6	8.2	43.3	28.6	14.7	5.2
Trap	*polo*	48.4	51.6	17.2	31.3	51.5	17.2	42.2	26.6	12.5	1.6
Hook/ lines	*sip*	53.9	46.1	18.7	20.9	60.3	18.7	27.2	33.7	13.5	6.8
Spear	*koch*	58.7	41.3	18.4	31.5	50.1	18.4	39.8	27.9	8.5	5.4
Cast net	*jhaki jal*	35.5	64.5	15.1	22.0	62.9	15.1	37.3	27.1	14.5	6.0
Push net	*thella jal*	8.6	91.4	8.3	16.8	74.9	8.3	38.2	31.0	17.8	4.7
Miscellaneous	hand fishing	15.1	84.9	5.0	11.0	84.0	5.0	49.9	31.3	8.7	5.1

Source : FAP 17 Fisheries Studies

1 The gears shown are those where more than 20% of the gear users ennumerated during FAP 17 catch assessment surveys claimed to be fishing for subsistence only

Subsistence or occupation

There is generally a fairly clear distinction between those who regard fishing as a regular source of income, and have accepted the social implications of this choice, and those who catch fish without regarding themselves as "fishermen." Many "subsistence" fishermen may be reluctant to admit that they fish, even if they do so frequently. They are likely to consider the activity as being "only for consumption" even if, seasonally, they may earn considerable income.

Year-to-year variation

This subsistence category is subject to the greatest degree of variation from year to year as it is highly dependent on flooding patterns and the extent of inundation. In a year of Many "subsistence" fishermen may be reluctant to admit that they fish, even if they do so frequently. They are likely to consider the activity as being "only for consumption" even if, seasonally, they may earn considerable income. During relatively high floods, the commonly cited figure of 80% of floodplain residents engaged in fisheries may well be close to the truth. But in a relatively dry year the figure might be dramatically less.

This was indicated by FAP 17's own experience. The original village census in the 16 agricultural villages selected for study around the country was conducted in November-December, 1992, towards the end of a drought year where flood levels were considerably below "normal" levels. The numbers of respondents reporting even minor fishing involvement were well below expectation. During the subsequent 1993 flood season, when floods and rainfall were higher, far higher levels of fishing activity were generally observed and measured during household monitoring. A supplementary survey looking at "subsistence" fishing activity in a sample of villages in the North Central Region early in 1994 (also a year of relatively "normal" flooding) seemed to confirm a higher level of fishing activity than had originally been reported in the same region during the census in 1992 (see Table 4.2).

The differences in flooding from one year to another play an important part in determining whether these "subsistence" fishermen are active or not. Many of the gears used for this kind of fishery require very low investment and only last, at the most, for one fishing season. So in a dry year it would be easy to find households who engage in some fishing in years of "normal" or high flooding, but during that particular year have not fished at all and do not even have any fishing gear in the house. If a census of fishing gear were to be conducted during such a "dry" year, the numbers of people involved in fishing would appear to be very low.

Consumption or sale

"Subsistence" fishing does not necessarily mean that catch is used purely for household consumption. All fish catch in Bangladesh is marketable and even the tiniest amounts of fish caught by children are frequently sold rather than consumed. A significant proportion of subsistence catches does end up in the family cooking pot, but as much of the catch of these "opportunistic" fishermen is probably sold as is consumed.

Regional variations

While these points outline certain common features of the subsistence fishing subsector there are clear regional variations in terms of importance and mode of operation which need to be highlighted.

North Central

The North Central Region is the area where subsistence fishermen play the most important role in terms of their contribution to overall fishing effort and the numbers of people in rural communities involved.

There are several reasons for this. On the one hand, there are a large number of relatively small water bodies which seem to lend themselves to exploitation by subsistence fishermen using low levels of technology. Many of the other areas studied are characterised by extensive and relatively inaccessible areas of lowland with large *beel* and wide flooded areas during the monsoon which constitute a considerable barrier to access for occasional fishermen. The North Central Region, while not lacking in water and fisheries resources, is characterised by smaller *baor* (*rak*), rivers and relatively small *beel* which are more accessible to surrounding people.

As shown in Table 4.3, particularly high proportions of medium (79%) and small (63%) farmers are involved in subsistence fishing. This may be due to the fact that they spend more time in and around their villages than labourers who tend to be more mobile in their search for employment. While the proportion of labourers is lower, at 48%, this nevertheless translates into high numbers of landless involved in fishing as there are many labourers in the region. In Table 4.4, the high proportions of fishermen using "subsistence" gears who report labouring as their principal source of income is notable.

The market for labour seems to be more active in the North Central Region, perhaps due to the proximity to urban centres. This may explain why more people are involved in subsistence fishing rather than seasonal fishing. Labourers may have a wider range of employment options which discourages them from taking up fishing on a more stable basis. Given the relative lack of concern for the social stigma attached to fishing in the area (compared to say the North West Region) a greater degree of fishing for income might have been expected. Labourers seem to prefer to seek employment elsewhere, however, although they may be active subsistence fishermen during the flooding season and drawdown.

Perhaps as importantly, the level of control exerted over these water bodies by leaseholders and others is not particularly strong, facilitating access for opportunistic fishermen. In Table 4.3 above, the high proportion of catches (by value) in the region going to subsistence fishermen from *beel* is particularly noteworthy. Over 62% of the value of catches from *beel* were accounted for by subsistence fishermen, roughly the same as that for floodplains. Many of the *beel* in the region are seasonal and not leased out, while those that are leased tend to be, at best, loosely supervised, either because the traditional fishermen cannot effectively enforce their rights or because the water bodies are not productive enough to justify the extra expense required for protection.

North West

The contrast with the North West Region could not be more marked. Here subsistence fishing plays a relatively minor rȯle. On *khal* about a quarter of the value of catch is taken by the subsector, but on *beel* only 6% is accounted for by subsistence fishermen. This reflects the larger, more deeply flooded areas which dominate the floodplains in the areas studied by FAP 17, the greater control exerted over the more productive fishing grounds by leaseholders and the social attitudes towards fishing which dominate.

The floodplains around Gandahasti *Beel* in Pabna District and in the Chalan *Beel* area are extremely extensive and relatively difficult to access during the floods and drawdown. Taking up fishing therefore requires more investment in time and money to acquire the proper gear and means of reaching fisheries resources. In many areas, those resources are tightly controlled by leaseholders and the professional fishermen, both Hindu and Muslim, who work for them. In order to take up fishing, households have to be willing to accept a fall in social status and, quite possibly, considerable ostracism from their neighbours. As a result, those that do turn to fishing, out of necessity or lack of alternatives, tend to fish more intensively, making them seasonal as opposed to subsistence fishermen.

Only around 30% of all landholding categories are generally involved in subsistence fishing. A relatively large proportion of most subsistence gear users are farmers and the involvement of labourers is more limited. Those who turn to fishing they do so as a regular source of income.

North East

In the North East, a different situation again prevails. On the one hand, the deep and sustained flooding to which the *haor* basin is subject creates considerable opportunities for fishing of all kinds. Natural conditions out in the *haor* may be somewhat unfavourable to subsistence gear users as the distances are great and water depths frequently higher than in many other areas. Around 50% of landless households are engaged in some subsistence fishing during the year, and even higher proportions of farmers.

Higher levels might have been expected given the abundance and ubiquity of the fisheries resources in the region, but the productivity of the resource attracts much higher levels of control by leaseholders and the fishermen working for them. This leaves more limited areas open to subsistence exploitation. The distribution of catch value shown in Table 4.3 illustrates this clearly. Whereas the proportions of rural households involved in fishing are not that much lower that in the North Central Region (about 57% as opposed to 61%) the proportion of the catch value which is taken by subsistence fishermen is dramatically less - between 15-20% on *khal* and floodplains and less than 10% on *beel* - whereas in the North Central the proportions are 44% for *khal* and 62% for floodplains and *beel*.

South West

The characteristics of subsistence fisherles in the South West Region are, in some respects, more similar to those in the North Central Region: relatively large numbers involved; easy access to extensive areas of floodplain and *beel*, and a more even distribution of catch value across different fishing categories. What is noticeable, however, is the relatively low proportion of landless households engaged in subsistence fishing. The main reason for this appears to be the greater levels of involvement in seasonal fishing for income. For many landless households in the region the options during the summer floods are limited to migration to urban areas to seek work or movement into fishing. As a result, the numbers of labourers who limit themselves purely to subsistence fishing are relatively low, at around 29%.

The limited amount of catch by value going to the subsistence subsector from floodplains and *beel* is particularly noticeable, although it is more than made up for by the very high proportion being taken by seasonal fishermen who, more than in other areas, tend to replace subsistence fishermen.

4.3.3 Seasonal fishermen

This category presents the greatest problems in terms of definition. The line dividing those involved in fisheries on a purely opportunistic basis, whether for income or consumption, from those for whom fisheries represents a more consistent part of their livelihood strategy and in which they invest time and resources on a regular basis is often difficult to draw.

As discussed above for subsistence fisheries, a large number of people living in floodplain areas fish seasonally when the annual floods make the fisheries resource accessible to practically everyone. Even those fishing exclusively for household consumption may sell or barter some of their catches when they have more than can be immediately consumed. For certain brief periods when fish are particularly easily caught, such as during the flood recession or the early flood season in the *haor* basin, large numbers of people who would not normally fish or admit to any dependence on fish may actually earn considerable amounts from intensive fishing over short periods.

As a general rule, however, "subsistence" fisheries are highly opportunistic and dependent on annual patterns of flooding. Those who actually involve themselves in seasonal fishing as a source of livelihood on a regular basis from year to year, and invest more substantial resources in fishing, are more clearly defined as a group. The majority of these are Muslims who have had to overcome the strong social stigma attached to fishing as an occupation before taking it up on a routine basis.

The development of seasonal fisheries

Before the 1970s, the numbers of people who would have fallen into this group was probably negligible. However, from that period on, in response to periods of crisis due to flooding or famine or simply due to the steady increase in competition for land and labour, groups of landless or small farming households started fishing on a more regular basis during the floods and drawdown. This often occurred in spite of intense social pressure from their co-religionists who regarded the involvement of anyone from their village in fishing as impinging on the status of the community at large. As is discussed later, the decline in the numbers of Hindu traditional fishermen, largely due to out-migration, has also played a role in encouraging this shift.

Those people who have overcome the social barriers surrounding involvement in fisheries by "non-fishermen" have often tended to make it worth their while and fish relatively intensively during the period when fisheries resources are accessible to them. This pattern was particularly pronounced in the North West Region. Undoubtedly, the expanded availability of a relatively cheap gear which requires little expertise in operation (*current jal* or monofilament gill net) also facilitated the involvement in fishing of more and more people.

Seasonal fishermen have generally started out by targeting areas of the floodplain not fished by traditional fishermen: higher parts of the floodplain during the floods; drawdown fisheries and peripheral water bodies such as the channels (*halot*), ditches (*maital*) and other areas which are not generally subject to traditional fishing rights. Where flood control, and other factors, have reduced higher-value fisheries, the area fished by traditional fishermen and regulated by leasing has been reduced, creating greater opportunities for these seasonal fishermen.

Perhaps more importantly, the steady exodus of Hindu fishermen from Bangladesh ever since Partition has left open the option of exploitation of the deeper and richer water bodies such as *beel* and rivers. If Muslims are willing to ignore the social consequences of being recognised as *jele* and are willing to invest time and money in acquiring the equipment and skill required, the level of competition with traditional fishermen has steadily been reduced over the years by the declining numbers of Hindu fishermen in many parts of the country. Even where traditional fishing communities are still active, they are generally easily displaced by the increasingly numerous seasonal fishermen.

Seasonal or professional

Considerable numbers of these "seasonal" fishermen are now effectively "professional" and may be involved in different fisheries practically all year round. However their fishing strategies, the gears they use and their relationship with fisheries institutions and regulations continue to be very different from the traditional "professional" fishermen discussed below although they are playing an important role in displacing traditional fishermen from their fishing grounds.

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Regional variations

Table 4.2 above shows the proportions of different landholding categories in the main (non-fishing) villages involved in fishing for income. In some particular communities studied by FAP 17 (in the North Central, North West and South West regions) these figures inevitably include some non-traditional fishermen who effectively fish all year round. But the majority of those who fish for income in the agricultural villages studied do so on a purely seasonal basis.

Table 4.5 shows the characteristics, region by region, of the users of those fishing gears which tend to be most used by seasonal fishermen. Across all regions, the extent to which the small-mesh monofilament gill net, *current jal,* is the gear of choice for a large portion of this category of fishermen, is clear. The relatively low investment required, the simplicity of operation, its flexibility in terms of where it can be used and the limited amount of labour required for operation, have made this gear extremely popular in spite of the fact that its use is illegal.

North Central

Seasonal fishing in the North Central Region is considerably less widespread than the high numbers of subsistence fishing might lead to expect, with only about 15% of landless and 10% of small farming households having some dependence on fishing as a source of livelihood. This may in part be due to the greater opportunities for other sources of employment particularly among landless households and labourers, as explained above. However, of those who are engaged in seasonal fishing for income, a relatively high proportion are landless, whereas for subsistence fishing, farmers are more heavily involved, as might be expected.

Several specific fisheries offer particular opportunities for seasonal fishermen in this area. The *shangla jal* fishery for *ilish* on the Padma River attracts a high level of activity with seasonal fishermen accounting for over 50% of the users of this gear and 34% of all catch by value on the main rivers where it is utilised.

North West

In contrast to the North Central Region, seasonal fishing is extremely important in the North West. Around 30% of all the households enumerated in FAP 17 agricultural villages had some kind of dependence on fisheries for their livelihoods. On the principal fisheries habitats

Table 4.5
Social and economic characteristics of seasonal gear users in different regions

NORTH CENTRAL REGION

Gear category (English)	Gear name (Bengali)1	Religion of gear users (%)		Fishing categories of gear users (%)			Gear users' first ranked source of income (%)				
		Hindu	Muslim	Prof.	Seas.	Subst.	Fishing	Farming	Labour	Trade	Other
Gill net	*current jal*	6.0	94.0	19.2	40.5	40.4	19.1	16.8	50.6	8.0	5.5
	koi / fashi jal	11.7	88.3	30.2	48.6	21.3	30.1	12.6	48.0	7.1	1.9
	monofilament gill net	6.1	93.9	77.5	20.2	2.3	77.6	8.2	11.3	2.7	0.3
Clap net	*shangla jal*	14.7	85.3	34.2	51.5	14.3	34.1	22.4	33.8	9.7	5.0
Trap	*doiar*	5.3	94.7	24.5	33.7	41.8	24.5	13.8	45.4	10.4	5.8
Hook/lines	*daun*	8.3	91.7	33.0	44.7	22.3	33.1	10.7	49.0	4.7	2.5

NORTH WEST REGION

Gear category (English)	Gear name (Bengali)1	Religion of gear users (%)		Fishing categories of gear users (%)			Gear users' first ranked source of income (%)				
		Hindu	Muslim	Prof.	Seas.	Subst.	Fishing	Farming	Labour	Trade	Other
Gill net	*current jal*	4.3	95.7	51.1	38.2	10.6	51.2	15.4	30.6	1.7	1.1
	koi / fashi jal	6.1	93.9	64.9	26.5	8.7	64.9	10.6	18.8	4.5	1.2
	monofilament gill net	17.5	82.5	71.3	26.7	2.0	71.2	6.5	16.4	3.8	2.0
Seine net	*deol*	3.4	96.6	6.2	34.2	59.5	6.3	62.2	24.5	1.7	3.2
	moi jal	16.3	83.7	65.9	26.4	7.7	65.9	6.4	20.4	2.0	5.3
	baoli	10.2	89.8	67.6	25.4	6.9	67.9	11.1	19.9	0.7	0.7
Bag net	*suti jal*	27.7	72.3	67.0	26.4	6.6	67.1	10.9	7.3	13.0	1.8
Lift net	*dharma jal*	1.4	98.6	7.8	67.8	24.5	7.7	43.0	26.8	12.1	10.4
Trap	*deal*	1.2	98.8	6.0	52.7	41.1	6.1	32.3	43.5	10.7	7.4
	doair	1.9	98.1	42.5	42.5	14.9	42.7	22.7	26.6	5.4	2.7
Hook/lines	*sip*	2.7	97.3	7.7	33.3	59.1	7.6	34.8	32.6	11.7	13.4
	tana barsi	27.4	72.6	24.6	22.6	52.7	24.6	15.4	13.6	25.4	20.9
	daun	7.8	92.2	54.9	37.7	5.5	56.9	6.0	33.6	3.0	0.6
	nol barsi	3.4	96.6	37.9	486.0	13.4	38.0	11.0	46.5		4.5
Cast net	*jhaki jal*	21.6	78.4	48.5	29.7	21.8	48.5	17.7	21.9	5.5	6.4
Push net	*thella jal*	1.6	98.4	11.0	44.0	44.9	11.1	36.5	38.2	6.0	8.2
Miscellaneous	hand fishing	1.9	98.1	4.4	27.7	67.9	4.4	48.0	32.5	5.3	9.7
	akra	2.2	97.8	44.2	38.8	17.0	44.2	10.3	40.3	1.2	4.0

NORTH EAST REGION

Gear category (English)	Gear name (Bengali)1	Religion of gear users (%)		Fishing categories of gear users (%)			Gear users' first ranked source of income (%)				
		Hindu	Muslim	Prof.	Seas.	Subst.	Fishing	Farming	Labour	Trade	Other
Gill net	*current jal*	8.9	91.1	65.5	27.4	7.2	65.4	20.8	11.1	1	3.2
	koi / fashi jal	6.7	93.3	72.9	22.3	4.8	72.9	18.1	5.9	1.7	1.7
Seine net	*deol*	22.9	77.1	19.5	28.9	51.9	19.6	53	18.2		3.2
Cast net	*jhaki jal*	15.1	84.9	54.8	27.6	17.6	54.8	20.6	17.7	2.9	2.6
Push net	*thella jal*	16.6	83.4	33.1	20.9	46.1	33.1	38.2	20.1	1.1	7.4

SOUTH WEST REGION

Gear category (English)	Gear name (Bengali)1	Religion of gear users (%)		Fishing categories of gear users (%)			Gear users' first ranked source of income (%)				
		Hindu	Muslim	Prof.	Seas.	Subst.	Fishing	Farming	Labour	Trade	Other
Gill net	*current jal*	47.7	52.3	47.9	38.8	13.2	48.0	22.9	24.0	4.0	1.2
	koi / fashi jal	55.8	44.2	63.2	27	9.8	63.3	18.1	15.1	3.1	0.3
	monofilament gill net	39.5	60.5	70.5	26.9	2.6	70.5	4.0	24.3	1.3	
Seine net	*moi jal*	35.5	64.5	69.4	26.5	4.1	69.4	6.4	21.1	2.5	0.6
Lift net	*dharma jal*	53.3	46.7	16.0	33.4	50.7	16.0	32.0	44.0	4.0	4.0
Trap	*doair*	49.4	50.6	49.9	36.8	13.2	50.0	24.0	19.5	5.7	0.7
	polo	48.4	51.6	17.2	31.3	51.5	17.2	42.2	26.6	12.5	1.6
Hook/lines	*sip*	53.9	46.1	18.7	20.9	60.3	18.7	27.2	33.7	13.5	6.8
	daun	38.9	61.1	62.5	35.0	2.5	62.5	11.1	20.4	6.0	
	nol barsi	56.4	43.6	57.8	34.7	7.4	57.8	13.9	24.3	3.2	0.7
Spear	*koch*	58.7	41.3	18.4	31.5	50.1	18.4	39.8	27.9	8.5	5.4
Cast net	*jhaki jal*	35.5	64.5	15.1	22.0	62.9	15.1	37.3	27.1	14.5	6.0
Push net	*thella jal*	8.6	91.4	8.3	16.8	74.9	8.3	38.2	31.0	17.8	4.7

Source : FAP 17 Fisheries Studies

1 The gears shown are those where more than 20% of the gear users ennumerated during FAP 17 catch assessment surveys claimed to be fishing for subsistence only

available to these seasonal fishermen who do not usually have official access rights, i.e. secondary rivers, *khal*, and floodplains the subsector accounts for between 35-40% of catch by value.

While the *current jal* and other small gill nets play the most important role for these fishermen, the range of gears used by this group in the North West is far greater. Apart from the large seine nets, the gear used by seasonal fishermen is also closer to that used by many Muslim professional fishermen in the area.

North East

Seasonal fishermen represent a relatively minor category in the North East Region. They account for about a quarter of catches by value on floodplains and *khal* but are almost completely excluded from the key fisheries on the *beel* and from access to rivers. This reflects above all the tight control on fisheries access exerted by leaseholders in the *haor* basin. This restricts the area available for exploitation on a seasonal basis. A considerable proportion of whatever seasonal fishing is carried out is "illegal" and entails considerable risks as leaseholders are not gentle when it comes to enforcing what they regard as their rights. The range of gears used is, predictably, also small.

South West

The South West Region seems to offer among the best opportunities for non-fishermen to exploit fisheries on a routine, if not year-round, basis and make fishing a regular part of their livelihood for at least part of the year.

Seasonal fishermen account for about the same proportion of catch by value as do professional fishermen on most habitats including on the main rivers such as the Arial Khan and the Padma, and on *beel*. On the latter, seasonal fishermen account for no less than 51% of catch by value.

Much of this is due to the relative lack of leased areas in the *beel* in the South West. A large proportion of the main *beel* areas are flooded only to shallow depths and dry up almost completely during the winter dry season. As a result the areas under *jalmahal* are fewer and the seasonally flooded land can be freely exploited by fishermen.

Farmers and labourers both fish although it is especially important for landless households.

The lack of alternative opportunities for many landless households in the area also encourages many people to move into fishing as a seasonal stop-gap during the summer months. Among landowners, many are involved in the seasonal exploitation of submersible ponds and fish pits (*kua*) which can contribute significantly to household income.

4.3.4 Women in subsistence and seasonal fisheries

Women in rural communities are often disproportionately reliant on the exploitation of open-access, common resources as their formal rights to land and other privately-held resources is frequently very limited. Such reliance on common resources often increases in direct proportion to the relative poverty of the household. The possibility of a particular reliance of women from poor rural households on fisheries, particularly when they are themselves heads of those households, needs to be considered.

Overall, the involvement of women in capture fisheries in rural Bangladesh is relatively limited. The regulation of women's exposure to the world outside the confines of the household tends to be limited, at least notionally, by the dictates of *purdah*. Fishing, as an activity, generally requires movement in a very open and exposed environment and this is enough to discourage the involvement of many women once they have reached adolescence.

However, *purdah* is, above all, an ideal of female behaviour which, especially among poorer sections of rural society, is in direct conflict with the day-to-day necessities of survival. While the idea of the women exposing themselves to the view of strangers in an area of open water may be frowned upon, at least by the men in the household, women in many areas of the country are more and more inclined to seek work and contribute to the household's livelihood. It is particularly noticeable that in areas where there has been intensive NGO activity with women's groups, such as in the North Central Region around Manikganj, more women are seen engaged in fishing as the taboos against women being seen in the open are being eroded.

In areas where *purdah* is more strictly enforced, women's involvement in fishing is usually extremely limited. They may participate in fishing in ditches and ponds immediately adjacent to the homestead, but they are unlikely to venture further afield.

Older women, particularly widows in conditions of dire need, are frequently seen fishing, almost exclusively with rod and line, in small water bodies near homesteads. However, the fact that they generally take care to choose areas which are away from public view and as hidden as possible is indicative of the sense of shame which is attached to being driven to such an activity.

4.3.5 Professional fishermen

Until relatively recently, "professional" fishermen in Bangladesh have represented a distinct group of exploiters of fisheries resources. Their prime characteristic was that they distinguished themselves as *jele,* a term which, for anyone except a member of a well-established, traditional fishing community, would only be used with extreme reluctance as it carries significant negative social connotations in relation to the rest of rural society. The term "traditional" could also be used to define the group and distinguish it from the growing community of "non-traditional" fishermen who effectively fish full-time and are becoming "professional."

Some of the apparent reasons for this are discussed below, but the extent to which this situation is true is now changing. In most areas, these "traditional" fishermen are rapidly being outnumbered by new entrants to the fishery who are mostly Muslim farmers or labourers who have moved into fishing in spite of the negative social connotations of the occupation and their relative lack of skills and knowledge regarding the fisheries resource.

Table 4.6 shows the gears commonly associated with professional fishermen and the characteristics of those fishermen who use them in each region. Note that in this table, the figures for proportions of gear users who are professional fishermen is divided into two categories: the first for those whose sole occupation is fishing, the second for those for whom it is the principal, but not the only, source of household income. This helps to show the extent to which the category of professional fishermen has come to include many non-traditional fishermen who may have other sources of income as well as fishing.

The social status of fishing as an occupation

Historically, fishing as an occupation has been associated with specific castes in Hindu society. These traditional, caste fishermen have tended to live as distinct communities clearly set apart from the rest of rural society although closely interdependent with them. The *jele para* is generally either a distinct hamlet set away from the rest of the village, or a closely knit unit within a larger village.

Table 4.6
Social and economic characteristics of professional gear users in different regions

NORTH CENTRAL REGION				Fishing categories of gear users (%)				Gear users' first ranked source of income (%)				
Gear category (English)	Gear name (Bengali)1	Religion of gear users (%)		Prof.2								
		Hindu	Muslim	1	2	Seas.	Subst.	Fishing	Farming	Labour	Trade	Other
Gill net	*koi / fashi jal*	11.7	88.3	14.7	15.5	48.6	21.3	30.1	12.6	48.0	7.1	1.9
	monofilament gill net	6.1	93.9	27.3	50.2	20.2	2.3	77.6	8.2	11.3	2.7	0.3
Seine net	*ber jal*	79.9	20.1	87.0	7.4	4.7	1.0	94.4	0.5	2.0	3.2	-
	kathi jal	49.1	50.9	56.3	10.9	19.3	13.5	67.3	6.1	24.3	-	2.4
	moi jal	42.1	57.9	52.2	27.2	11.2	9.4	79.4	4.9	10.0	3.9	1.8
Bag net	*suti jal*	93.8	6.2	97.0	-	-	3.0	97.0	-	3.0	-	-
Lift net	*veshal*	79.9	20.1	85.1	1.6	9.5	3.9	86.7	1.6	7.7	3.3	0.7
Clap net	*shangla jal*	14.7	85.3	10.4	23.8	51.5	14.3	34.1	22.4	33.8	9.7	5.0
Trap	*doiar*	5.3	94.7	24.5	10.1	14.4	41.8	24.5	13.8	45.4	10.4	5.8
Hook/lines	*tana barsi*	16.4	83.6	18.8	19.6	8.1	53.4	38.5	11.4	26.6	13.8	9.8
	daun	8.3	91.7	12.6	20.4	44.7	22.3	33.1	10.7	49.0	4.7	2.5
Cast net	*jhaki jal*	54.6	45.4	53.9	1.7	4.3	40.0	55.7	17.3	15.0	8.4	3.7

NORTH WEST REGION				Fishing categories of gear users (%)				Gear users' first ranked source of income (%)				
Gear category (English)	Gear name (Bengali)1	Religion of gear users (%)		Prof.2								
		Hindu	Muslim	1	2	Seas.	Subst.	Fishing	Farming	Labour	Trade	Other
Gill net	*current jal*	4.3	95.7	29.3	21.8	38.2	10.6	51.2	15.4	30.6	1.7	1.1
	koi / fashi jal	6.1	93.9	22.4	26.5	26.5	8.7	64.9	10.6	18.8	4.5	1.2
	monofilament gill net	17.5	82.5	23.4	26.7	26.7	2.0	71.2	6.5	16.4	3.8	2.0
Seine net	*ber jal*	59.0	41.0	84.5	11.2	4.4	-	95.6	1.0	1.6	1.7	-
	moi jal	16.3	83.7	44.2	21.7	26.4	7.7	65.9	6.4	20.4	2.0	5.3
	baoli	10.2	89.8	44.1	23.5	25.4	6.9	67.9	11.1	19.9	0.7	0.7
Bag net	*suti jal*	27.7	72.3	55.5	11.5	26.4	6.6	67.1	10.9	7.3	13.0	1.8
Lift net	*veshal*	61.1	38.9	84.6	8.4	6.7	0.4	92.9	2.7	3.3	0.8	0.4
Trap	*doair*	1.9	98.1	24.0	18.5	42.5	14.9	42.7	22.7	26.6	5.4	2.7
Hook/lines	*tana barsi*	27.4	72.6	24.6	17.7	6.9	52.7	24.6	15.4	13.6	25.4	20.9
	daun	7.8	92.2	54.9	22.0	37.7	5.5	56.9	6.0	33.6	3.0	0.6
Cast net	*jhaki jal*	21.6	78.4	48.5	36.0	12.5	21.8	48.5	17.7	21.9	5.5	6.4
Miscellaneous	*akra*	2.2	97.8	44.2	17.0	38.8	17.0	44.2	10.3	40.3	1.2	4.0

NORTH EAST REGION				Fishing categories of gear users (%)				Gear users' first ranked source of income (%)				
Gear category (English)	Gear name (Bengali)1	Religion of gear users (%)		Prof.2								
		Hindu	Muslim	1	2	Seas.	Subst.	Fishing	Farming	Labour	Trade	Other
Gill net	*chandi jal*	-	100	65.7	14.3	11.5	8.6	80	11.4	5.7	2.8	-
	current jal	8.9	91.1	47.4	18.1	27.4	7.2	65.4	20.8	11.1	1	3.2
	koi / fashi jal	6.7	93.3	44.3	28.6	22.3	4.8	72.9	18.1	5.9	1.7	1.7
Seine net	*ber jal*	25.7	74.3	77.5	16.1	5.4	1	93.6	3.9	1.7	0.8	-
	uttar jal	13.5	86.5	70.4	24.9	4.7	-	95.3	2.7	1.5	0.5	-
	dora jal	34.0	66.0	84.2	11.6	4.3	-	95.7	2.5	0.9	0.9	-
Bag net	*ghori jal*	1.0	99.0	77.4	17.0	1.0	4.6	94.3	4.2	-	1.5	-
Lift net	*veshal*	5.0	95.0	83.8	12.5	2.7	1.1	96.1	2.4	0.9	0.3	0.3
Clap net	*shangla jal*	28.6	71.4	61.2	32.7	6.1	-	94.0	2.0	2.0	2.0	-
Trap	*doair*	46.4	53.6	31.3	36.3	27.5	5.0	67.6	17.6	12.1	-	3.1
Hook/lines	*sip*	4.0	96.0	17.6	12.8	18.0	51.6	30.5	25.7	29.3	3.1	31.7
	tana barsi	10.5	89.5	31.3	29.2	18.7	20.7	60.5	27.0	8.3	-	2.6
	nol barsi	4.5	95.5	94.0	1.4	2.9	1.6	95.5	1.6	2.9	-	-
Cast net	*jhaki jal*	15.1	84.9	43.4	11.4	27.6	17.6	54.8	20.6	17.7	2.9	2.6
Push net	*thella jal*	16.6	83.4	23.0	10.1	20.9	46.1	33.1	38.2	20.1	1.1	7.4
Miscellaneous	dewatering	4.4	95.6	26.4	7.6	7.2	58.8	34	52.2	6.9	-	7.7

SOUTH WEST REGION				Fishing categories of gear users (%)				Gear users' first ranked source of income (%)				
Gear category (English)	Gear name (Bengali)1	Religion of gear users (%)		Prof.2								
		Hindu	Muslim	1	2	Seas.	Subst.	Fishing	Farming	Labour	Trade	Other
Gill net	*current jal*	47.7	52.3	2.2	45.7	38.8	13.2	48.0	22.9	24.0	4.0	1.2
	koi / fashi jal	55.8	44.2	60.9	27.0	27.0	9.8	63.3	18.1	15.1	3.1	0.3
	monofilament gill net	39.5	60.5	28.8	26.9	26.9	2.6	70.5	4.0	24.3	1.3	-
Seine net	*ber jal*	55.5	44.5	33.3	47.7	18.3	0.7	81.0	7.6	8.3	3.1	-
	moi jal	35.5	64.5	16.6	52.8	26.5	4.1	69.4	6.4	21.1	2.5	0.6
Lift net	*veshal*	78.6	21.4	28.5	52.9	17.6	1.0	81.4	10.1	7.2	1.3	-
Clap net	*shangla jal*	1.2	98.8	6.5	36.8	49.5	7.1	43.4	17.7	37.6	0.7	0.6
Trap	*doair*	49.4	50.6	5.9	44.0	36.8	13.2	50.0	24.0	19.5	5.7	0.7
Hook/lines	*daun*	38.9	61.1	19.5	43.0	35.0	2.5	62.5	11.1	20.4	6.0	-
	nol barsi	56.4	43.6	51.9	34.7	34.7	7.4	57.8	13.9	24.3	3.2	0.7

Source : FAP 17 Fisheries Studies

1 Gears shown are those where more than 20% of the gear users claimed to have fishing as their sole or main source of household income
2 Professional fishermen are divided into the following sub-categories :
1 - fishing as sole source of household income : 2 - fishing as main source of household income

In traditional Hindu society this was clearly a function of their involvement in an "unclean" activity i.e. fishing. This may be due to a number of factors: fishing involves killing animals, which generally is a polluting activity; fishing may also cause pollution because it involves immersion in water, which can both pollute and cleanse; perhaps fishing is, more importantly, a hunting activity which places it outside the structured world of the Hindu agricultural community. It is worth noting that even within fishing there appear to be gradations in status, although the exact order of different fishing groups depends very much on who you are talking to. The riverine fishermen on the main rivers seem to occupy pride of place as they use larger, more expensive technology and seem to belong to old fishing castes. There may even be a connection with the fact that they spend less time actually in the water and fish from boats. Other groups involved in *beel* and floodplain fisheries tend to spend more time immersed in the water to operate their gears and this seems to be reflected in their status. It is also notable that many of these fishing castes or groups seem to be more recent entrants into fisheries.

Table 4.7 reviews some of the principal traditional fishing groups, where they are found, the habitats they exploit, the gears they use and provides a very brief note on what is known of their background.

Changes in participation in "professional" fishing

Until the 1970s, most professional fishermen in Bangladesh were also "traditional" fishermen. Fishing as an occupation and principal source of livelihood was almost entirely limited to specific social groups whose position in society and identity as a community was defined by their involvement in fishing. These traditional fishermen are frequently thought of as being almost all Hindu, but, as shown in Table 4.7, in many areas of the country, there are extensive communities of Muslim "traditional" fishermen who are either Hindu fishing communities who have converted to Islam at some point in the past or poor Muslim communities which have been involved in fishing for so many generations that they have become traditional fishermen and effectively occupy the same social niche.

However, during the 1970s a combination of rising population, the accompanying increase in competition for all resources and the out-migration of many traditional Hindu fishermen to India seem to have created the circumstances which have encouraged more and more non-traditional fishermen to turn to fishing as a means of livelihood. As mentioned above, many have concentrated on purely seasonal activity. But, once they have entered the fishery, a sizeable proportion of Muslim agriculturalists have realised that it is potentially lucrative and have effectively become full-time fishermen.

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Table 4.7
Terms used with reference to castes or groups of professional fishermen

Name of caste or group associated with fisheries	Religion	Regions where active	Habitats exploited	Gears used	Current status	Notes on origins
bagdi	Hindu	NC / SW	*khal, beel, floodplain*	small gear, spears, traps, barriers	Very minor fishing group. Limited secure access to water bodies	Originally a caste of agricultural labourers brought to work on the indigo plantations from West Bengal during the 19th Century. Turned to fishing after partition.
barman	Hindu	NC / NW NE / SW	main & secondary rivers, *khal*	large seine nets and gill nets, cast nets, lift nets	Important fishing caste. Tradition of access control on some important rivers.	Apparently one of the original fishing castes in the country. Certainly the group with some of the most profound cultural traditional associated with fishing. Very active on many of the most important rivering fisheries on the Padma and Meghna rivers.
gain	Hindu	SW	*beel, floodplain, khal* & secondary rivers	seine nets, current jal, traps, lift nets, guiding barriers	Apparently important in limited areas of the South West, particularly in the Madaripur beel tracts	Apparently a namasudra subcaste not necessarily involved in fishing, but in some areas, regarded as jele.
haldar	Hindu	NC / NW / SW	N.A.	N.A.	N.A.	A rather deceptive term used in different ways by different groups. For non-fishermen, it is generally used to refer generically to Hindu traditional fishermen. By non-riverine Hindu fishermen, it is generally used to refer to riverine traditional Hindu fishermen i.e. barman or malo, particularly on the Padma and Ganges rivers. Among the barman and malo fishermen it is used to refer to the hear fishermen or skipper" of a fishing team on the river. It is not the name of a caste.
jala das	Hindu	NC / NW / SW / SE	main & secondary rivers, estuaries, beel	seine nets, gill nets, bag nets	Certainly important on the Lower Meghna River, possibly elsewhere.	Perhaps a sub-caste of the kaibarta das caste fishing groups, but this may be simply a generic term for fishermen ["net" (jala) das as opposed to "plough" (halia) das].
jele / jaola / jeola	Hindu or Muslim	everywhere	N.A.	N.A.	N.A.	Generic bangla term for fishermen.
jiani	Muslim	NW / SW	*beel, khal & floodplain*	traps, guiding barriers, small seine nets, lift nets	Generally in beel areas such as Chalan beel and the Madaripur beel tracts.	Derogatory term used to refer to Muslim professional fishermen. Particularly used around Chalan beel.
kaibarta das	Hindu	NC / NW NE / SW	main & secondary rivers, *beel, khal, floodplain*	various	Seem to be found all over the country but concentrated along lower Meghna.	Hindu caste fishermen, probably one of the largest of the fishing castes. Frequently also involved in fish trading.
maimul	Muslim	NE	*beel, khal, floodplain*	large seine nets, lift nets, gill nets, cast nets, lines	Generally fishing on beel in the haor region of the North East.	A caste-like group of traditional Muslim fishermen specific to the North East Region. Also used more generically for anyone from the region associated closely with fisheries, including fish dealers and leaseholders.
malo	Hindu	NC / NW / SW	main & secondary rivers	large seine nets, large gill nets, lift nets	Important fishing caste. Tradition of access control on some important riverine fisheries.	A traditional Hindu fishing caste apparently very close to the barman. Particularly associated with riverine fisheries, whether on main or secondary rivers.
matsya das	Hindu	NE	main & secondary rivers, *beel, khal, floodplain*	seine nets, gill nets, lines, lift nets cast nets	One of principal Hindu fishing groups in the North East Region.	This may simply be a regional name for the kaibarta das caste.
namasudra	Hindu	NE / SW	*beel, floodplain, khal*	small seine nets, current jal, cast nets	Encountered as "fishermen" in the North East and South West in particular, but common throughout the country in other occupations.	A generic term for a large group of sudra sub-castes, some of whom engage in fishing. However, not a "fishing caste" as such. Some of these sub-castes engaged in fishing have different names of their own (see gain). Mostly commonly referred to in the haor basin for non-traditional Hindu fishermen other than matsya das or patni.
nikari	Muslim	NC / NW NE / SW	N.A.	N.A.		Usually a generic term for fish traders but also sometimes used generally for Muslims involved in fisheries in any way.
patni	Hindu	NE	secondary rivers	N.A.		Hindu caste boatmen, but also involved in fisheries in some areas.
rajbangshi	Hindu	NC / NW / SW	*beel, floodplain, khal,* rivers	smaller seine nets, gill nets, current jal, cast nets	Widespread in the North Central and North West in particular.	A large caste of fishermen, apparently more recent entrants to the fisheries (perhaps over the last 150 years). They may be part of a tribal group which has mover onto the plains from the North West. Generally fishing internal water rather than rivers.

Source : FAP 17 Village Studies

There is considerable regional variation in the extent of this phenomenon as shown in Table 4.6.

Regional variation

North Central

Most Hindu fishermen in the North Central Region can be assumed to be traditional caste fishermen. Members of the *malo* and *barman* castes are generally active on the Padma and Jamuna rivers and the various secondary rivers which cross the region such as the Kaliganga and the Dhaleswari.

The many *rajbangshi* fishermen tend to fish more on the internal waters, such as *beel* and on floodplains. Some are increasingly involved in aquaculture as well. In addition, there does not seem to be a long tradition of Muslim involvement in fishing in this area, although this is rapidly changing.

It can be seen from Table 4.6 that, for certain gears, Hindu fishermen still make up the vast majority of the category 1 professional fishermen (no other source of income). For example, looking at the gear which perhaps most typifies traditional Hindu fishermen, 87% of all *ber jal* users are have no source of income besides fishing and 80% are also Hindu. Similar figures were recorded for several gears, such as the bag net *suti jal*, and the lift net *veshal*. All these can be regarded as relatively specialised gears requiring either high investments or special skills to be operated successfully.

However, for many of the other gears operated predominantly by "professional" fishermen it can be seen that the numbers of Hindu traditional fishermen involved in their operation are generally matched by the numbers of Muslim fishermen operating the same gear. Gears such as *kathi jal*, used for the harvesting of *katha*, and *moi jal*, a small seine net, are used as extensively by Muslim fishermen as they are by Hindu. While many of these Muslim fishermen are purely seasonal in their operations, more and more are working in fishing for longer periods of the year and may regard fishing as their main source of income.

Muslim "professional" fishermen are most likely to use similar gears to those used widely for seasonal fishing, particularly the monofilament gill nets, whether *current jal* or the larger mesh drift nets used on the main rivers, particularly for *ilish*.

North West

Measuring the extent to which professional fishing is being taken up by Muslim new entrants is more difficult in the North West Region as there are some areas covered by FAP 17 where there is a relatively long tradition of Muslims engaged in fishing, particularly in the Chalan *Beel* area. However, the high proportions of professional gears used by Muslim fishermen, many of whom also have alternative sources of income other than fishing is a clear indicator that many of these are probably relatively recent entrants to fisheries. As noted above, seasonal fishing is very widespread in the region and more and more of these seasonal fishermen seem to be moving into full-time fishing.

While *ber jal* and *veshal* fisheries are still the preserve of the traditional Hindu professionals and Muslim fishermen who have been in fishing for at least several generations, most of the other gears in use in the area are more commonly in the hands of Muslims who have recently taken to fisheries. Once again, the *current jal* and other gill nets are particularly popular among this group.

Some of the communities of Muslim fishermen who have a longer tradition of fishing, particularly in Chalan *Beel*, are specialised in fisheries specifically adapted to the vast expanses of shallowly-flooded seasonal floodplain in that area using a variety of traps. Other sections of the Muslim fishing community have specialised in the "harvesting" of the many residual water bodies left in the *beel* after the drawdown.

The history of these Muslim fishing communities, who have taken on many of the characteristics of the Hindu caste fishing communities, is not clear. Often they live in the same villages as declining Hindu fishing communities suggesting that they may be people who have moved into fishing over the 50 years as more and more Hindus have left.

North East

There is a very extensive traditional Muslim fishing community, the *maimul* community, in the *haor* basin. As can be seen in Table 4.6, Muslim fishermen dominate the professional subsector in the region to more or less the same extent as in the North West but a slightly higher proportion are completely dependent on fisheries. This is because of the near total dependence of this very extensive community of professional fishermen on fisheries.

Hindu fishermen have somewhat different patterns of gear use to those in other areas. Only some of the *hindu* fishing community in the North East seem to belong to true fishing castes, such as the *matsya das*. Other Hindus involved in fishing seem to be merely low-caste *namasudra* who fish using mostly gears not normally typical of "professional" Hindu fishermen. Note the high proportion of Hindus using *doiar*, a simple bamboo trap commonly used by seasonal and subsistence fishermen.

At least in the areas of the North East Region covered by FAP 17, the Muslim *maimul* are the dominant traditional fishing community. Many of these communities are linked to powerful local *mahajan* and leaseholders, some of whom come from the fishing community themselves. Given the strict control of leased water bodies which is typical of the region, those groups who are linked to the controllers of access to these water bodies are those who are most bound to fish.

The distribution of catch by value for the North East, shown in Table 4.3, indicates the importance of this in the region. On secondary rivers, such as the Manu, the Kushiyara and the Surma, and on *beel*, professional fishermen, who are mostly either *maimul* or Hindu caste fishermen, take over 80% of the value of the catch (although a considerable portion of this goes to the leaseholders rather than to the fishermen themselves). On the *khal* and floodplains, the figures are lower but still well over 50%.

South West

In the South West Region, the movement of Muslims into professional fishing has also been considerable. In some areas this may have quite a long history. It would seem that some parts of the Madharpur *Beel* tracts have always been considered so wild and remote that many of the traditional caste fishermen did not regularly exploit the potentially rich fisheries resources there. In addition, the relatively shallow flooding depths which predominate seem to have discouraged the involvement of professional fishermen who habitually used larger gears better suited for deeper water in local rivers.

As a result, many of the fisheries on *beel* and floodplain areas and on some of the *khal* which criss-cross the area have apparently always been the preserve of both Muslim and Hindu fishermen of varying degrees of professionalism. The high proportions of "professional" fishermen who have other sources of income is indicative of this. *Veshal*, the lift net used on *khal* and rivers which is frequently a gear used specifically by traditional Hindu fishermen, is used more by fishermen who have other sources of income.

One important feature which may also explain the apparent diversification of income sources professional fishermen in the region is the high level of aquaculture activity which is found there. During FAP 17 village studies several traditional *malo* communities were encountered who have shifted the focus of their activity from capture fisheries over to culture fisheries. This additional activity may be regarded as a source of livelihood "other than fisheries."

4.4 Other Beneficiaries from Fisheries

The beneficiaries from fisheries include not only those physically engaged in the catching of fish but all those who are involved in the various stages and levels of servicing the sector. Obviously, any changes in the fisheries resource is likely to affect these factors as well.

4.4.1 Traders

The lack of refrigeration in most rural areas and the overwhelming consumer preference for fresh fish means that the marketing of fish in Bangladesh offers enormous possibilities for employment and gain for a large number of people in both rural and urban areas.

The fish marketing system in Bangladesh is discussed in some detail in the Report on the Inland Fish Marketing System in Bangladesh, Supporting Volume No. 20 of the FAP 17 Final Report. However, in brief, it is clear that it is of great importance as a source of rural livelihood. The poor communications and transport in rural areas, linked with the need for rapid movement of fish once it has been caught, create a complex series of employment opportunities ranging from the simplest transport of individual baskets of fish from a landing place to a point of sale or collection to the complex systems of regional and national distribution controlled by large *aratdar* in the important urban centres.

Seasonal or opportunistic fish traders

Fish traders are as varied in terms of their degree of involvement as are fishermen in general. A large number of "subsistence" and "seasonal" fishermen are likely to become traders when they have occasional catch to dispose of and the sale or barter of fish is frequently carried out by the household members of the fishers themselves. Other rural households may regard fish trading as a seasonally important source of income in which they engage on a regular basis.

It is notable, however, that many of the attitudes regarding fishing apply even more strongly to fish trading. Some poor small farming or labouring households take advantage of the fact that larger traders to whom they sell are often willing to advance credit for the purchase of fish which would otherwise be impossible to obtain. Generally, however, fish trading seems to be left to traders associated with the fishing community. The sale of fish in markets is an even more "public" activity than the actual catching of fish and, while many children can be encountered in local *hat* all over the country during the flooding season selling small amounts of excess catch, many seasonal or subsistence fishermen who regard fishing as an additional source of income are apparently unwilling to be seen actually selling fish. Given these social attitudes, it is difficult to establish with precision to what extent involvement in fish trading might have been under-reported to researchers.

Professional fish traders

In addition to these "opportunistic" fish traders there are also groups of professional fish traders who are more or less completely dependent on fish trading as a source of income. These groups exist in various levels of the fish trading hierarchy.

On the one hand, there are specific communities in rural areas who are associated with fish trading. Sometimes these may be groups of traditional fishermen who, because of changes in local water bodies or competition with other fishers, have been forced out of fishing and have turned to fish trading as a substitute. Groups of Hindu fishermen who have turned to fish trading as a profession were encountered by FAP 17 researchers in several areas in the North Central and South West regions.

Significantly, the process can also function in the opposite direction, with groups of fish traders becoming increasingly involved in capture fisheries. In the North Central Region, near Saturia *Thana* headquarters, a community of *nikari*, in this case professional Muslim fish traders, had, over the past 20 years, turned increasingly to capture fishing on local *beel* and *khal* as the Hindu traditional fishermen who had exploited these water bodies in the past migrated out to India. They are now the most important group of fishermen in the immediate vicinity and have also become very active in fish culture in the area.

On another level are the fish traders based in urban centres who deal with the movement and sale of fish over wider areas. These *chalani* and *aratdar* can operate on many scales, from individual retailers to large-scale fish dealers with direct contacts to international markets.

4.4.2 Fish processors

The overwhelming preference of fish consumers in Bangladesh is for fresh fish. Although the infrastructure for ensuring that fresh fish can reach consumers is often limited, the ubiquity of fresh water resources, and the fish they contain, throughout the country, means that consumers are seldom very far from a source of fresh fish. This may explain why fish processing is not as developed an activity as might be expected. The sun-drying of fish is almost exclusively carried out when there is a glut and only for small, low-value species.

Drying of fish may be more common where households have excess catch which they wish to conserve for their own use. However, it seems more likely that households tend to convert any excess into cash or other goods given the ready market for most fish.

4.4.3 Leaseholders and landowners

Control or tenure of fisheries resources in Bangladesh has never resided in any formal sense with the fishermen who are physically responsible for catching fish. At the most, some water bodies such as the major rivers were "open" and no-one except traditional fishermen was interested or able to take advantage of the resources they contained. But fisheries in *beel*, *khal*, and even on some areas of floodplain have practically always been controlled, at least nominally, by land or water lords from whom the fishermen have had to obtain some form of permission to fish.

In some areas, those exercising control of fisheries resources have come from the traditional fishing community itself, but more frequently they have been local landowners, farmers and influential people who have little or nothing to do with fishing as an activity.

Current institutional arrangements for the leasing of fisheries *jalmahal* effectively perpetuate this situation. Those who catch fish directly are rarely able to muster the resources necessary to gain direct control of *khas* fisheries or, if they do formally control them, to enforce that control. As a result an additional stratum of leaseholders form an important part of the fisheries system. These are sometimes people with links to the fishing community, but more often they are rural *mahajan*, moneylenders, fish traders or simply businessmen investing in fisheries. The degree to which they involve themselves in the actual fishery varies, but for the most part it is limited. As competition for the resource increases, and the value of fisheries leases rises, the role of these fisheries financiers is becoming increasingly important.

In areas not under lease, which, when flooded, are theoretically open-access for fishing, the growing awareness of the value of the fisheries resource is encouraging land owners on the floodplains and along the banks of *khal* to establish tenurial claims to the water and fish which are found on and around their land during the floods. Through the excavation of fish pits (*kua*) and the placement of brush-piles (*katha*) which aggregate the fish as the flood waters recede, landowners are able to establish some control over fisheries resources and extract benefits from it without suffering the negative connotations of involvement in capture fisheries. Much of the actual fishing is still done by fishermen or labourers, but the benefits are further subdivided, with the "owner" of the resource taking a sizeable proportion.

This category of people who claim some kind of tenurial rights over the fisheries resource is growing steadily. FAP 17 researchers commonly encountered cases where those with some form of tenure, either through landowning or through fisheries leaseholding, were claiming an extension of that right to any fish which could end up, at the end of the flood season, being caught on their land. Thus landowners are increasingly claiming a right to exclude fishing both on and around their land areas when it is flooded. This is particularly so where submersible ponds or *kua* been excavated. Similarly, the holders of fisheries leases are tending to extend the area over which they claim control on the grounds that even if the water is not theirs, the fish are.

The characteristics of this particular group of resource users is of key importance in looking at the distribution of benefits from fisheries and, consequently, the distribution of impacts from changes in the fisheries. This is discussed in further detail in the next chapter.

4.4.4 Conclusions

The limits of any categorisation of the groups involved in floodplain fisheries in Bangladesh have to be recognised. The conditions are too diverse and too variable to permit anything but a very approximate set of groupings which can act as a guide in discussions of the fishing population. But certain characteristics of these groups are of particular importance when discussing the impacts of flood control.

1. Of most significance is the clear distinction between the various groups of traditional professional fishermen and the rest of the rural population that in some way makes use of fisheries resources. The fact that the traditional fishers in Bangladesh constitute a distinct

social, and often religious, group with clear characteristics in terms of their access to fisheries resources, the technology which they use and the social position which they occupy is of key importance in understanding the way in which the impacts of flood control are distributed.

2. The scale of the shift of many non-traditional fishermen into more-or-less full-time fishing needs to be appreciated. The last 30-40 years has seen the ratio between traditional fishermen and non-traditional but "full-time" fishermen engaged in fishing change radically. Immediately after partition, most fishing was done by traditional fishermen with only a small number of subsistence fishermen exploiting peripheral resources on an opportunistic basis. At present, professional but non-traditional fishermen are at least as numerous and frequently outnumber traditional fishermen on most fishing grounds. The exceptions are areas, such as the leased *jalmahal* on the *haor* in the North East and some parts of the North West, where leaseholders are sufficiently powerful and the resources sufficiently rich to make strict enforcement of access restrictions worthwhile.

3. Control of access is therefore one of the key factors determining who fishes and to what extent in Bangladesh. This is highlighted by the differences in the distribution of catch by value between different groups of fishermen from region to region. These differences are primarily a result of the differences in both the cultural background to fisheries access control and the levels of enforcement of those controls.

4. The numbers and groups of people involved in fishing, particularly in subsistence and seasonal fishing, varies greatly from season to season as the extent of flooding has a important impact on the ease of access to fisheries for non-professionals.

4.5 Income from Fisheries

The distribution of fishing income provides a basis for estimating the impact that any change in the total value of the fishery will have on different groups.

Significance of Fisheries Income to Different Groups - North Central

Professional fishermen in fishing villages

Analysis of the size and breakdown of the income of professional fishermen serves two important functions. First, their absolute income levels serve as a good indicator of their relative economic status and hence of their vulnerability to a decline in their fishing opportunities due to a change in either the fish stock or their access to it. Second, the relative contribution of their other economic activities determines their capacity to benefit from both the intended impacts achieved by flood control and from different types of mitigation measure.

Fishing communities were studied to ensure adequate coverage of professional fishermen, a group of principal importance to FAP 17 that was liable to be missed in any random sample of villages, due to clustering. The selection of fishing categories covered in monitoring was therefore strongly biased towards HFC1 and HFC2 households, the full-time professionals. However, in some communities, a significant proportion of households were found to be in transition from (or to) livelihoods chiefly dependent on capture fisheries. These (HFC3) households were therefore included. In North Central, this involved three of the seven fishing communities covered.

The average income for all the fishing communities monitored in North Central is presented in Table 4.8 and Figure 4.3 below. The average annual household income was about Tk.22,000, very similar to that of the agricultural villages within the region (see below). Of this, 41% came from capture fisheries. These figures disguise considerable variations between communities. The richest (NC3-2) had an average income of Tk.74,000, of which only 12.5% came from fishing; the poorest (NC3-3), which was in the same cluster, an average of less than Tk.14,000, with 60% from capture fisheries. Such variations may be more likely to occur between fishing than agricultural communities for a number of reasons, but the variation should be borne in mind when interpreting these results.

HFC1 households (which gave fishing as the only ranked source of income) had an average income of around Tk.19,000, of which over 90% came from fishing or fishing labour. This is very close to the average income of the landless in North Central.

HFC2 households, as was common across all regions, had higher average incomes (Tk.25,510) than HFC1. Returns from fishing were slightly less than those of HFC1 households and they earned less from fishing labour. But with a sizable average contribution from both fish culture and fish trading, fish related sources of income made up nearly 80% of the total. Farming (including crop cultivation and livestock) providing over Tk.4,000 (16%), more than North Central landless.

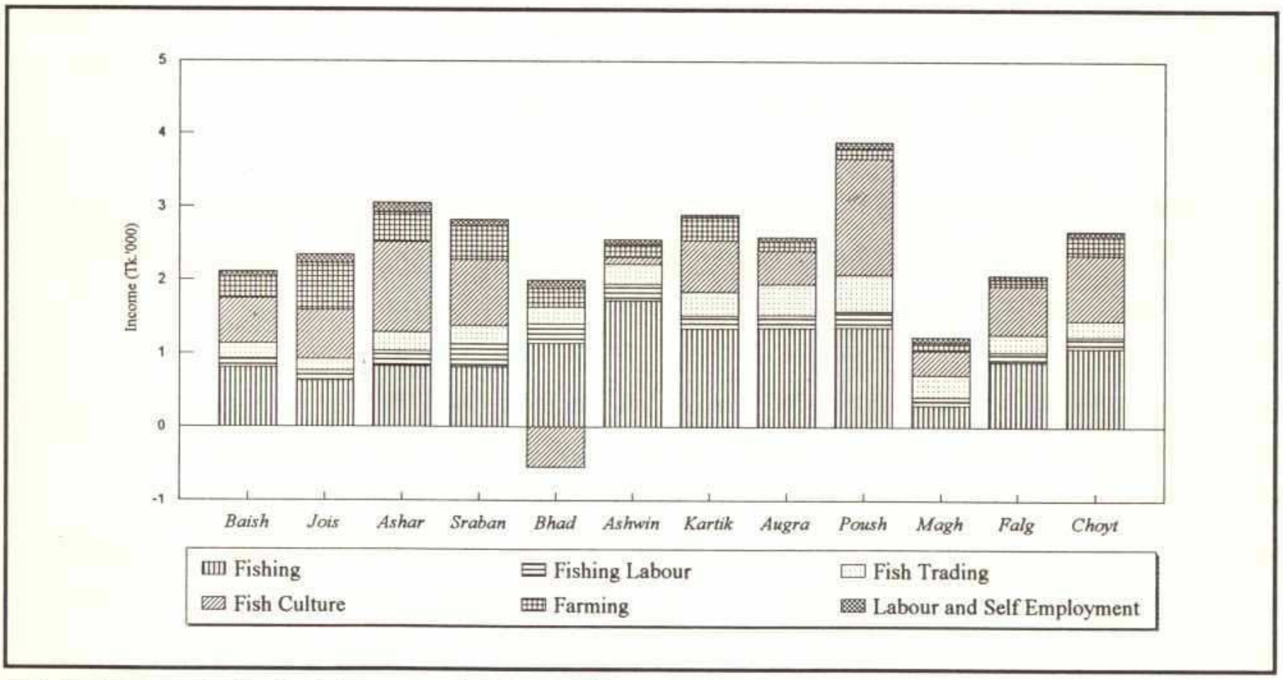
Table 4.8 Income by different household fishing categories in fishing villages - North Central

Units: Tk.

	Activity	Baish Mar/Apr	Jois Apr/May	Ashar May/Jun	Sraban Jun/Jul	Bhad Jul/Aug	Ashwin Aug/Sep	Kartik Sep/Oct	Augra Oct/Nov	Poush Nov/Dec	Magh Dec/Jan	Falg Jan/Feb	Choyt Feb/Mar	Total	%
HFC1	Fishing	922	660	1,185	1,057	1,545	2,058	1,817	1,384	1,701	(1,003)	945	950	13,221	69.2
	Fishing Labour	180	193	576	544	634	571	312	322	418	180	170	345	4,443	23.3
	Fish Trading	0	0	0	0	0	0	0	0	9	0	25	0	33	0.2
	Gear Making	2	61	11	25	18	12	4	18	23	7	4	4	186	1.0
	Farming	35	74	95	72	65	40	4	44	53	37	32	65	613	3.2
	Agricultural Labour	46	67	2	0	0	0	14	0	0	0	0	37	165	0.9
	Self Employment	175	11	26	9	4	0	0	4	11	7	4	2	250	1.3
	Non-Agric.& FFW	2	32	79	28	0	0	0	21	19	9	0	0	189	1.0
	Total	1,362	1,096	1,972	1,734	2,265	2,681	2,149	1,792	2,233	(763)	1,178	1,402	19,100	100.0
HFC2	Fishing	1,080	821	961	896	999	1,844	1,498	1,484	1,313	(2,079)	1,228	1,359	11,404	44.7
	Fishing Labour	93	101	101	236	171	138	117	191	214	84	124	75	1,645	6.4
	Fish Trading	167	173	291	245	141	266	288	405	555	339	202	224	3,296	12.9
	Fish Culture	592	799	1,518	879	(7,292)	(131)	1,120	640	2,506	481	1,104	1,167	3,383	13.3
	Gear Making	0	2	0	4	33	7	4	6	3	3	0	1	63	0.2
	Farming	309	729	450	599	585	228	486	138	174	218	92	180	4,188	16.4
	Agricultural Labour	10	34	21	6	0	0	0	0	49	0	0	9	129	0.5
	Self Employment	48	105	61	110	182	101	61	68	32	102	99	116	1,085	4.3
	Non-Agric.& FFW	13	7	16	52	52	23	21	56	61	8	4	4	317	1.2
	Total	2,312	2,771	3,419	3,027	(5,129)	2,476	3,595	2,988	4,907	(844)	2,853	3,135	25,510	100.0
HFC3	Fishing	743	902	578	431	1,137	2,328	958	864	445	2,237	743	671	12,037	36.0
	Fishing Labour	26	114	0	103	96	0	0	0	0	56	70	26	489	1.5
	Fish Trading	918	480	548	811	1,049	885	983	1,288	1,261	883	906	725	10,737	32.1
	Fish Culture	536	(736)	1,202	496	(895)	(729)	(301)	133	438	538	359	655	1,696	5.1
	Gear Making	0	75	21	0	0	0	14	0	0	0	0	0	110	0.3
	Farming	473	843	1,838	725	370	58	54	461	408	112	51	850	6,244	18.7
	Agricultural Labour	0	0	126	0	0	0	0	0	249	0	0	0	375	1.1
	Self Employment	0	5	1,107	9	12	0	0	0	7	2	2	2	1,146	3.4
	Non-Agric.& FFW	37	49	0	0	0	0	0	0	0	165	165	200	617	1.8
	Total	2,733	1,731	5,420	2,575	1,768	2,542	1,708	2,747	2,808	3,994	2,297	3,129	33,452	100.0
Community	Fishing	806	631	828	819	1,139	1,715	1,344	1,349	1,362	303	885	1,083	12,264	55.5
	Fishing Labour	127	137	210	310	263	232	171	177	218	109	142	159	2,255	10.2
	Fish Trading	205	160	253	253	231	275	323	422	496	302	236	216	3,372	15.3
	Gear Making	1	33	7	14	30	9	6	10	13	6	1	2	132	0.6
	Farming	285	635	400	455	253	181	314	124	140	115	79	247	3,228	14.6
	Agricultural Labour	12	26	11	2	0	0	4	0	24	0	0	10	89	0.4
	Self Employment	57	43	73	44	65	37	16	20	13	49	47	56	520	2.4
	Non-Agric.& FFW	9	17	36	24	17	15	12	28	32	16	10	12	228	1.0
	Total	1,502	1,682	1,818	1,921	1,998	2,464	2,190	2,130	2,298	900	1,400	1,785	22,088	100.0

Note: Data for community were based on the weighted average of all households sampled

Figure 4.3 Income by different household fishing categories in fishing villages - North Central



Note: Data in figure include fish culture but these were omitted in tabulated data

HFC3 households incomes were the most varied. In some communities (NC4-2 and NC4-3), the majority of their income did come from fishing, suggesting misclassification during the community census. In others, fishing was a relatively minor source, with fish trading or fish culture important. Together, fish related activities accounted for nearly 75% of total income; farming accounted for nearly 20%; the (small) balance was made up by labouring and self employment.

The overall picture therefore is of communities, with a similar average economic status to the main, agricultural floodplain villages, that are still heavily dependent on fish related activities. Were fisheries to be seriously damaged by flood control, these communities would clearly be vulnerable.

Fishing in agricultural villages

Assessing the significance of fishing in the agricultural villages requires an understanding of both the extent of participation in the fishery - what proportion of households fish, and the value of catch to the households that do fish, relative to their other sources of income. These measures of the breadth and depth of the impact of a decline in the fishery will determine which mitigation measures may be appropriate.

The initial census of the agricultural villages chosen for socioeconomic monitoring suggested a lower level of part-time and subsistence fishing than has been reported elsewhere, particularly in the North West and North East regions. The subsequent monitoring of households from these villages (which included a sample of those not reporting fishing in the census) indicated that some under-reporting had taken place, but not enough to explain the discrepancy. To clarify this issue, a further survey was undertaken. Two villages were chosen adjacent to each of the monitored villages and a sample of 100 households taken. The levels of fishing activity reported were, in general, closer to those originally expected. The pattern of the type and level of fisheries involvement for different landholding categories was however consistent between the initial census and the follow-up surveys. Reporting on participation below gives the merged results for the two surveys.

In North Central fishing was relatively more widely spread among households in the villages monitored than elsewhere; but, in common with other regions, as landholdings rise participation in the fishery increases but its significance to the households involved declines (Table 4.9).

Fishing either for subsistence or as a source of income was more common among farmers than for the landless in all 12 North Central villages. The lower participation of the landless reflects lack of resources to purchase gears. It may also be that the search for work, which in North Central is primarily non-agricultural, takes them away from the village either for long hours or days at a time. Farmers, in contrast, can combine more easily the casual setting of traps or *current jal* in their paddy with the routine agricultural operations that keep them on the floodplain: their opportunity cost of labour for subsistence fishing is thus lower than for the landless.

Table 4.9 Fishing participation (%), North Central

Category	For Income	Subsis -tence	Non-fishing
Medium Farmers	6	79	14
Small Farmers	10	63	23
Landless	15	48	37
Village	12	61	27

Source: FAP17 Census and Supplementary Surveys

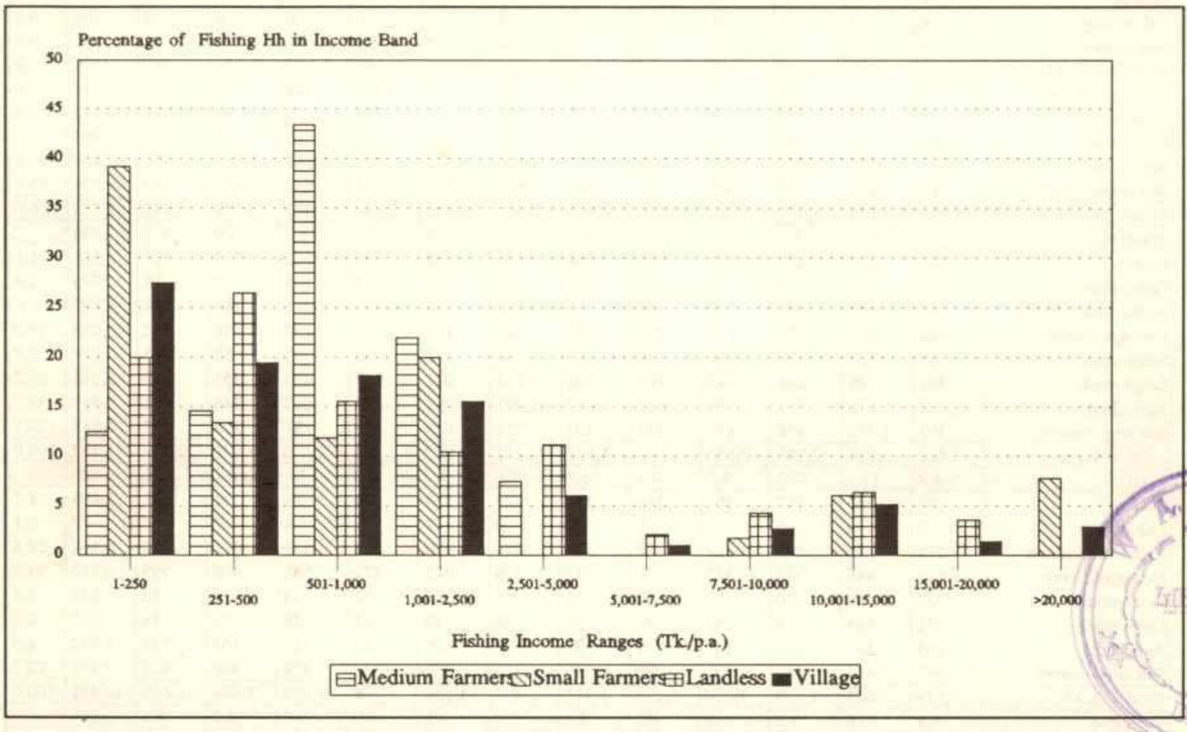
Note: Data for village derived from weighted average of all categories

Among all categories, fishing did not however tend to be ranked as a source of income. For the landless it was ranked more often than for farmers, but still represented less than a quarter of those fishing. That the landless should tend to sell their catch more than the landed reflects their higher marginal utility of income: **they cannot afford to forego the potential income.**

The household monitoring allowed the calculation of the net value of fish caught through the year, both sold and consumed within the household. The percentage distribution of households catching fish within different ranges of value is shown in Figure 4.4.

In contrast to the other regions, in North Central there is a progressive decline in the proportion of households earning successively higher quantities of income. The modal range for the value of fish caught was Tk.250 per annum or less, which included around 27% of the households fishing. Indeed nearly two thirds of fishing households caught fish worth less than Tk.1,000. The range is extended, with nearly 10% of fishing households earning more than Tk.10,000.

Figure 4.4 Distribution of fishing income for fishing households, North Central



Note: Data for village derived from weighted average of all categories

The relative significance of fishing is best gauged in relation to its contribution to total income. This is shown for each landholding category and overall in Table 4.10, which gives the average income (both cash and monetized value of consumption**) from each category of enterprise through the year. Overall fishing was the fifth ranked source of annual income, contributing 7.4% of a total of Tk.29,792. Seasonally it was of greatest importance in the flood season, when it contributed just under 10% of the total, though there was a secondary spike in December-February. Figure 4.5 gives a graphical presentation of this data.

Between the different groups there were however important differences. For medium landholders, despite their high level of participation, fishing was only of marginal significance, contributing a little over 1% of the total income. Fishing gave both the greatest amount (Tk.3,638) and the highest proportion (11.6%) to small farmers. In part this reflects their high involvement in fishing combined with their greater willingness than medium farmers to do so on a commercial basis. Their pattern of income is also noteworthy, as it is consistently highest in the dry season.

** Subsistence production of rice was monetized in the month when it was eaten, not when produced. This had the effect of spreading agricultural incomes through the year.

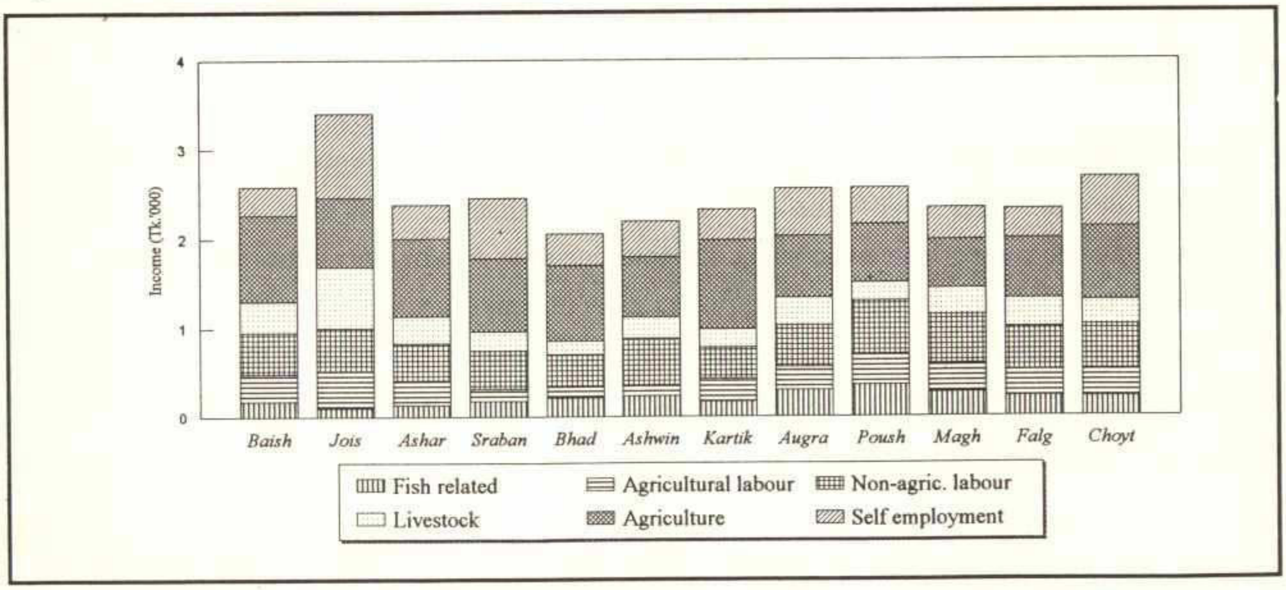
Table 4.10 Sources of income by landholding category in agricultural villages - North Central

Units: Tk.

Category	Activity	*Baish* Mar/Apr	*Jois* Apr/May	*Ashar* May/Jun	*Sraban* Jun/Jul	*Bhad* Jul/Aug	*Ashwin* Aug/Sep	*Kartik* Sep/Oct	*Augra* Oct/Nov	*Poush* Nov/Dec	*Magh* Dec/Jan	*Falg* Jan/Feb	*Choyt* Feb/Mar	Total	%
Medium Farmers	Fishing	14	19	21	128	70	99	85	62	60	25	36	32	650	1.2
	Fish trading	4	29	24	31	20	0	0	0	0	0	0	0	108	0.2
	Fish culture	9	0	0	0	0	0	0	0	0	31	20	81	141	0.3
	Agricultural labour	10	29	16	10	0	0	0	60	49	23	16	16	229	0.4
	Non-agric. labour	448	523	407	414	407	967	396	479	901	488	488	530	6,448	12.0
	Small stock	39	168	94	392	83	47	103	73	41	75	50	77	1,238	2.3
	Large stock	783	890	340	244	160	554	445	695	343	511	478	464	5,905	11.0
	Agriculture	3,161	3,177	3,578	3,022	3,763	2,332	3,180	1,501	1,822	1,243	1,565	2,066	30,408	56.8
	Self employment	512	1,274	575	845	507	969	871	756	637	597	485	369	8,396	15.7
	Total (Tk.)	4,980	6,109	5,055	5,086	5,010	4,968	5,080	3,626	3,853	2,993	3,138	3,635	53,523	100.0
	Total (%)	9.3	11.4	9.4	9.5	9.4	9.3	9.5	6.8	7.2	5.6	5.9	6.8	100	-
Small Farmers	Fishing	405	170	172	170	288	234	206	158	196	612	515	514	3,638	11.6
	Fish culture	5	0	0	0	0	(42)	(42)	326	488	9	9	18	770	2.4
	Agricultural labour	130	268	161	113	57	78	175	166	165	215	188	185	1,899	6.0
	Non-agric. labour	422	408	396	432	356	348	286	424	472	492	486	492	5,014	15.9
	Small stock	77	128	93	60	33	59	56	143	68	55	55	48	874	2.8
	Large stock	402	798	296	143	109	139	135	172	167	235	353	270	3,218	10.2
	Agriculture	1,037	676	711	774	657	617	1,095	988	678	,647	740	898	9,517	30.2
	Self employment	303	1,386	458	894	494	403	311	675	429	231	224	747	6,552	20.8
	Total (Tk.)	2,781	3,834	2,287	2,586	1,994	1,836	2,222	3,052	2,663	2,496	2,570	3,172	31,482	100.0
	Total (%)	8.8	12.2	7.3	8.2	6.3	5.8	7.1	9.7	8.5	7.9	8.2	10.1	100	-
Landless	Fishing	85	68	157	201	216	339	223	154	76	83	71	26	1,699	8.7
	Fish culture	0	0	0	0	0	0	0	2	5	8	2	2	17	0.1
	Agricultural labour	578	722	500	227	238	244	459	428	596	539	490	545	5,564	28.6
	Non-agric. labour	439	446	372	333	270	332	326	471	473	551	406	395	4,812	24.8
	Small stock	26	149	50	38	64	55	55	32	62	45	29	42	646	3.3
	Large stock	21	144	65	34	26	36	21	43	17	78	71	16	570	2.9
	Agriculture	203	133	199	151	125	81	98	100	182	117	135	198	1,722	8.9
	Self employment	367	401	336	366	289	330	316	326	345	478	440	421	4,411	22.7
	Total (Tk.)	1,719	2,063	1,679	1,350	1,228	1,417	1,498	1,556	1,756	1,899	1,644	1,645	19,441	100.0
	Total (%)	8.8	10.6	8.6	6.9	6.3	7.3	7.7	8.0	9.0	9.8	8.5	8.5	100	-
Village	Fishing	173	100	136	172	215	261	191	142	119	258	224	202	2,191	7.4
	Fish trading	1	5	4	6	4	0	0	0	0	0	0	0	20	0.1
	Fish culture	3	0	0	0	0	(21)	(21)	161	242	12	7	20	404	1.4
	Agricultural labour	310	423	274	142	121	120	264	258	342	325	287	314	3,180	10.7
	Non-agric. labour	468	479	420	430	363	527	347	470	602	551	490	492	5,636	18.9
	Small stock	55	146	87	93	58	49	57	85	63	59	48	54	852	2.9
	Large stock	294	532	217	118	91	189	149	222	138	235	271	218	2,671	9.0
	Agriculture	959	770	867	824	851	670	999	691	648	541	674	819	9,312	31.3
	Self employment	316	941	371	662	350	395	338	525	402	352	323	552	5,526	18.5
	Total (Tk.)	2,579	3,396	2,376	2,447	2,053	2,190	2,324	2,554	2,556	2,333	2,324	2,671	29,792	100.0
	Total (%)	8.7	11.4	8.0	8.2	6.9	7.4	7.8	8.6	8.6	7.8	7.8	9.0	100	-

Note: Data for village derived from weighted average of all categories

Figure 4.5 Seasonal variation in the distribution of income in agricultural villages - North Central



Source: FAP17 Socioeconomic Monitoring

For the landless, fishing, on an annual basis, was relatively less important than for the small farmers sampled; but it constituted almost a quarter of income earned in the flood season, when all three of their main sources (agricultural labour, non-agricultural labour and self-employment) are at their annual low.

Significance of Fisheries Income to Different Groups - North East

Professional fishermen in fishing villages

The tight control over the richest fisheries resources in this region limits the incomes earned by most professional fishermen. These are shown in Table 4.11. The average annual income in the fishing communities monitored was a little less than Tk.20,234, of which 78% came from fish related activities (53% from capture fisheries). There was however considerable variation between communities, ranging from Tk.42,805 in NE1-3, where half the total came from fish culture, to Tk.11,578 in NE1-2. There was also considerable variation within communities, often relating to leasing. Though the majority of fishermen benefit from the leasing system only to the extent that it stops a free-for-all, some households do gain significantly, either by obtaining a sub-lease or by assisting in the management of *beel* for larger leaseholders. This also accounts for the considerable irregularity in income flows from fishing, see Figure 4.6. (The average income of Tk.2,533 in *Poush* was largely accounted for by one leaseholder in one community.)

Reflecting the importance of large gears, there is a significant contribution of income from fishing labour (10.3%). Fish trading was also important. Fish culture is not shown because anomalies in the survey resulted in negative values at the community level. (The early rounds of data collection failed to pick up income flows from pond culture in all cases; later rounds caught expenditure but, due to timing, not the ultimate harvest.)

Fishing in agricultural villages

In other regions, the relative importance of subsistence and part-time fishermen derived from the analysis of the FCA data and that derived from the socioeconomic monitoring was broadly consistent. In the North East, this was not the case. In the socioeconomic surveys, part-time fishing was of only minor significance: it was reported less frequently than anywhere else in the village surveys (including the initial census) see Table 4.12; in the household monitoring, it was a rarity (9 households, compared to 281 for subsistence) and it gave a much lower average level of income than in other regions. Though there are

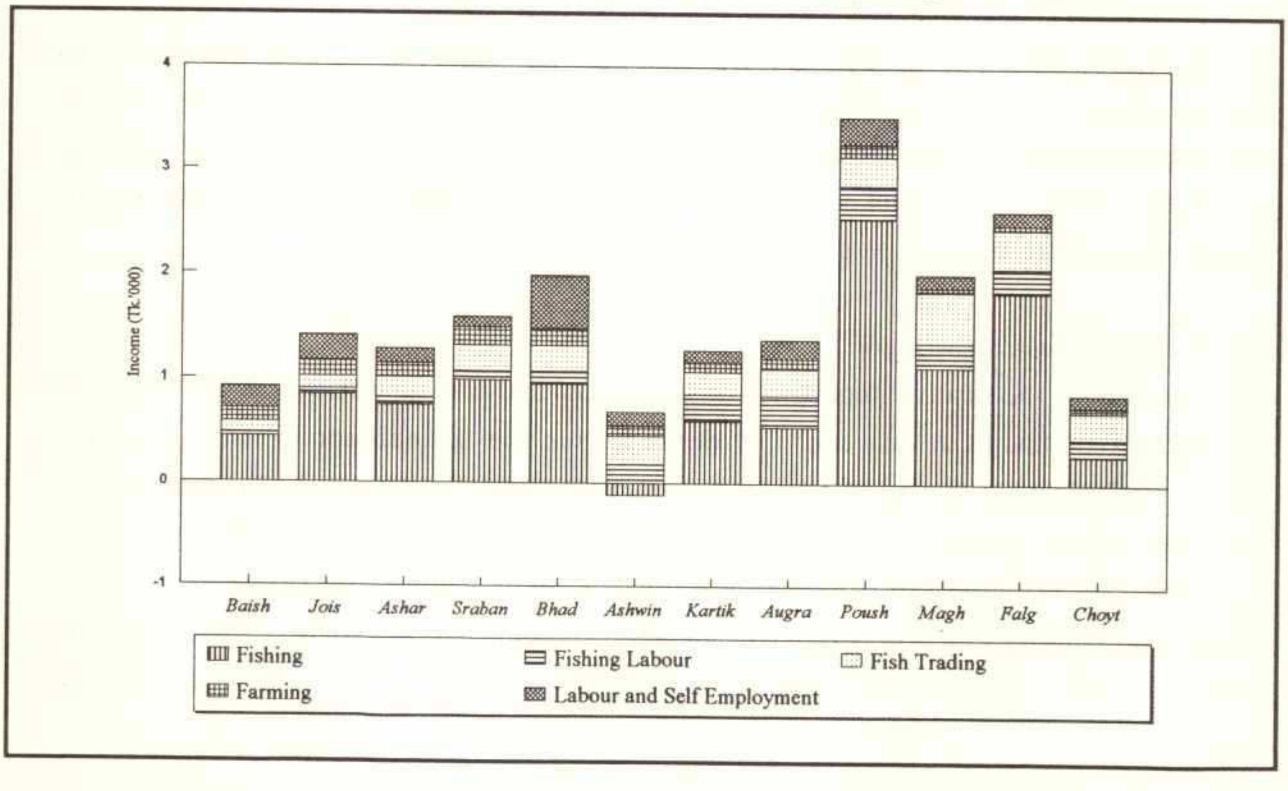
Table 4.11 Income by different household fishing categories in fishing villages - North East

Units: Tk.

	Activity	*Baish*	*Jois*	*Ashar*	*Sraban*	*Bhad*	*Ashwin*	*Kartik*	*Augra*	*Poush*	*Magh*	*Falg*	*Choyt*	Total	%
		Mar/Apr	Apr/May	May/Jun	Jun/Jul	Jul/Aug	Aug/Sep	Sep/Oct	Oct/Nov	Nov/Dec	Dec/Jan	Jan/Feb	Feb/Mar		
HFC1	Fishing	306	986	676	1,056	1,010	780	428	364	687	1,143	988	731	9,154	55.8
	Fishing Labour	31	39	49	74	109	106	331	308	447	144	211	182	2,030	12.4
	Fish Trading	236	205	253	333	166	156	174	(335)	279	246	266	237	2,217	13.5
	Farming	96	161	82	6	36	9	23	13	9	0	3	24	462	2.8
	Agricultural Labour	373	217	79	38	19	19	80	104	190	195	153	35	1,501	9.2
	Self Employment	0	6	157	129	129	157	129	157	0	1	1	1	868	5.3
	Non-Agric.& FFW	0	0	0	0	0	0	0	0	0	0	92	72	164	1.0
	Total	1,041	1,613	1,296	1,635	1,471	1,228	1,164	610	1,613	1,729	1,715	1,283	16,397	100.0
HFC2	Fishing	576	946	766	992	967	928	602	590	867	875	1,898	(540)	9,467	45.8
	Fishing Labour	39	69	87	100	134	228	253	332	319	282	278	175	2,296	11.1
	Fish Trading	102	(390)	167	222	223	261	228	321	257	508	391	244	2,534	12.2
	Fish Culture	(153)	(153)	(950)	1,113	2,132	0	0	3	0	208	3	14	2,217	10.7
	Farming	111	156	129	194	175	111	87	110	110	41	49	47	1,320	6.4
	Agricultural Labour	228	110	40	33	26	0	13	85	83	79	43	20	760	3.7
	Self Employment	57	174	75	57	562	85	57	85	190	91	53	39	1,525	7.4
	Non-Agric.& FFW	19	60	44	44	58	76	73	28	40	23	52	51	568	2.7
	Total	979	972	358	2,755	4,277	1,689	1,313	1,554	1,866	2,107	2,767	50	20,687	100.0
HFC3	Fishing	133	278	683	758	696	(5,599)	445	221	12,074	2,507	413	354	12,963	51.6
	Fishing Labour	0	0	0	0	0	0	0	0	53	0	56	26	134	0.5
	Fish Trading	152	224	584	555	704	493	266	443	600	674	501	378	5,573	22.2
	Gear Making	0	0	0	0	0	26	21	32	35	0	0	0	114	0.5
	Farming	309	203	200	210	149	155	118	96	363	70	74	85	2,032	8.1
	Agricultural Labour	74	0	0	0	0	0	13	112	0	0	0	0	198	0.8
	Self Employment	1,648	282	144	45	21	27	0	429	757	250	232	259	4,093	16.3
	Total	2,315	987	1,611	1,568	1,570	(4,898)	862	1,333	13,882	3,501	1,275	1,101	25,107	100.0
Comm-unity	Fishing	443	844	747	989	950	-117	605	549	2533	1126	1833	278	10,780	53.3
	Fishing Labour	35	59	75	88	121	187	257	300	322	231	237	163	2,075	10.3
	Fish Trading	106	117	191	240	249	266	211	255	281	485	365	258	3,024	14.9
	Gear Making	7	-1	5	2	3	5	2	4	4	-2	0	1	30	0.1
	Farming	127	154	136	172	158	101	85	97	117	40	46	51	1,284	6.3
	Agricultural Labour	222	125	47	36	26	4	23	89	74	82	46	23	797	3.9
	Self Employment	194	183	93	61	455	73	55	155	230	111	81	75	1,766	8.7
	Non-Agric.& FFW	13	55	40	40	48	62	61	25	35	16	43	40	478	2.4
	Total	1,147	1,536	1,334	1,628	2,010	581	1,299	1,474	3,596	2,089	2,651	889	20,234	100.0

Note: Data for community were based on the weighted average of all households sampled

Figure 4.6 Income by different household fishing categories in fishing villages - North East



reasonable explanations for this (see below) this downward bias must be borne in mind in the interpretation of the results presented. The level of part-time fishing may be lower in the villages monitored because of the distinct cultural barriers to the sale of fish among the traditional inhabitants of agricultural communities in the North East. Traditional Muslim fishermen (*maimuls*) are longer and more widely established in the NE than in any of the other areas monitored by FAP 17. But their social status within the wider community is particularly low and farmers are therefore reluctant to fish for income. There are however significant communities of migrants, settled in the region in the last two generations, who, being less socially constrained, do fish seasonally for income. The migrants are generally located on the lower land away from the older communities that occupy the ridges. As a result, there is a distinct clustering of part-time fishermen in separate communities - none of which happened to be covered by the socioeconomic monitoring.

Table 4.12 Fishing participation (%), North East

Category	For Income	Subsis -tence	Non-fishing
Medium Farmers	2	64	34
Small Farmers	3	58	28
Landless	10	49	41
Village	6	57	37

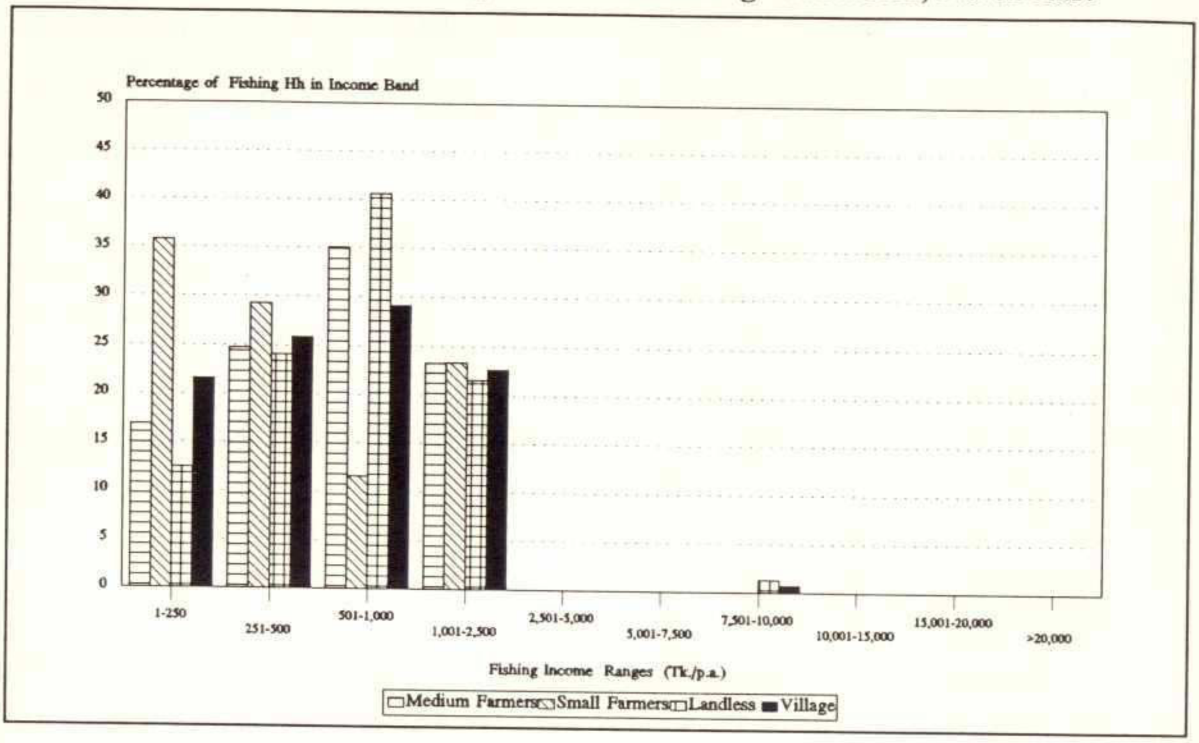
Source: FAP17 Census and Supplementary Surveys

Note: Data for village derived from weighted average of all categories

It is also possible that the levels of income from fishing recorded in the monitored communities were underreported, both because of cultural taboos and because of the detailed questioning that linked fishing activities to local water bodies. Leaseholders in the North East are particularly aggressive in the policing of fishing of their *beel* and, increasingly and illegally, on the surrounding floodplain. Subsistence fishing is sometimes tolerated, independent fishing for sale is not. Where questions are asked generally, households may be willing to admit that they earn income from fishing; where the questions relate to specific water bodies, they may not.

The distribution of households across different fishing income ranges (cash plus monetary value of consumption) is shown in Figure 4.7. The modal range was Tk.500-Tk.1,000, though there was little difference across the first four ranges. The most notable feature of this Figure is the almost complete lack of households catching fish worth more than Tk.2,500 (and very few came close to this figure).

Figure 4.7 Distribution of fishing income for fishing households, North East



Note: Data for village derived from weighted average of all categories

Together with the relatively lower participation rates (second lowest after the North West), this made fishing less important to the monitored villages in the North East, than to those covered in any other region. The overall distribution of income by source is given in Table 4.13 and Figure 4.8. Annual fishing income was relatively invariant across landholding classes, at Tk.418, Tk.380 and Tk.346 for medium farmers, small farmers and landless respectively and accounted for only 1.7% of average village income. The profile of income through the year, indicates an earlier peak than other regions. In the North East it came in *Joisthya, Ashar* and *Sraban* (mid-April to mid-July). Elsewhere, it occurred more commonly in the period from August to October. This reflects the earlier flooding patterns in the North East and the heavier policing of fishing by leaseholders as soon as the floods start to recede.

In the agricultural villages in the North East incomes varied significantly. In the villages on the Surma-Kushiyara floodplains (NE1-1 and NE2-1), the overall levels of village income were both significantly higher than anywhere except North Central. The villages in the *haor*, NE3-1 and NE4-1, which are more remote and subject to deeper and more protracted flooding, had much lower village incomes, comparable to the poorer villages of the North West or the South West. It was in the North East however that the disparity between

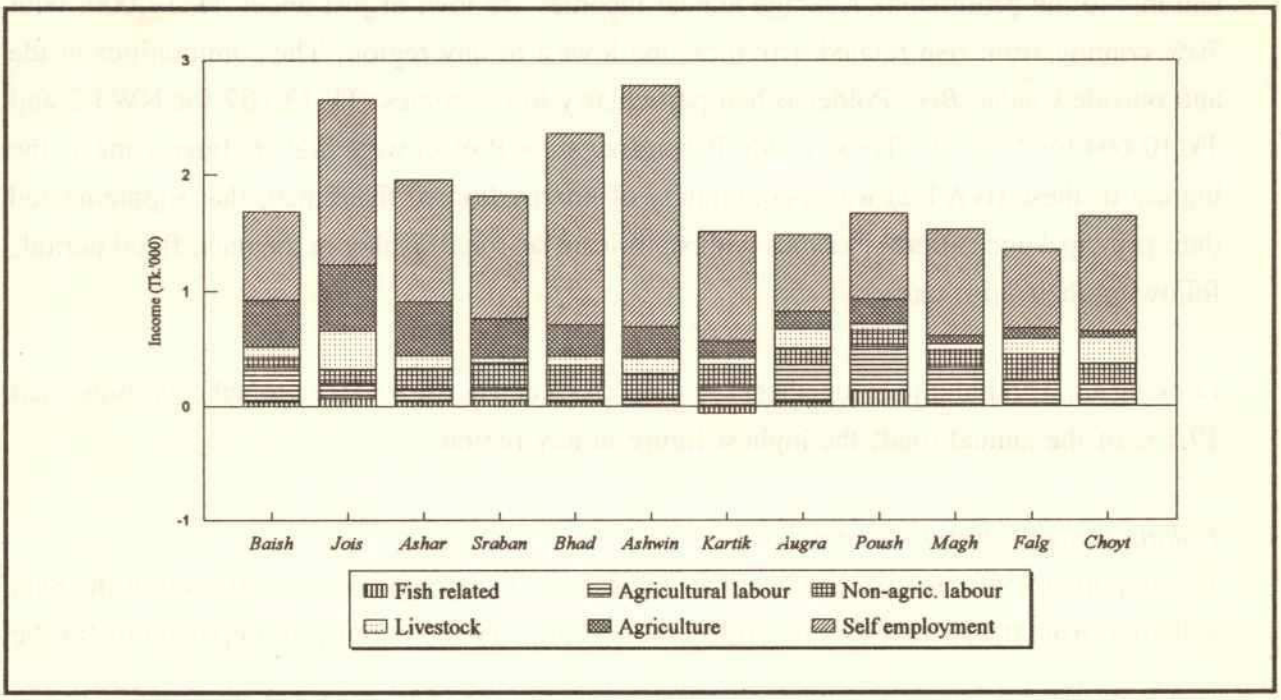
Table 4.13 Sources of income by landholding category in agricultural villages - North East

Units: Tk.

Category	Activity	*Baish* Mar/Apr	*Jois* Apr/May	*Ashar* May/Jun	*Sraban* Jun/Jul	*Bhad* Jul/Aug	*Ashwin* Aug/Sep	*Kartik* Sep/Oct	*Augra* Oct/Nov	*Poush* Nov/Dec	*Magh* Dec/Jan	*Falg* Jan/Feb	*Choyt* Feb/Mar	Total	%
Medium Farmers	Fishing	49	100	53	73	31	10	11	11	3	30	25	25	418	0.9
	Fish culture	0	0	0	0	0	0	(703)	0	879	0	0	0	176	0.4
	Agricultural labour	0	0	0	0	0	0	0	0	0	15	0	0	15	0.0
	Non-agric. labour	27	44	44	67	64	67	57	155	77	44	47	52	743	1.5
	Small stock	35	113	17	31	35	35	26	64	23	7	27	40	451	0.9
	Large stock	235	413	162	58	38	81	172	364	68	127	510	171	2,399	4.9
	Agriculture	1,157	1,244	1,068	1,173	741	968	569	552	715	216	194	110	8,706	17.8
	Self employment	2,480	3,324	2,403	3,237	5,429	5,710	3,297	1,260	1,626	3,093	1,399	2,666	35,920	73.6
	Total (Tk.)	3,983	5,238	3,747	4,639	6,338	6,871	3,429	2,406	3,391	3,532	2,202	3,064	48,828	100
	Total (%)	8.2	10.7	7.7	9.5	13.0	14.1	7.0	4.9	6.9	7.2	4.5	6.3	100	
Small Farmers	Fishing	38	73	41	43	45	37	20	16	13	22	24	10	380	1.6
	Agricultural labour	194	67	79	88	106	90	177	310	322	234	158	147	1,970	8.2
	Non-agric. labour	15	61	119	142	146	165	173	91	49	47	117	84	1,207	5.0
	Small stock	28	11	3	8	13	15	17	24	8	13	13	21	171	0.7
	Large stock	35	176	41	39	177	320	33	145	62	42	44	233	1,345	5.6
	Agriculture	452	709	635	389	372	321	142	130	193	44	39	39	3,464	14.4
	Self employment	643	2,285	1,521	642	1,691	2,817	780	838	1,077	665	812	1,717	15,486	64.5
	Total (Tk.)	1,405	3,382	2,439	1,351	2,550	3,765	1,342	1,554	1,724	1,067	1,207	2,251	24,023	100
	Total (%)	5.8	14.1	10.2	5.6	10.6	15.7	5.6	6.5	7.2	4.4	5.0	9.4	100	
Landless	Fishing	29	57	39	55	33	9	30	40	25	12	12	8	346	2.5
	Agricultural labour	454	192	158	139	140	44	201	430	535	457	281	238	3,268	23.9
	Non-agric. labour	147	175	247	300	302	306	263	184	198	221	346	280	2.966	21.7
	Small stock	5	3	4	25	20	11	5	11	1	2	3	8	96	0.7
	Large stock	32	316	135	6	5	56	0	36	39	24	24	223	896	6.5
	Agriculture	165	285	219	62	95	56	35	44	66	19	73	38	1,156	8.4
	Self employment	280	388	393	447	558	756	368	446	354	360	377	228	4,953	36.2
	Total (Tk.)	1,112	1,416	1,195	1,034	1,153	1,238	902	1,191	1,218	1,095	1,116	1,023	13,681	100
	Total (%)	8.1	10.4	8.7	7.6	8.4	9.0	6.6	8.7	8.9	8.0	8.2	7.5	100	
Village	Fishing	37	70	41	54	37	16	25	30	19	17	17	11	373	1.7
	Fish culture	0	0	0	0	0	0	(88)	0	110	0	0	0	22	0.1
	Agricultural labour	306	132	114	108	106	47	167	331	395	325	202	172	2,403	10.7
	Non-agric. labour	90	125	179	218	216	224	199	152	134	145	234	190	2,106	9.4
	Small stock	15	30	5	24	20	17	12	24	7	5	9	17	183	0.8
	Large stock	74	305	105	24	58	121	47	132	49	50	124	208	1,297	5.8
	Agriculture	403	567	465	341	271	271	148	159	221	76	100	58	3,078	13.8
	Self employment	760	1,422	1,047	1,049	1,650	2,082	941	655	735	912	670	983	12,904	57.7
	Total (Tk.)	1,685	2,651	1,956	1,818	2,358	2,778	1,451	1,483	1,670	1,530	1,356	1,639	22,366	100.0
	Total (%)	7.5	11.9	8.7	8.1	10.5	12.4	6.5	6.6	7.5	6.8	6.1	7.3	100	

Note: Data for village derived from weighted average of all categories

Figure 4.8 Seasonal variation in the distribution of income in agricultural villages - North East



landholding groups was the sharpest, with medium landowners generally recording much higher incomes than other groups and with the landless earning considerably less in all villages except NE1-1, where proximity to Moulvibazar enabled self-employment to hold up the annual total. Two additional features stand out: the very low levels of agricultural income, and the much greater significance of self-employment across all landholding groups. In the North East, the average income earned from agriculture by medium farmers was similar to that earned by small farmers in the North West and less than that earned by them in North Central. The very deep and extended flooding in this region undoubtedly contributes to this, as it severely constrains cropping options, often to a single local *boro* crop. Furthermore, early in the year, even this is vulnerable to flash floods (which did occur in the period monitored). Self-employment, therefore, has to assume a greater degree of importance than in other regions. But, adding to this, are the flows of income from remittances, which for ease of tabulation have been classified as "self-employment." For medium farmers, in particular, these remittances were a very important component of total annual income. Accordingly, the figure recorded for their self-employment in the North East is three times that recorded by them in the next highest region (South West).

Significance of Fisheries Income to Different Groups - North West

Professional fishermen in fishing villages

The income structures of fishing communities are shown in Table 4.14 and Figure 4.9. The professional fishermen in the North West include a significant number of more recent entrants to the profession. Average annual incomes are low, at just under Tk.17,000, with 70% coming from fish related activities, the lowest of any region. The communities inside and outside Chalan *Beel* Polder B had particularly low incomes (Tk.13,657 for NW3-2 and Tk.10,694 for NW4-2). Those inside Pabna Irrigation Project were higher. Interestingly, the highest of these (NW1-2) was a community of non-traditional fishermen, that supplemented their principal agricultural incomes with significant seasonal fishing in the main flood period, following their *boro* harvest.

Looking at all communities together, farming (crops and livestock taken together) represented 19.1% of the annual total, the highest figure in any region.

Fishing in agricultural villages

The importance of part-time, rather than subsistence fishermen, is also reflected in the data gathered from the socioeconomic village monitoring, and has significant implications for the

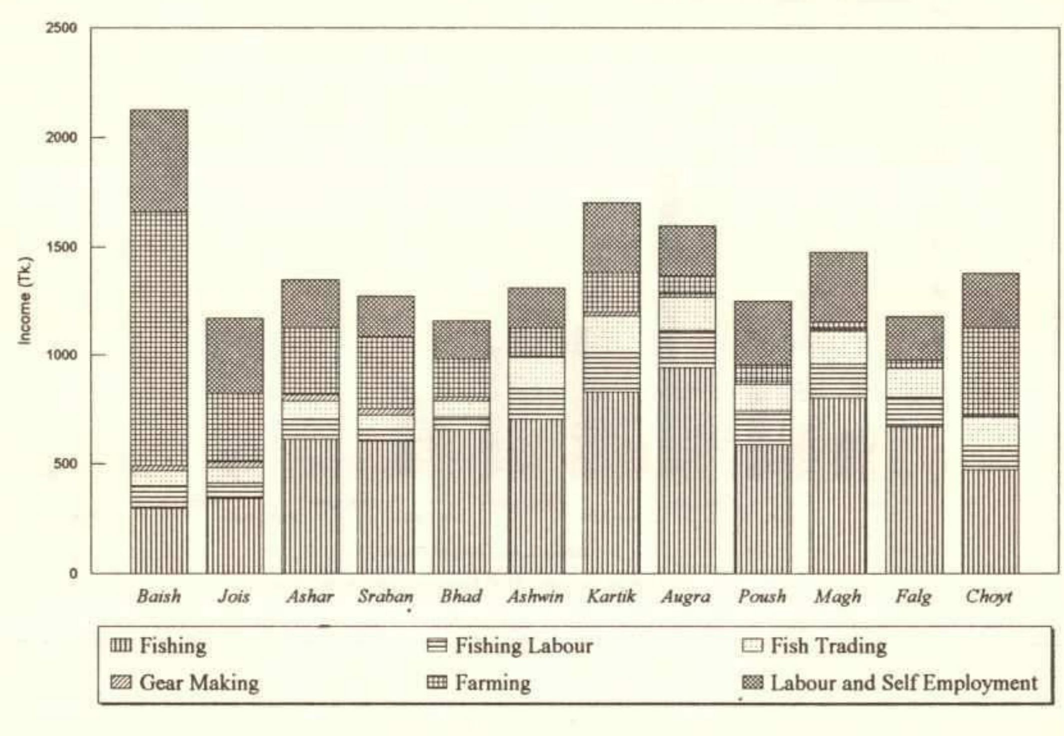
Table 4.14 Income by different household fishing categories in fishing villages - North West

Units: Tk.

	Activity	*Baish* Mar/Apr	*Jois* Apr/May	*Ashar* May/Jun	*Sraban* Jun/Jul	*Bhad* Jul/Aug	*Ashwin* Aug/Sep	*Kartik* Sep/Oct	*Augra* Oct/Nov	*Poush* Nov/Dec	*Magh* Dec/Jan	*Falg* Jan/Feb	*Choyt* Feb/Mar	Total	%
HFC1	Fishing	662	472	593	612	592	683	773	767	562	1,318	1,290	940	9,263	71.1
	Fishing Labour	85	88	112	60	62	128	160	68	112	75	78	70	1,098	8.4
	Fish Trading	0	0	18	22	35	28	30	38	22	0	0	0	193	1.5
	Fish Culture	0	(12)	0	0	0	0	0	0	28	0	95	0	112	0.9
	Gear Making	18	12	12	28	12	13	17	18	28	0	0	5	163	1.3
	Farming	62	0	2	3	40	0	2	3	7	3	2	2	125	1.0
	Agricultural Labour	30	0	0	0	0	0	0	0	0	0	0	13	43	0.3
	Self Employment	63	65	57	68	68	95	107	62	67	52	55	53	812	6.2
	Non-Agric.& FFW	57	162	162	147	105	105	147	147	147	15	15	20	1,227	9.4
	Total	977	787	955	940	913	1,053	1,235	1,103	972	1,463	1,535	1,103	13,037	100.0
HFC2	Fishing	139	276	604	628	661	553	1,009	1,603	828	749	469	320	7,839	49.0
	Fishing Labour	196	112	129	40	51	181	270	326	273	288	259	237	2,362	14.8
	Fish Trading	48	73	82	34	38	68	131	112	83	193	148	170	1,180	7.4
	Gear Making	28	44	45	34	29	7	21	19	12	12	5	9	265	1.7
	Farming	116	218	110	285	82	74	282	20	22	0	21	550	1,780	11.1
	Agricultural Labour	116	78	8	0	7	0	13	26	9	31	44	67	399	2.5
	Self Employment	13	133	59	32	58	52	63	19	20	63	50	85	647	4.0
	Non-Agric.& FFW	141	114	120	160	141	159	83	63	78	133	167	169	1,528	9.6
	Total	797	1,048	1,157	1,213	1,067	1,094	1,872	2,188	1,325	1,469	1,163	1,607	16,000	100.0
HFC3	Fishing	236	456	685	(363)	766	858	743	360	165	564	490	341	5,301	22.6
	Fishing Labour	43	25	58	126	119	206	189	228	173	163	115	51	1,494	6.4
	Fish Trading	313	216	256	241	240	741	751	635	488	478	478	406	5,243	22.4
	Farming	2,494	743	690	619	460	366	413	335	334	75	64	490	7,081	30.2
	Agricultural Labour	59	64	66	46	28	21	54	39	71	38	45	79	609	2.6
	Self Employment	625	271	206	183	186	223	419	304	390	420	148	255	3,629	15.5
	Non-Agric.& FFW	0	0	0	0	0	0	0	0	0	33	30	0	63	0.3
	Total	3,769	1,775	1,961	853	1,799	2,415	2,568	1,900	1,620	1,769	1,369	1,623	23,419	100.0
Community	Fishing	298	342	612	605	658	703	829	940	588	801	669	473	7,518	44.3
	Fishing Labour	102	70	92	53	56	143	182	173	154	157	136	111	1,429	8.4
	Fish Trading	69	70	83	64	71	140	170	155	123	153	131	128	1,357	8.0
	Gear Making	22	27	29	28	19	7	20	17	14	9	3	7	202	1.2
	Farming	1,171	309	309	333	178	133	181	83	73	32	37	407	3,246	19.1
	Agricultural Labour	133	99	43	25	21	12	41	43	46	46	47	84	640	3.8
	Self Employment	262	168	95	75	82	94	209	124	184	205	57	92	1,647	9.7
	Non-Agric.& FFW	69	84	86	91	74	79	71	62	68	74	98	77	933	5.5
	Total	2,126	1,169	1,349	1,274	1,159	1,311	1,703	1,597	1,250	1,477	1,178	1,379	16,972	100.0

Notes: 1. Negative values for fish culture removed
2. Data for community were based on the weighted average of all households sampled

Figure 4.9 Income by different household fishing categories in fishing villages - North West



Source: FAP 17 Socioeconomic Monitoring potential impact of flood control measures that would affect the value of the fishery. The participation percentage in the fishery of different landholding classes is given in Table 4.15. Of all regions the North West had the highest proportion of non-fishing households (53%). The next highest, North East, was 16 percentage points lower, and the other two regions were less than 30%. However, of those that did fish, the ratio of those fishing for income to those fishing only for subsistence was high; just under half for all groups but rising to nearly two thirds for the landless.

Table 4.15 Fishing participation (%), North West

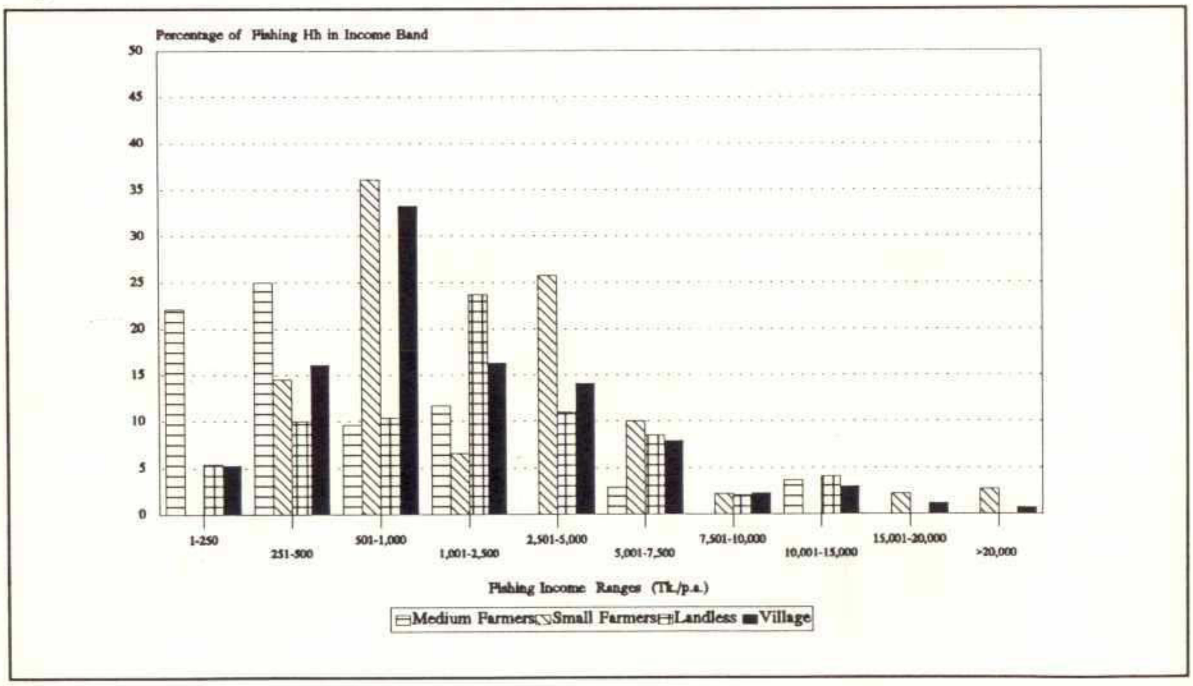
Category	For Income	Subsis -tence	Non-fishing
Medium Farmers	11	34	55
Small Farmers	12	31	45
Landless	18	28	53
Village	15	32	53

Source: FAP17 Census and Supplementary Surveys

Note: Data for village derived from weighted average of all categories

The distribution of households across different income ranges (cash income plus the monetized value of catch consumed) is shown in Figure 4.10. In contrast to North Central, where the modal income was less than Tk.250, in the North West it was in the range Tk.500 to Tk.1,000. There were relatively few households with income less than Tk.500 and the distribution had a long tail stretching into the upper ranges.

Figure 4.10 Distribution of fishing income for fishing households, North West



Note: Data for village derived from weighted average of all categories

In the four villages studied, the average income earned by those selling fish was relatively steady across all landholding categories, at around Tk.5,000 and the numbers of households recording no cash sales was significantly lower than any other region. Such incomes are clearly of varying significance to these households, depending on their other sources but for the landless, whose average income in this region was around Tk.12,500, they are clearly of great significance.

The overall picture of the significance of fishing to each landholding group is given in Table 4.16 and Figure 4.11. Two opposing forces were at work: the low level of participation and the generally high incomes of those who did fish. The monitored villages reported here had a generally lower level of participation than those covered in the subsequent subsistence survey and included one village (NW2-1) in which fishing was systematically underreported, due to a bitter dispute over access on their most important fishing ground. As a result, despite the high household fishing incomes for those participating, fishing does not feature significantly when averaged across any of the groups: for medium farmers it was less than 1% of total income; for small farmers it was 3.7%; and for the landless it was only 4.5%.

Aside from the significance of fishing, though not unrelated to it, one particular feature emerges from this Table. Again, for the average rural household, activities unrelated to agriculture contribute a major fraction of total income; here, in the North West, non-agricultural labour and self-employment made up over one third of the total. For the landless, not unnaturally, this picture is that much stronger, with nearly 50% of the annual total coming from these two sources.

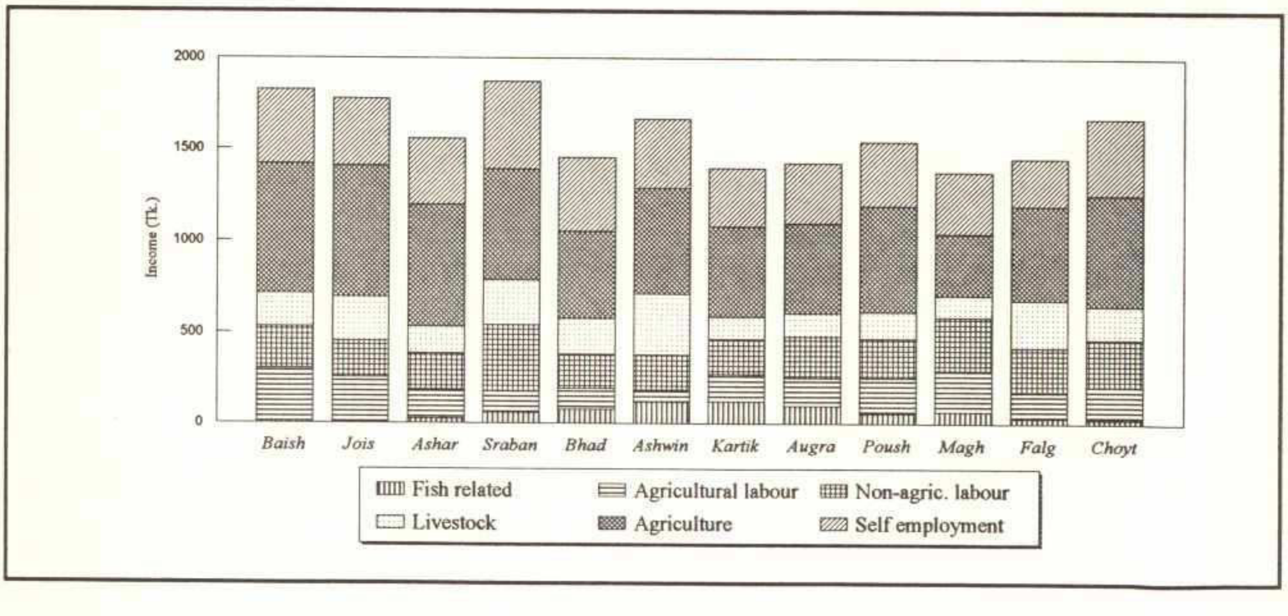
Table 4.16 Sources of income by landholding category in agricultural villages - North West

Units: Tk.

Category	Activity	*Baish* Mar/Apr	*Jois* Apr/May	*Ashar* May/Jun	*Sraban* Jun/Jul	*Bhad* Jul/Aug	*Ashwin* Aug/Sep	*Kartik* Sep/Oct	*Augra* Oct/Nov	*Poush* Nov/Dec	*Magh* Dec/Jan	*Falg* Jan/Feb	*Choyt* Feb/Mar	Total	%
Medium Farmers	Fishing	0	0	7	31	34	38	36	43	13	27	16	15	259	0.8
	Fish culture	(1)	0	0	(1)	(2)	0	(1)	0	14	94	19	87	209	0.7
	Agricultural labour	28	29	35	15	21	0	20	42	43	17	10	22	281	0.9
	Non-agric. labour	260	260	260	266	260	260	260	297	317	267	269	287	3,264	10.5
	Small stock	15	22	6	11	20	15	9	49	27	14	22	16	225	0.7
	Large stock	325	827	230	203	423	173	180	154	255	333	356	362	3,821	12.3
	Agriculture	1,993	2,132	1,539	1,867	1,392	1,863	1,752	1,464	1,972	1,253	2,279	1,405	20,910	67.1
	Self employment	298	139	383	64	64	297	73	81	71	95	38	603	2,204	7.1
	Total (Tk.)	2,918	3,409	2,460	2,456	2,212	2,646	2,329	2,130	2,712	2,100	3,009	2,797	31,173	100.0
	Total (%)	9.4	10.9	7.9	7.9	7.1	8.5	7.5	6.8	8.7	6.7	9.7	9.0	100	
Small Farmers	Fishing	31	16	13	80	90	191	205	131	56	53	27	0	891	3.7
	Fish trading	0	0	7	7	7	4	3	0	0	6	5	0	38	0.2
	Fish culture	0	0	(4)	(1)	2	2	(2)	10	19	5	7	0	38	0.2
	Agricultural labour	324	172	94	92	105	38	105	116	149	252	92	124	1,662	6.9
	Non-agric. labour	291	298	294	993	278	283	284	307	319	676	367	327	4,713	19.6
	Small stock	41	30	33	176	79	56	32	59	51	48	35	40	677	- 2.8
	Large stock	276	181	233	427	186	505	185	162	155	65	173	158	2,705	11.2
	Agriculture	846	757	937	762	640	738	470	603	571	360	415	959	8,056	33.5
	Self employment	443	550	359	732	437	412	391	377	384	506	303	382	5,278	21.9
	Total (Tk.)	2,252	2,004	1,966	3,268	1,824	2,229	1,673	1,765	1,704	1,971	1,424	1,990	24,058	100.0
	Total (%)	9.4	8.3	8.2	13.6	7.6	9.3	7.0	7.3	7.1	8.2	5.9	8.3	100	
Landless	Fishing	7	1	35	57	75	105	110	90	45	30	16	4	574	4.5
	Fish trading	0	0	0	0	0	0	0	12	11	14	13	0	49	0.4
	Agricultural labour	368	361	237	167	152	112	221	212	274	295	214	267	2,879	22.7
	Non-agric. labour	199	144	156	167	140	142	140	185	149	154	194	228	1,995	15.7
	Small stock	22	17	14	45	35	35	19	40	21	29	33	51	361	2.8
	Large stock	35	28	28	21	23	252	31	24	43	15	200	62	759	6.0
	Agriculture	227	217	237	139	118	96	138	146	141	42	94	198	1,790	14.1
	Self employment	421	306	325	415	466	348	339	361	405	320	279	303	4,287	33.8
	Total (Tk.)	1,279	1,074	1,032	1,011	1,009	1,090	998	1,070	1,089	899	1,043	1,113	12,694	100.0
	Total (%)	10.1	8.5	8.1	8.0	7.9	8.6	7.9	8.4	8.6	7.1	8.2	8.8	100	
Village	Fishing	11	5	25	60	76	117	123	89	43	36	19	5	608	3.2
	Fish trading	0	0	0	0	0	0	0	6	6	8	7	0	27	0.1
	Fish culture	0	0	(1)	(1)	0	1	(1)	2	6	21	5	18	52	0.3
	Agricultural labour	292	248	161	120	116	70	154	155	200	232	143	185	2,073	10.9
	Non-agric. labour	228	200	204	363	192	194	193	230	218	292	248	259	2,820	14.8
	Small stock	26	21	18	76	44	37	21	47	31	31	31	40	424	2.2
	Large stock	154	222	125	168	151	292	100	82	111	85	226	141	1,856	9.8
	Agriculture	709	713	665	607	476	578	490	488	579	339	516	608	6,767	35.6
	Self employment	405	366	360	478	399	378	318	326	350	335	255	414	4,381	23.0
	Total (Tk.)	1,825	1,775	1,557	1,871	1,454	1,667	1,398	1,425	1,544	1,379	1,450	1,670	19,008	97
	Total (%)	9.6	9.3	8.2	9.8	7.6	8.8	7.4	7.5	8.1	7.3	7.6	8.8	100	

Note: Data for village derived from weighted average of all categories

Figure 4.11 Seasonal variation in the distribution of income in agricultural villages - North West



Significance of Fishing to Different Groups - South West

Professional fishermen in fishing villages

Professional fishermen in the South West have a higher average income than those in either the North West or the North East. The breakdown of their income is shown in Table 4.17 and Figure 4.12. All fishing categories earned similar total incomes (around Tk.24,000), though the balance between different sources varied.

The HFC1 households earned only around 60% of income from the fishing, but other fish-related sources (fishing labour, fish trading and fish culture) took this up to nearly 94% of the total. Month to month variation is high, even discounting the unnaturally low incomes in *Baishak* due to cash outflows related to fish trading. Open-water fishing and fish culture are used as complementary features of the overall strategy. The former is particularly important in the period August-December; the latter cuts in towards the end of this period but continues on into the dry season.

The HFC2 households earn slightly more (Tk.16,500) than the HFC1 from open-water fishing, which is close to or above the total annual income of many fishing households in the North East and North West. But their sources are more diversified, they get less from fishing labour and more from farming and agricultural labour (15% together). One particular feature of HFC2's incomes is their seasonality, with a steady rise from *Baishak* (March/April), a peak in *Ashwin* (August/September) and then a steady fall until *Choytra* (February/March).

The HFC3 households are diversified again. Fishing incomes are lower (Tk.10,000), at around 45% and activities unrelated to fishing make up more than half the total, with significant contributions from farming (19%) and non-agricultural labour (18.8%).

Fishing in agricultural villages

Fishing was a major contributor to household incomes for the wider agricultural community in the South West. The seasonal character of the fishery does not support a completely specialised sub-group of professional fishermen, as it does in the other regions. Further fishing here is an activity which all groups feel little hesitation in taking up, when the opportunities arise, whether it be for subsistence or income.

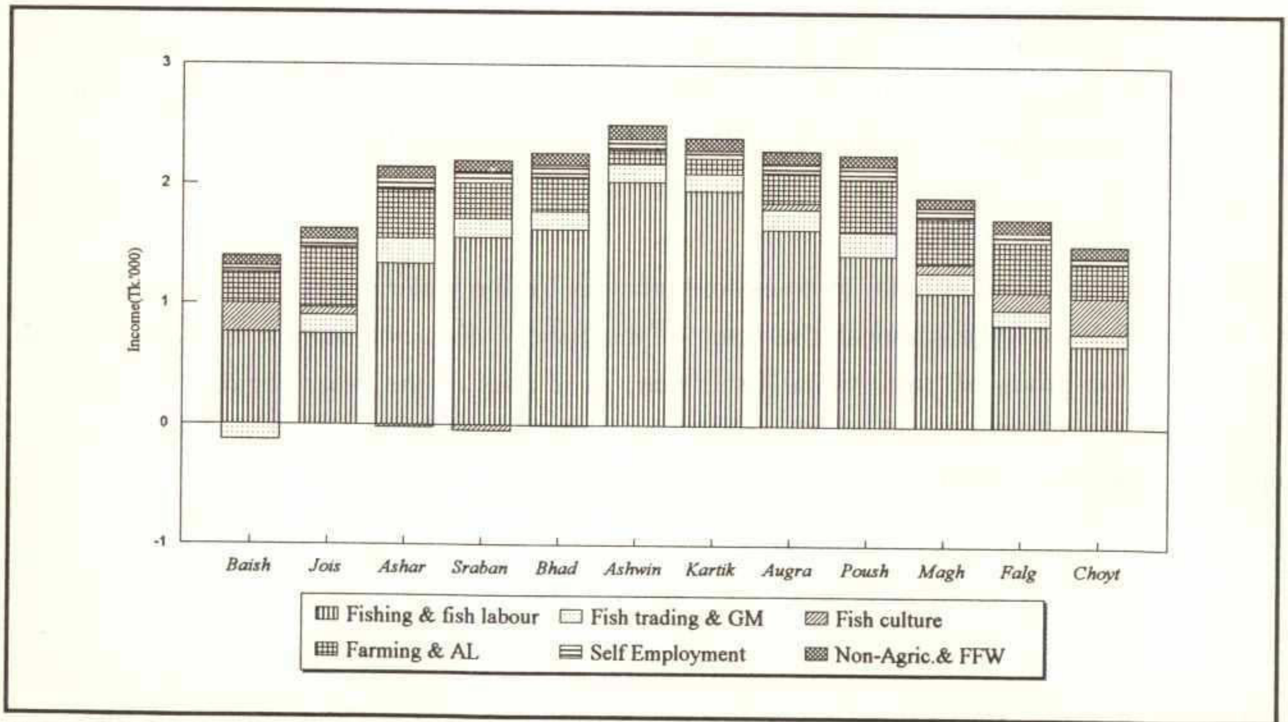
Table 4.17 Income by different household fishing categories in fishing villages - South West

Units: Tk.

	Activity	Baish	Jois	Ashar	Sraban	Bhad	Ashwin	Kartik	Augra	Poush	Magh	Falg	Choyt	Total	%
		Mar/Apr	Apr/May	May/Jun	Jun/Jul	Jul/Aug	Aug/Sep	Sep/Oct	Oct/Nov	Nov/Dec	Dec/Jan	Jan/Feb	Feb/Mar		
HFC1	Fishing	1,032	1,056	809	875	523	1,805	1,642	1,460	1,430	1,265	1,184	1,007	14,088	60.2
	Fishing Labour	90	87	235	180	116	84	70	815	762	556	411	429	3,835	16.4
	Fish Trading	(1,058)	330	500	275	171	87	86	15	0	106	127	72	711	3.0
	Fish Culture	929	316	(129)	(224)	(36)	0	0	110	0	235	735	1,346	3,282	14.0
	Gear Making	0	0	0	0	0	8	0	0	0	0	0	0	8	0.0
	Farming	21	29	31	14	27	43	9	5	5	25	33	23	265	1.1
	Agricultural Labour	96	84	0	0	0	0	0	0	50	131	150	127	638	2.7
	Self Employment	4	3	7	10	5	142	142	10	4	5	4	4	340	1.5
	Non-Agric.& FFW	0	84	50	0	0	0	18	38	38	0	0	0	228	1.0
	Total	1,114	1,989	1,503	1,130	806	2,169	1,967	2,453	2,289	2,323	2,644	3,008	23,395	100.0
HFC2	Fishing	573	617	1,656	1,918	2,261	2,271	2,249	1,622	1,399	907	585	459	16,517	68.7
	Fishing Labour	119	107	97	77	68	73	79	147	150	162	132	144	1,355	5.6
	Fish Trading	72	86	104	79	123	139	107	150	157	186	102	91	1,396	5.8
	Fish culture	89	(3)	4	(4)	(3)	(4)	(3)	(1)	(1)	4	11	41		
	Gear Making	7	11	16	13	3	13	10	7	13	8	8	11	120	0.5
	Farming	107	255	243	228	188	73	60	121	250	175	132	45	1,877	7.8
	Agricultural Labour	171	182	128	75	29	20	36	114	178	270	296	236	1,735	7.2
	Self Employment	18	29	47	51	57	38	7	23	56	66	46	22	460	1.9
	Non-Agric.& FFW	62	50	17	26	42	73	58	58	44	27	68	72	597	2.5
	Total	1,218	1,334	2,312	2,463	2,768	2,696	2,603	2,241	2,246	1,805	1,380	1,121	24,057	100.0
HFC3	Fishing	908	696	1,162	1,324	1,200	705	987	945	714	629	836	751	10,857	45.8
	Fish Trading	0	0	0	0	0	0	0	0	70	0	0	0	70	0.3
	Fish Culture	3	3	0	0	0	0	0	66	0	63	2	2	139	0.6
	Gear Making	50	50	50	60	60	53	63	106	106	35	47	39	719	3.0
	Farming	113	731	547	190	674	151	346	284	516	306	390	262	4,510	19.0
	Agricultural Labour	162	187	81	53	45	22	40	125	180	219	207	195	1,516	6.4
	Self Employment	89	101	141	131	122	109	109	135	154	117	111	104	1,423	6.0
	Non-Agric.& FFW	268	227	421	406	478	408	349	413	411	407	355	316	4,459	18.8
	Total	1,593	1,995	2,402	2,164	2,579	1,448	1,894	2,074	2,151	1,776	1,948	1,669	23,693	100.0
Comm-unity	Fishing	634	635	1,215	1,458	1,549	1,946	1,869	1,386	1,178	903	694	512	13,977	58.3
	Fishing Labour	125	113	120	95	74	79	82	244	239	212	154	166	1,703	7.1
	Fish Trading	(160)	126	173	117	122	115	107	119	134	140	95	77	1,165	4.9
	Fish Culture	241	63	(24)	(48)	(9)	(2)	(2)	51	0	77	154	299	802	3.3
	Gear Making	29	32	36	38	29	34	34	52	60	23	29	28	423	1.8
	Farming	101	315	316	248	258	98	103	136	279	136	169	59	2,218	9.3
	Agricultural Labour	157	187	91	54	30	17	26	114	166	240	246	219	1,548	6.5
	Self Employment	51	63	93	95	96	92	68	78	105	93	78	53	966	4.0
	Non-Agric.& FFW	85	89	97	88	104	116	105	105	92	80	105	95	1,161	4.8
	Total	1,263	1,624	2,118	2,146	2,253	2,495	2,391	2,286	2,254	1,903	1,723	1,508	23,963	100.0

Note: Data for community were based on the weighted average of all households sampled

Figure 4.12 Income by different household fishing categories in fishing villages - South West



Note: Data in figure include fish culture but these were omitted in tabulated data

This is reflected in the participation rates of different groups in the fishery, shown in Table 4.18. Though the region has a slightly higher rate (29%) of non-participation than North Central (27%), fishing is important for all. Interestingly, it is the landless that have the highest non-participation rate of all groups (37%) but, of those who do fish, the majority do so for income - the only agricultural village group for which this is true in any region. The greater interest in fishing as a source of income is also shared by both small and medium farmers: in the South West, fishing was ranked as a source of income by 26% and 15% of these groups respectively, compared to 12% and 11% in the North West, the next highest region.

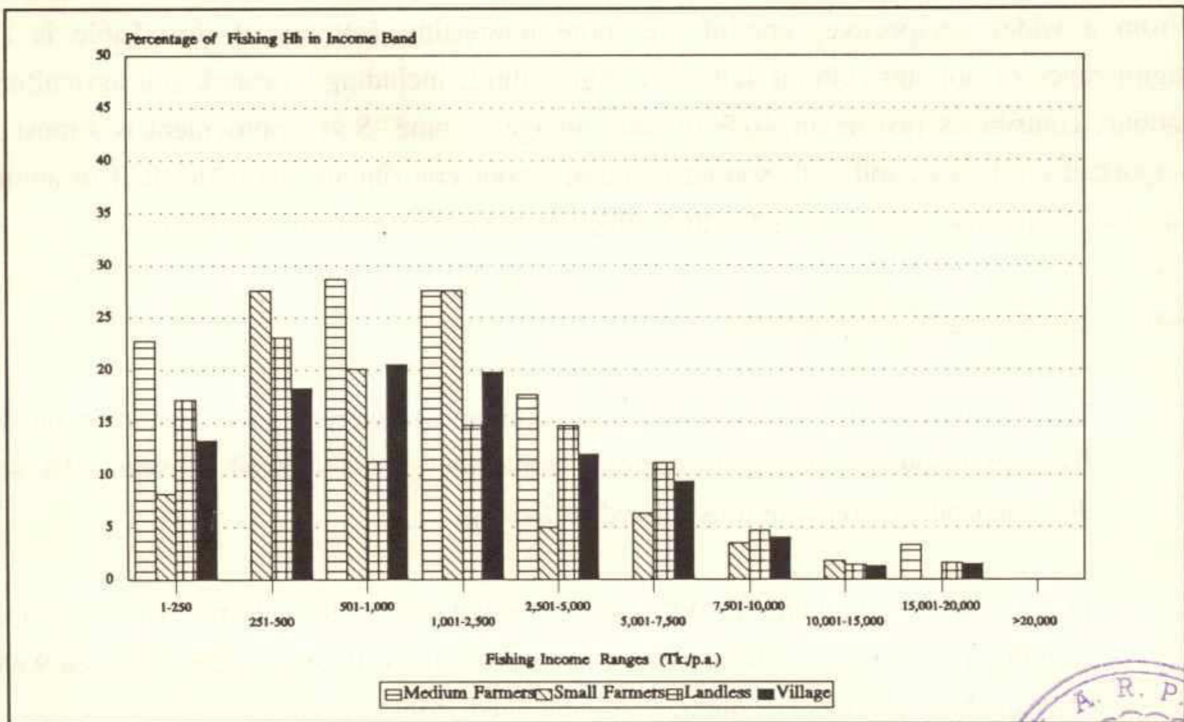
Table 4.18 Fishing participation (%), South West

Category	For Income	Subsis -tence	Non-fishing
Medium Farmers	15	60	24
Small Farmers	26	48	33
Landless	32	29	37
Village	27	44	29

Source: FAP17 Census and Supplementary Surveys

Note: Data for village derived from weighted average of all categories

Figure 4.13 Distribution of fishing income for fishing households, South West



Note: Data for village derived from weighted average of all categories

The distribution of fishing households across income bands is shown in Figure 4.13. The modal range is, again, Tk.500-Tk.1,000 but the distribution is less sharply peaked than in the North West, with a greater proportion of households on either side of the mode. Like the North West, there is a long tail to the distribution, with a significant proportion (28%) of fishing households catching fish worth more than Tk.2,500 per annum.

In the agricultural communities monitored in the South West, the overall participation rate was not as high as in North Central, and the levels of income earned by households that did fish was not as high as for the North West. But the combination of high participation and high incomes, gave villages in the South West the highest dependence on fisheries income.

The overall distribution of income through the year for each landholding category and for the village is given in Table 4.19 and the distribution for the latter is shown in Figure 4.14. Fishing contributes just over 10% of annual income, reaching a peak of over 20% in the Bangla month of *Ashwin* (mid-August to mid-September). For the landless this seasonal income is even more important, as it represents a little less than a third of the total at this time.

From a wider perspective, one of the more interesting features of this Table is the significance of non-agricultural activities. Agriculture, including livestock and agricultural labour, contributes just under 40% of total village income. Self-employment is almost as important on its own and with non-agricultural labour contributes just under half of annual income. Naturally, what is true for the village is even more true for the landless.

4.6 Summary and Conclusions

1. The incomes of households in fishing communities were highly dependent on the fisheries resource - across all regions, those households showed between 50% and 90% dependence on activities related to fishing.

2. In the North West and South West regions, small and landless farmers in agricultural communities were significantly dependent on fisheries. In those areas, between 9 and 15% of these farmers' incomes were generated from fisheries.

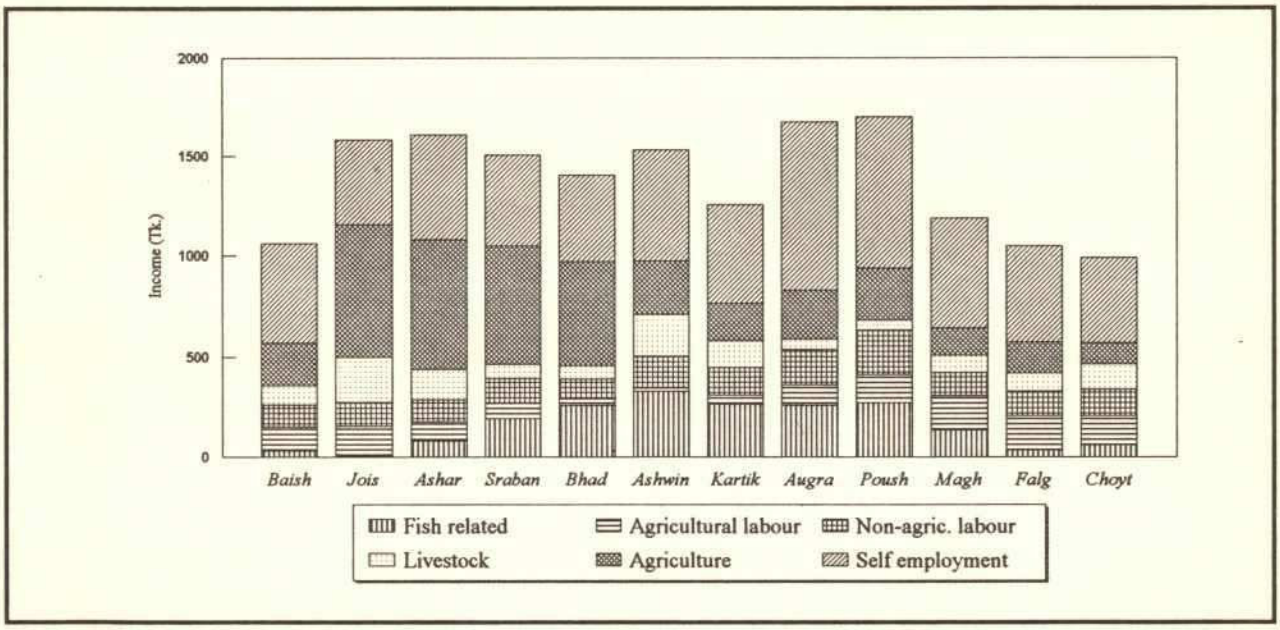
Table 4.19 Sources of income by landholding category in agricultural villages - South West

Units: Tk.

Category	Activity	*Baish* Mar/Apr	*Jois* Apr/May	*Ashar* May/Jun	*Sraban* Jun/Jul	*Bhad* Jul/Aug	*Ashwin* Aug/Sep	*Kartik* Sep/Oct	*Augra* Oct/Nov	*Poush* Nov/Dec	*Magh* Dec/Jan	*Falg* Jan/Feb	*Choyt* Feb/Mar	Total	%
Medium Farmers	Fishing	11	13	32	113	164	269	149	204	101	109	28	5	1,195	4.2
	Fish culture	0	(38)	(31)	(2)	0	(38)	(27)	(1)	339	141	49	94	487	1.7
	Agricultural labour	7	0	0	0	0	14	0	1	0	0	0	0	23	0.1
	Non-agric. labour	195	204	225	211	194	180	177	201	205	111	111	204	2,216	7.9
	Small stock	28	32	14	41	17	33	24	37	28	22	41	24	339	1.2
	Large stock	307	297	68	44	30	157	470	33	47	125	263	522	2,361	8.4
	Agriculture	458	1,841	1,422	1,707	1,261	668	761	710	595	432	174	347	10,374	36.8
	Self employment	704	852	1,537	631	642	921	822	1,398	1,069	1,056	851	679	11,161	39.6
	Total (Tk.)	1,710	3,201	3,267	2,745	2,308	2,204	2,376	2,583	2,384	1,996	1,517	1,875	28,156	100.0
	Total (%)	6.1	11.4	11.6	9.7	8.2	7.8	8.4	9.2	8.5	7.1	5.4	6.7	100	-
Small Farmers	Fishing	45	11	29	142	229	307	231	148	69	22	18	11	1,259	7.3
	Fish culture	44	(1)	(36)	(36)	(83)	(29)	36	32	130	73	2	93	226	1.3
	Agricultural labour	91	118	55	56	9	8	53	86	98	144	154	110	981	5.7
	Non-agric. labour	115	133	77	104	89	150	116	128	146	102	94	114	1,365	7.9
	Small stock	31	32	45	19	30	25	17	18	20	29	23	26	314	1.8
	Large stock	90	291	156	88	78	425	93	48	52	125	104	103	1,652	9.6
	Agriculture	251	752	978	617	483	263	112	280	372	147	233	69	4,556	26.4
	Self employment	493	388	474	574	554	602	509	1,028	895	518	485	392	6,910	40.0
	Total (Tk.)	1,160	1,724	1,778	1,564	1,389	1,751	1,167	1,768	1,782	1,160	1,113	918	17,263	100
	Total (%)	6.7	10.0	10.3	9.1	8.0	10.1	6.8	10.2	10.3	6.7	6.4	5.3	100	-
Landless	Fishing	27	6	132	237	290	332	268	292	151	66	31	12	1,843	14.4
	Fish trading	0	0	0	0	4	7	8	12	43	0	0	0	73	0.6
	Fish culture	0	0	3	0	(2)	(1)	(5)	9	45	6	2	0	57	0.4
	Agricultural labour	162	199	156	111	48	21	58	139	207	230	217	201	1,747	13.6
	Non-agric. labour	54	50	109	127	84	151	148	225	300	118	154	125	1,643	12.8
	Small stock	18	24	8	16	16	13	6	24	9	9	10	12	163	1.3
	Large stock	0	138	168	22	28	12	12	3	5	0	0	0	386	3.0
	Agriculture	45	206	184	181	276	159	68	91	71	2	62	51	1,393	10.9
	Self employment	597	333	347	377	317	453	427	765	675	454	393	396	5,531	43.1
	Total (Tk.)	903	956	1,107	1,071	1,061	1,147	990	1,560	1,506	885	869	797	12,836	100
	Total (%)	7.0	7.4	8.6	8.3	8.3	8.9	7.7	12.2	11.7	6.9	6.8	6.2	100	-
Village	Fishing	29	9	90	204	261	344	272	255	128	70	30	11	1,701	10.3
	Fish trading	0	0	0	0	3	4	5	8	11	0	0	0	30	0.2
	Fish culture	4	(6)	(9)	(11)	(5)	(20)	(11)	(5)	132	65	6	51	192	1.2
	Agricultural labour	120	151	97	74	30	17	45	103	141	172	171	144	1,264	7.6
	Non-agric. labour	107	119	108	126	102	161	138	176	222	115	122	132	1,627	9.8
	Small stock	25	29	23	20	22	22	13	24	16	18	19	19	250	1.5
	Large stock	73	198	130	50	45	183	118	27	32	70	70	108	1,104	6.7
	Agriculture	212	657	644	585	516	264	185	244	259	136	157	105	3,961	23.9
	Self employment	492	427	528	460	429	556	490	843	757	543	476	421	6,420	38.8
	Total (Tk.)	1,062	1,584	1,611	1,508	1,403	1,531	1,255	1,675	1,698	1,189	1,051	991	16,549	100
	Total (%)	6.4	9.6	9.7	9.1	8.5	9.3	7.6	10.1	10.3	7.2	6.4	6.0	100	-

Note: Data for village derived from weighted average of all categories

Figure 4.14 Seasonal variation in the distribution of income in agricultural villages - South West



3. In all areas except the North East, fisheries accounted for significant portions of the incomes of the landless during the flood season. Between 10 and 25% of landless farmers' incomes in those areas was derived from fisheries during the flood season.

4. In agricultural communities in all regions, there were high levels of participation in fishing even by those groups which reported low-levels of dependence on fishing for their income. In North Central, North East and South West areas over 60% of all categories of farmers reported some participation in fishing.

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5 RECOMMENDED MITIGATION MEASURES

5.1 Background

According to recent fisheries sector reviews in Bangladesh, [31, 34] fish provides 80% of the dietary intake of animal protein and 7% of the total protein supply and yet per capita consumption of fish has reportedly decreased from about 12 kg/year in the early sixties to 7.5 kg/year in the late eighties. With an annual population growth of 2.4%, pressure on fisheries resources continues to increase. The Bangladesh Bureau of Statistics[35] estimated that there were about 750,000 professional fishermen employed in inland fisheries in 1987-88. However, very large numbers of people, perhaps as many as 70-80% of the rural population, engage in seasonal subsistence fishing on the floodplain during the wet season. This flood season is the time when many poorer households can gain access to a fishery. The relatively open access subsistence fishery therefore adds to the incomes and the animal protein intake of poor rural households. Value adding activities, particularly fish distribution and processing, also generate income and employment. Inland capture fisheries are thus of considerable importance in Bangladesh, as also seen by the contribution made to the annual fish catch which for 1991/92 was estimated at 480,000 t, about 50% of the national total.

The Government of Bangladesh has now recognised the significance of this resource and, in the sector objectives of the current Fourth Fiver-Year Plan, include increased fish production for improved nutritional standards and improved environmental management.

The rapid, large-scale expansion of flood control developments during the last three decades caused serious concern about their impact on fisheries. This concern increased during the eighties when estimated catches from floodplains began to fall. The prospect of further planned expansion of flood control projects under the FAP in nineties resulted in the establishment of the present study which aimed to provide quantitative assessments of the impacts of flood control on inland fisheries and to formulate technically feasible mitigation measures to reduce or avoid the identified adverse impacts.

In this section, the impacts of flood control on fisheries described earlier in the report (section 3.6) are summarised and used as a basis for recommended mitigation measures. Impacts and mitigation measures have been documented previously in a series of supporting volumes of fisheries studies covering individual flood control projects studied by FAP 17.

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5.2 Summary of Impacts

1. Loss of catch through loss of habitat

Whenever flood control projects reduce the area of flooded land there will be a loss of habitat for fish production. The results from unregulated floodplains, *beel* and canals outside eight flood control projects in four FAP regions showed that the annual fish yield or catch per unit area from this lost habitat varied geographically between regions and between different land heights. The yields given here refer to land heights within the flood phase series F2-F4 and ranged from 68 kg/ha to 202 kg/ha with an arithmetic mean value of 119 kg/ha.

2. Reduction in catch per unit area (CPUA)

Prior to the FAP 17 study, the general perception in Bangladesh was that FCD/I development had reduced fish catches through loss of habitat and reduced catch per unit area from the remaining regulated floodplains. The FAP 17 results revealed, however, a more complex relationship between catch, the degree of flood control, fish densities and the amount of fishing effort. Under full flood control annual CPUA was reduced by 81%; under controlled flooding for deepwater rice catches increased in two projects due to higher fishing effort, and was reduced in a third by 37%. Under partial flood control CPUA values were similar inside and outside three projects but were reduced in a fourth by 20% because of restricted entry of fish.

3. Reduced fish density/abundance

Of the four projects providing full flood control or controlled flooding, statistical analyses revealed that fish densities were significantly lower in two of them. In two projects which provided only partial flood control no significance differences in fish densities inside and outside embankments were detected. In a third, the MIP, significantly lower densities were found prior to cuts in embankments and significantly higher densities later in the year following several cuts which allowed fish through the embankments. It is concluded from these results that flood control can result in a significant reduction in biological productivity by decreasing fish abundance even when sluice gates provide restricted access to floodplains.

4. Increased fishing effort

Under full flood control, lower flooding substantially reduced the opportunities for fishing and the amount of fishing effort per unit area of floodplain compared with that on unregulated floodplains. In contrast, controlled river flooding provided more stable and predictable hydrological conditions which stimulated increased fishing effort by small-scale subsistence gears along village shorelines. This increase in fishing effort resulted in higher catches from regulated floodplains than on unregulated areas. In three projects providing partial flood control, fishing effort was again higher than outside. Increased effort invariably stemmed from the greater use of subsistence gears near homesteads. It is not known at present what effect such increased fishing pressure has on the long-term sustainability of fish stocks.

5. Reduced biodiversity

Full flood control and controlled flooding had an adverse impact on fish diversity. The effect of full flood control was more severe and resulted in a reduction of 33% in the total number of species recorded annually. Projects which used controlled flooding in the North West Region reduced diversities by 19% to 25% while in the South West Region diversity was less affected (4% reduction) but this was due more to the relatively low diversity of migratory fish on both regulated and unregulated floodplains. Partial flood control had little adverse impact on biodiversity. Comparisons of different fish groups showed that there were greater reductions in diversities of migratory species than floodplain residents. Reductions of 95% and 29-45% were found for migratory species under full flood control and controlled flooding. These results demonstrate clearly the mitigating effect on species diversity of controlled flooding for deepwater rice compared with the impact of full flood control for HYV *t. aman*.

6. Reduction in migratory fish

The contribution to catches by migratory species was substantially reduced by full flood control and controlled flooding but relatively unaffected by partial flood control except in the MIP where a reduction on regulated floodplains of 19% was found despite cuts in embankments. The results showed that as the degree of flood control increased, catches of migratory species which included large, high-value species such as major carps and catfish, decreased.

7. Disruption of fish community structure

Results from analyses of catch compositions revealed that fish community structure in flood controlled areas was disrupted not only by a loss of riverine and migratory species but also by major changes in the composition of the remaining floodplain resident species. As the degree of flood control increased there was a corresponding loss in community heterogeneity and catches were increasingly dependent on a relatively small number of abundant floodplain resident species. Under these conditions there is a danger that the capability of fish stocks to sustain increased fishing pressure may be impaired and that disease outbreaks may be more frequent and damaging. At present it is not known how serious these potential problems may be.

8. Reduced fish migrations

Full flood control and controlled flooding reduced lateral fish migrations between rivers and floodplains in two ways; firstly, by reducing the number of entry points on to floodplains and thereby concentrating fish into fewer channels where they were more susceptible to capture, and secondly, by closing gates of regulators for extended periods during the pre-monsoon and monsoon. Controlled flooding did, however, offer greater opportunity for fish to enter floodplains than under full flood control since gates were opened intermittently to allow the entry of river waters for the cultivation of deepwater *aman*. Gate closures also blocked the entry of fish hatchlings carried downstream in rivers by passive drift and prevented them reaching nursery areas on floodplains. Even when gates were open, severe hydraulic conditions reduced densities and supply rates in regulated rivers. Submersible embankments used for partial flood control in the North East Region delayed entry of hatchlings and juvenile fish such as *rui*, *kalbaus* and *chapila*.

9. Increased capture at regulators

Several examples were seen across all types of flood control in which regulatory structures on rivers and canals were deliberately used to prevent or hinder the passage of fish and facilitate their capture. In other cases, structures by their very presence acted as obstacles to passage, for example the Charghat regulator on the Baral River in North West Region, provided the opportunity for the establishment of specialist fishing techniques to operate from the walls of the structure as fish were slowed or blocked during attempts to migrate upstream through open gates to the Padma River. On other rivers, regulator gates were opened for short intervals to allow the capture of incoming fish immediately downstream.

10. Reduced opportunity for mitigation measures

Exclusion of external river waters under full flood control for the increased cultivation of HYV *t. aman* substantially reduces the options available to mitigate against adverse impacts of fisheries compared with those available under controlled flooding for deepwater *aman*.

11. Reduced potential for stock enhancement

Whenever flood control results in a reduction in the extent and magnitude of flooding, the area available for potential stock enhancement by stocking floodplains with fish, is reduced. The severity of this impact is related directly to the degree of flood control exerted by the project and the topography of regulated floodplains. Under full flood control there would be little opportunity for extensive stocking of open-water floodplains.

Social and economic impacts depend on who is exploiting the fishery prior to flood control and the degree of flood control planned and achieved. In the present study, the project which provided the highest degree of flood control, the BRE, was not covered by socioeconomic surveys and therefore the greatest impacts undoubtedly went unrecorded. This also explains why it was extremely difficult to identify quantitatively any impacts which could be related solely to the effects of flood control since only those projects in which there were substantial monsoon floods were surveyed. It is possible, however, on the basis of information collected on the characterisation of fishing groups and their varying levels of economic dependence on capture fisheries, to identify several potential general impacts which are listed below.

i) Whenever full flood control effectively reduces the magnitude, extent and duration of flooding resulting in a decrease in fish production, all groups dependent on the fishery will lose income, a cheap source of animal protein and employment opportunities. The adverse impacts will affect subsistence, seasonal and professional fishermen, and also leaseholder and fish traders.

ii) Under controlled flooding for deepwater *aman*, professional fishermen may lose income through a reduction in the extent of public water bodies which they traditionally fished and through increased competition from agricultural communities.

iii) Under controlled flooding for deepwater *aman*, subsistence and seasonal fishermen can gain through increased fishing opportunity so long as they have access to waters.

iv) Where flood control allows greater control of drainage, fisheries leaseholders may make short-term gains through increased catches when *beel* and *khal* are drained almost completely by sluice gates or when sluice gates are closed temporarily to trap fish and increase their ease of capture. In the longer-term, however, these practices may be very damaging to the sustainability of fisheries.

5.3 Recommended Mitigation Measures

Effective planning for mitigation of fisheries losses in flood controlled areas requires an understanding of the nature of the impacts on the diversity and abundance of the fish resources affected. It also requires a knowledge of the rural communities which will be impacted and the magnitude and source of their losses. Finally, it is necessary to have available a range of management strategies and technologies which can be integrated into the overall management of the resources and which are viewed by the impacted communities of people as realistic and viable options.

During the course of the FAP, several short-term fisheries studies recommended aquaculture development as a principal means to compensate for losses to capture fisheries caused by flood control. In the present study, however, a clear distinction was drawn between compensation and mitigation strategies. Compensation measures rely on aquaculture and culture-based methods to increase fish production and thereby compensate, to varying degrees, for the lost tonnage of fish due to flood control. In contrast, mitigation measures are designed to reduce or avoid losses to capture fisheries and, if successful, also reduce or avoid the need for compensatory measures.

The FAP 17 study focused attention on the need for mitigation rather than compensation measures. This approach has been adopted for a number of reasons. Small-scale aquaculture developments such as the expansion of pond or cage culture or rice/fish culture systems cannot usually compensate for the potential loss to capture fisheries where extensive full flood control on low-lying floodplains is planned. Secondly, increases in cultured species cannot compensate for the loss in diversity of natural fish populations. Finally, beneficiaries of aquaculture developments are not usually those most severally affected by the loss of open-access fisheries; i.e. professional fishermen and other landless, poor sections of the rural community. Stock enhancement through open-water stocking of carps is reportedly a technically and economically viable option to increase floodplain fish production and further work continues both inside and outside flood control projects under the Third Fisheries Project.

In comparison, mitigation measures when tightly focused on identified impacts, can produce potential extensive increases in a large number of different fish species, including both large, high value migratory species and numerous small, cheaper species, thereby providing benefits to a broad spectrum of fishing groups within the rural community, ranging from the landless poor to land-owning farmers and leaseholders.

This does not imply, however, that aquaculture developments should not be encouraged. Indeed, the ODA has supported work in various aspects of fish culture in Bangladesh for many years, covering activities such as pond culture, cage culture, rice-fish culture and open-water stocking of floodplains. Many of these techniques could be developed further inside and outside areas of controlled flooding.

The recommended mitigation measures which are listed below include a series of initiatives for implementation within full flood control and controlled flooding areas, some of which have a particular regional focus which is noted wherever applicable. In addition, recommendations are made that involve institutional development, mainly within BWDB/

WARPO, which will facilitate the integration of fisheries development and aquatic resource management into water management and flood control systems.

1. Production of deepwater *aman* and capture fisheries

This mitigation measure questions a principal rationale of flood control: to convert low-lying seasonal wetlands to drier land where deepwater *aman* can be replaced by HYV *t. aman*. The numerous harmful impacts on capture fisheries caused by full flood control for the cultivation of HYV *t. aman* have been detailed in section 3.6 of this report. Contrary to the expectations of planners of full flood control projects, farmers in projects which were structurally secure and operationally functional, preferred to operate sluice gates to provide controlled flooding by external rivers for the continued production of deepwater rice rather than attempt to convert to HYV *t. aman* on lowlands prone to rainfall flooding.

This is the most effective mitigation measure to reduce losses to capture fisheries caused by full flood control and one which has spread through rural communities as a result of farmers' needs and preference. The measure is applicable to all lowland floodplains (F2-F3 flood phase categories) where local rainfall flooding cannot be drained by gravity because of high river levels. These areas cover most of those targeted by the Flood Action Plan, outside the North East Region.

2. Habitat rehabilitation and protection

This measure is designed to reduce the negative impact of flood control on fish production caused by loss of winter and pre-monsoon habitats. Important dry season habitats such as perennial *beel* and *baor* in which the magnitude, extent and duration of flooding have been severely reduced by flood control, should be rehabilitated by reconnection to original feeder river systems and maintenance of adequate dry season water levels. It is anticipated that canal re-excavation work will be needed inside and outside flood control embankments together with modifications to sluice gate operations referred to in mitigation measure number 3 below. This measure is applicable in higher land areas of full flood control and controlled flooding where strategic connections to external rivers can be made via canal systems leading to *beel* or *baor* without causing extensive flooding of surrounding agricultural land. It has considerable potential value in the North West Region in flood protected areas behind the Brahmaputra Right Embankment, in the PIRDP and in areas to the west along the Padma River. It also has potential in areas of the North Central Region where natural siltation has resulted in impacts on fisheries similar to those caused by flood control.

3. Increased fish migration across flood control structures

This measure is designed to increase fish production by increasing movements of fish and fry between rivers and floodplains. It requires no change to the design of structures but relies upon a modification to the operating schedule of sluice gates. Under full flood control there is little opportunity to introduce this measure as a realistic means of increasing fish recruitment on to floodplains because of the incompatibility of flood level requirements of HYV *t. aman*. In contrast, the measure offers considerable potential under controlled flooding for deepwater rice where small adjustments in gate operations at critical periods between June and July would allow the entry of major carp hatchlings at times when their densities and supply rates are at a maximum. It is anticipated that this measure would also result in increased species diversity as more migratory adult and juvenile fish would be able to reach floodplains together with hatchlings brought in by passive downstream drift. The measure is applicable to all floodplains which can support deepwater rice under natural and controlled flooding regimes and to the deeper *beel* areas associated with these floodplains.

A related mitigation measure has been established recently in the North East Region where a fish pass has been installed in the MIP to allow the passage of fish from floodplains to river against high water level differences during the pre-monsoon and early monsoon. The measure may have wider application on the Jamuna and Padma rivers where structures on regulated distributary rivers were shown by FAP 17 to block the upstream movement of many migratory fish.

4. Fisheries conservation: *beel* management

This measure is designed to increase the survival of fish broodstock during the dry season, a critical period in their life, when they are vulnerable to over-fishing in flood controlled areas. Increased survival of broodstock should result in a greater recruitment of juveniles into the following year's fishery which in turn should lead to increased fish productivity. The measure has national applicability and can be undertaken on a range of different types and sizes of perennial water bodies. It will involve the control of dry season *beel* and their conversion to temporary fish sanctuaries during the winter. This can be achieved most easily by the installation of large *katha* which prevent most opportunistic fishing methods and provide shelter for fish. On a smaller scale, the same approach can be adopted using artificial water bodies, *kua*, on floodplains particularly in the South West Region where they are very common. This measure should protect a large number of different fish species and therefore benefit to the fishery will be spread across a broad spectrum of fishing groups within the rural community.

5. Fisheries conservation: prohibited fishing zones on regulators

Flood control structures which block or delay movements of fish in rivers or canals thereby increasing their susceptibility to capture should be classified as prohibited fishing zones. Fishing from the structure itself and from a set distance upstream or downstream from it should be made illegal. Distances will vary depending on the size and location of the structure and the size and nature of the regulated water course.

6. Fisheries conservation: protection of river (*duar*) fisheries

Studies carried out by FAP 17 and FAP 6 have demonstrated the great importance of river *duar* (scour holes) as winter refuges for large species of fish, particularly catfish and major carps. *Duar* are presently included in riverine *jalmahal* where they are intensively fished by leaseholders during the dry season. FAP 6 has recommended prohibition of fishing *duar* during the dry season and the establishment of river patrols by DoF to enforce protective fisheries regulations. FAP 17 results support this measure as a means of conserving important overwintering broodstock of high value species which form the basis of both riverine and floodplain fisheries. This measure has particular relevance to the North East Region.

7. Conversion of full flood control to partial control

In areas such as the Manu Irrigation Project in the North East Region, full flood control and river confinement by embankments have resulted in higher flooding levels and increased frequency of damaging floods. Local people have responded by cutting embankments to reduce flooding of their homesteads. A similar situation was seen in Chalan *Beel* in the North West Region. In that area FAP 2 recommended converting full flood control projects to partial flood control to reduce flood levels and increase deepwater *aman* and fish production. This is also the recommendation made by FAP 17 for similar situations in the North East Region and specifically for the MIP.

8. Provision of flood pathways in extensive areas protected by submersible embankments

Examination of the impact on fisheries of a single partial flood control project in the North East Region revealed little cause for concern. However, the wider, cumulative effects of extensive contiguous developments were not investigated but FAP 6 expressed concern about the possibility of increasing flood levels in rivers due to channel confinement and sediment deposition. As a possible solution to this problem FAP 6 suggested that certain *haor* remain unregulated to reduce flood levels at critical points in rivers and allow wider deposition of silt loads. The option would benefit capture fisheries so long as siltation did not threaten the long-term survival of *beel* and thus overwintering fish broodstock. It is therefore recommended as a mitigation measure in those areas of the North East Region where extensive partial flood control developments exist or are planned.

9. Increased fish migration across rural roads

Unplanned rural road development, often supported by the Food for Work Programme, have resulted in blockage to floodwaters and fish on floodplains. The adverse impact of rural road construction was seen clearly in one study in the South West Region in which fisheries outside formal flood control areas were less abundant and diverse than in areas of partial flood control. To reduce the adverse impacts of rural road construction there is a need for institutional changes in the inter-sectoral planning process (see mitigation measure no. 10) and a practical change to ensure greater provision of culverts through roads wherever they cross existing canals or traverse extensive areas of open floodplain. Although this problem was identified clearly in the South West Region, the mitigation measure has national relevance to fisheries.

10. Strengthening of technical assessment and planning capabilities of BWDB/WARPO

There is a need to establish within BWDB/WARPO a multidisciplinary technical assessment unit comprising expertise from fisheries, agriculture, environment, hydrology and hydraulic engineering. The unit should be responsible for the re-evaluation of operating procedures of existing structures and for the examination of future flood control projects. Proposals for major new road or rail links should also be assessed by the unit in terms of their impact on flooding patterns, fisheries and agriculture. The eventual siting of the assessment unit would depend on the future roles of BWDB and WARPO.

11. Establishment of national database on FCD/I projects

A detailed and comprehensive national database should be established by BWDB to provide information on all flood control projects in Bangladesh and the major regulatory structures within these projects. The database should provide a basic description of the design and size of each structure, its function within the project area and its state of repair. Daily water level data at each structure should also be provided with computed head differences. The database should be made available, in a user-friendly form, to other government agencies.

12. Improvement of data collection by BWDB

There is an urgent need to improve the quality of data collection by BWDB personnel responsible for the operation of regulatory structures. Supervisory personnel should ensure that accurate detailed daily records are maintained of water levels at the structure (inside and outside), numbers of gates open and height to which each gate is opened. These data should be incorporated into the national database at monthly intervals.

13. Establishment of water-user groups

Local groups of water users should be established in flood control projects to represent the full range of sectors affected by modified flooding patterns. This should include capture fisheries as a water-user group. Representatives from each group should form a local committee in association with relevant government departments to establish operating procedures of regulatory structures. The committee would provide the mechanism for the establishment of local integrated water management.

14. Training within BWDB

An annual series of training courses should be established within BWDB to give engineers a basic understanding of the water requirements within each natural resource sector, focusing on fisheries and agriculture. The fisheries course should contain descriptions of identified adverse impacts of flood control on fish and various methods of mitigation against such impacts.

15. Development of flood modelling techniques

There is a need to continue the development of flood modelling techniques using the MIKE11 hydrodynamic model. The SWMC and FAP 19 are currently active in this field but require future support, both financial and technical, to continue to make progress. The work would require detailed field surveys to improve basic topographical information.

6 FUTURE RESEARCH REQUIREMENTS

FAP 17 investigations provided quantitative baseline data on several aspects of freshwater fisheries in various regions of Bangladesh. Because of the widespread nature of sampling effort and the relative short duration of field data collection (12-19 months), it was not possible to obtain a detailed understanding of the ecology, biology or population dynamics of even the few most important floodplain fish in relation to changes in flooding patterns. It is therefore important to use the baseline data of FAP 17 as a foundation for further longer term fisheries studies which should provide both greater detail and scope of research activities.

A series of mitigation measures has been recommended for implementation in the short or near term. This needs to be strengthened by further research, some basic, but most adaptive. Areas requiring more research work were identified during studies on each of eight flood control projects and in three ancillary supporting studies. Most of these have been documented previously in the supporting volumes of fisheries studies. From these studies a more generalised list of research topics has been compiled and is listed below.

1. Quantitative catch assessment surveys to obtain estimates of fish densities and yield per unit area of floodplain. These data, when collected over a long-term period of up to five years on representative floodplains and linked with a concomitant set of quantitative data on flooding patterns, will provide the first rational basis for the development of a floodplain fisheries model. This can then be used as a predictive tool to provide future advice on fisheries management and development.

2. Stock assessment using length frequency analysis and ageing techniques to obtain information on the population dynamics of selected species of fish and prawns dominating floodplain catches. This study will provide information on growth, mortality and the status of stocks and allow predictions to be made of the effects on fisheries of further increases in fishing pressure. This study is particularly relevant to flood controlled areas where higher levels of fishing effort have been recorded on fish communities in which diversity has been reduced and a greater dependence placed on a small number of floodplain resident species. The current status of the stocks of these species is not known.

3. Investigation of the biology and ecology of selected fish and prawn species dominating floodplain catches inside and outside FCD areas. Information collected should include data on age, breeding biology, feeding habits and micro-distributions in relation to seasonal changes in flooding and the distribution of aquatic vegetation including deepwater rice. The study should also include detailed limnological investigations which examine plankton, macroinvertebrates and water quality, particularly nutrient levels. The role of deepwater rice fields in providing shelter from certain fishing gears and natural predators in addition to providing food, should also be explored in detail. This study will provide an understanding of the overall functioning of the dominant fish and prawn community in relation to open-water habitats and deepwater rice fields.

4. Assessment of the impact of FCD projects on the diversity of fish and prawns. Standardised systematic, intensive sampling is required to record not only the more common species but also the numerous rarer species which may be more vulnerable to adverse impacts of flood control.

5. A national capability to provide systematic quantitative information on geographical variations in diversity of aquatic resources of Bangladesh should be established. This measure is designed to improve the basic knowledge of the diversity of fish, shrimp and prawns and to identify environmental problems, including flood control, linked with reductions in biodiversity. This information can then be considered at the project identification and planning stage of future developments which impact on aquatic resources. The measure should involve the strengthening of institutions such as DoF and FRI through training in a) fish taxonomics b) procedures for the establishment of fish reference collections c) methods for planning and implementing field surveys and sample collections and d) data analysis. It is anticipated that there would be a need to assist institutions in the design and implementation of national field surveys and sample collections.

6. Investigation of the movements of fish and prawns between rivers and floodplains which are free-flooding and others on which flooding is controlled. This study will require continuous daily monitoring of catches in canals linking rivers with floodplains. Tagging studies may also be employed if preliminary studies indicate that the method provides useful information.

7. Investigation of movements by passive downstream drift of fish and prawn hatchlings between rivers and floodplains in relation to seasonal changes in river discharge. This study is essential on the BRE where the Jamuna River provides an annual supply of hatchlings of major carps and many other species of fish.

8. Investigation of the impact of water regulators on the survival and movement by passive downstream drift of fish and prawn larvae in relation to seasonal changes in river discharge. This study has particular relevance on the Brahmaputra/Jamuna and Padma rivers.

9. Determination of water velocities from a range of different types of structures operating under varying head differences and gate openings. These data should be collected by BWDB and incorporated into a national database on water regulators.

10. Determination of swimming speeds of selected fish species. This work requires carefully controlled laboratory flume studies and therefore the most appropriate approach may be a joint study between the Fisheries Research Institute (FRI) and the River Research Institute. Results from this study would be related to data on water velocities at regulators to provide quantitative management advice on the operation of various types of regulator.

11. Integration of biological information derived from research studies (numbers 6-10) and flood modelling techniques to improve the predictive capability of impact assessments of flood control projects and assist in the design of future water regulator structures. This work requires institutional collaboration between fisheries research organisations and hydrodynamic modelling specialists such as the SWMC, Dhaka.

12. Identification of possible spawning grounds of major carps in the Brahmaputra and Padma rivers in Bangladesh and investigation of upstream breeding migrations in these rivers.

13. Investigation of the migrations of fish along rivers of the North Central Region to identify possible environmental factors which might explain the general scarcity of riverine and migratory species compared to some other regions in Bangladesh.

7 GUIDELINES FOR FCD/I PROJECT APPRAISAL

7.1 Existing Guidelines

During the course of the Flood Action Plan, much attention has been focused on the development and application of environmental impact assessments in the planning of project appraisals. Between July 1991 and October 1992, series of reports entitled Guidelines for Environmental Impact Assessment (EIA), were prepared by Irrigation Support Project for Asia and the Near East (ISPAN) with support from the US Agency for International Development towards the FAP 16 Environmental Study component of the Flood Action Plan. The objectives of the EIA Guidelines were to identify environmental impacts including those on fisheries, of proposed plans, programmes and projects, and thereby:

a) assist decision-makers and in making informed decisions on project developments and resource allocation;

b) provide where possible quantitative environmental information so that potential impacts could be avoided in project and programme design; provide a basis for the development of management measures to avoid or reduce negative impacts; and provide an environmental management plan for each project to promote sustainable development.

The Guidelines were developed from similar guidelines used in industrialised and developing countries on a variety of water resource developments and by various government and donor agencies but modified to satisfy the needs of the Flood Action Plan of Bangladesh. The Guidelines specifically addressed EIA at the pre-feasibility and feasibility levels of project design but not programmes or policies. They were intended to be used in close conjunction with Guidelines for Project Assessment which provided guidance on the economic appraisal of regional plans and individual flood control projects. In all sectors covered by the Guidelines the information requirements were the same at both pre-feasibility and feasibility stages of projects design, however three were differences in the level of detail and scale of data and information used. It was recommended that pre-feasibility studies rely on existing information supplemented where needed by rapid field reconnaissance methods. Feasibility studies however, required more specific investigation and longer-term data collection programmes. The pre-feasibility studies within the FAP were designed to address regional planning options for water resource development. The main objective at this stage was to establish the range and potential magnitude of impacts, identify key issues and compare the consequences of alternative options for flood control. At feasibility level EIA provided the basis for detailed impact assessments on selected project options, mitigation and compensation plans, and the design of post-project monitoring programmes.

The Guidelines also included detailed lists of information requirements which, under biological resources, covered capture and culture fisheries in addition to similarly detailed lists for water resources, agriculture, social and economic conditions.

7.2 Weakness of Existing Guidelines

Information requirements listed in the Guidelines for assessment of the impact of flood control on fisheries were detailed and wide-ranging. They included physical quantification of a range of different aquatic habitats with accompanying maps. They also called for descriptions of the chemical and limnological environment in each habitat and their seasonal variations. A detailed and comprehensive list of data requirements was almost compiled for the fisheries. Types of information needed comprised the following:

i) General description of fish community structure and species diversity in each habitat (including prawns and shrimp) together with indications of how these change in relation to the hydrological cycle.

ii) Definition of the fish population structure in terms of dominant species; rare or threatened species; life stages (larvae, fry juveniles, adults); stages of maturation and spawning grounds by season and species. Description of how the population structure changed in relation to changes in the hydrological cycle.

iii) Description of the migratory behaviour of species present and their dependence on the hydrological cycle.

iv) Description of the types of gears used by different categories of fishermen with an indication of how each gear is used in relation to each habitat and to changes in the hydrological cycle.

v) Quantification of the seasonal intensity of fishing in the various habitat types by numbers of gears units for each category of fishermen and/or numbers of fishermen per unit of habitat and time. Desirable statistics included catch per unit effort expressed as weight of fish caught (by species if possible) per category of fishermen per unit fishing time.

vi) Computation of the total fish production (including shellfish) in the area, on a monthly basis, for each habitat type. This should include the distribution of species, fishermen category, gear type and flood season.

vii) Description of the fisheries management area including the type of leasing system used and an indication of the strength of enforcement of fisheries regulations. Any management practices such as fish stocking programmes were also to be included.

viii) Description of fish landing and marketing practices identifying traders, landing sites, markets fish processing plants and distribution routes.

For the aquaculture sector an equally detailed list of information requirements was also compiled in the Guidelines.

Whilst the scope and level of detail included in the information requirements of the Guidelines are impressive there are some weaknesses in a) the proposed procedures for the utilisation of such information, b) a lack of guidance on how such data should be obtained and over what time scale in project design and planning and c) a lack of guidance on how the data should be used in conjunction with the anticipated changes in flooding patterns resulting from proposed flood control projects.

The Guidelines were issued for use in ongoing and future FAP and similar flood control, drainage, irrigation and water management projects. It was suggested by ISPAN that the Guidelines be viewed not as an inflexible set of rules but should be modified and updated to incorporate new data provided by field investigations. In the following section recommendations are made to improve certain areas of weakness.

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7.3 Recommended Procedures to Strengthen Guidelines

A concluding report based on the findings of the Flood Action Plan put forward a series of proposals for further large-scale flood control developments in Bangladesh.[36] In addition, there are a number of other large-scale flood control developments currently in operation outside the auspices of the FAP. These include projects such as the Systems Rehabilitation Project and the Small-Scale Water Resources Development Sector Project,[37] both of which aim to rehabilitate flood control projects and return them to conditions whereby they can fulfil their original design objectives. Both projects are extensive, for example, the Small-Scale Water Resources Project includes 400 projects covering a total area of 144,000 ha. BWDB also has its own programme of rehabilitation and new developments which fall outside the FAP. Of the eight projects studied by FAP 17, there were proposals in six of them for further flood control developments (Table 7.1). In view of these extensive on-going developments and large-scale proposals put forward by the FAP, it is important to ensure that the results of FAP 17 are widely circulated and used to improve the present Guidelines for Impact Assessment.

The first weakness identified in the existing Guidelines refers to the requirement that pre-feasibility studies be based principally on existing information on the fisheries resource. Prior to the FAP 17 study, there was little reliable, detailed quantitative information on fisheries. There was also a lack of understanding of the complex interactions between fish yield, fish densities and fishing effort and the impact on these of different types of flood control. As a result many projects passed through to the feasibility level of project design without adequate considerations being given to the impact on capture fisheries. This problem still exists today despite the considerable volume of data collected by FAP 17 which is available in the form of a fisheries database held by both the Department of Fisheries and the Flood Plan Coordination Organisation. In the absence of wide dissemination of the baseline data and guidance on the utilisation of the information, there is a danger that current large-scale developments will continue to operate using a traditional, uninformed approach to flood control which does not take account of current policies of integrated water management developed largely as a result of the FAP.

Table 7.1 **Future flood control proposals in projects studied by FAP 17**

Type of flood control	Name of project	Proposals for future flood control
Full Flood Control	Brahmaputra Right Embankment (BRE) (NW)	1. FAP 1: embankment strengthening and river training to prevent erosion. 2. Construction of Jamuna Bridge.
Controlled Flooding	Pabna Irrigation and Rural Development Project (PIRDP) (NW)	1. Completion of PIRDP Phase I pumped drainage for HYV *t. aman* cultivation. 2. PIRDP Phase II based on completion of Phase I.
	Chalan *Beel* Polder B (NW)	1. FAP 2: partial and full flood control. 2. BWDB: rehabilitation for full flood control.
	Satla-Bagda Project Polder 1 (SBP) (SW)	1. BWDB: rehabilitation for full flood control.
Partial Flood Control	Shanghair *Haor* Project (SHP) (NE)	None known
	Manu Irrigation Project (MIP) (NE)	1. FAP 6: river flood reduction by Manu River diversion to Hakaluki *Haor*. 2. Systems Rehabilitation Project: rehabilitation of MIP for full flood control and irrigation.
	Chatla-Fukurhati Project (CFP) (SW)	None known
	Compartmentalization Pilot Project (CPP) in Tangail (NC)	1. Completion of CPP 2. Construction of Jamuna Bridge resulting in closure of distributary river feeding CPP.
River Regulation	Baral Basin Development	1. BWDB: construction of a second regulator on Baral River for irrigation of winter rice on higher floodplains.

To counter this problem it is recommended that the results of FAP 17 be made available as widely and rapidly as possible following the standard examination procedures adopted by the FPCO. It is recommended that the current estimates of fish yield ranging from 68 kg/ha to 202 kg/ha from unregulated floodplains form the basis of preliminary estimates of the magnitude of the fish resource in the regions studied. It is also recommended that FAP 17 results should be used separately for each region because of the wide geographical variations recorded. The estimates of yield per unit area should be used in conjunction with flood simulation models to estimate the area of flooded land lost by flood control. However, other identified adverse impacts such as the loss of species diversity are extremely difficult to quantify in economic terms.

The detailed list of information requirements contained in the Guidelines can only be obtained through quantitative surveys such as those completed by FAP 17. These studies demonstrated clearly that it is possible to complete complex, detailed fisheries appraisals using catch assessment survey techniques undertaken on the water. It is recommended therefore, that this approach be employed whenever the objective is to obtain quantitative descriptions of fisheries resources such as those outlined in the Guidelines. The survey techniques can be adjusted and refined to satisfy the requirements of different types of quantitative surveys. The database and its documentation are available in Bangladesh and field surveys methods have been described in the Inception and Interim Reports of FAP 17 and documented again in Appendix 3 of the Final Report.

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APPENDIX 1

Appendix 1 List of fishing gears recorded during FAP 17 surveys in Bangladesh

Gear Type	Name	Code	Description
Gill Net	*Current jal(Stationary)*	88	Monofilament fixed gill net, usually small mesh
	Current jal(Drifting)	282	Monofilament drifting gill net, usually top set, any mesh size
	Koi jal	123	Multifilament fixed gill net, usually small mesh
	Chandi jal	65	Multifilament drifting gill net, usually top set, any mesh size
	Par jal	315	Multifilament drifting gill net, usually bottom set, large mesh
	Kajuli jal	316	Multifilament drifting gill net, usually bottom set, small mesh
	Awo jal	324	Multifilament fixed gill net set in zig-zag pattern to catch large fish
	Foot jal	327	Very small gill set horizontally at surface in shallow water
	Gai Dasem	132	Drifting net used in rivers, has pockets at base
Seine Net	*Ber jal*	45	Seine net: small, medium or large size
	Baoli jal	306	Medium sized seine net pulled by 2 ropes
	Moi jal	202	Small drag net with pockets at base
	Dora jal	325	Similar to moi jal but pulled by 2 long ropes
	Konaber jal	268	Seine net with pocket at one end
	Dhor jal	89	Small seine usualy pulled by 2 men by sticks on each end of net
	Horhori	297	Seine net with a series of large pockets along net
	Kathi jal	175	Seine net with a series of vertical sticks along net
	Chabi jal	293	Seine/gill net pulled to shore, often used with polo traps
	Hat panch	276	Medium size seine pulled at each end by one man while man in boat beats water to drive fish into net
	Satiber jal	304	Seine net with a series of pockets at base
	Kachitana	277	Type of lift net hung from boat on floodplain or beel. Net used with drag rope to drive fish into net.
	Ferra jal	126	Drag rope used to drive fish into gill net/seine net
Bag Net	*Thaga*	285	Barrier across river with bag nets set perpendicular to it
	Suti jal	271	Single bag net staked to river bed
	Ghori jal	320	Barricade/fence with nets set in gaps to trap fish
	Bhuti jal	328	Clap net on bamboo frame hung from boat anchored in a gap of barrier fence
Lift Net	*Veshal*	266	Triangular lift net on large bamboo frame
	Dharma jal	105	Square or round lift nets on bamboo pole
	Jhali jal	160	Small veshal used on main rivers at night for prawns
	Jhap jal	319	Boat lift net: lifted at 4 corners by men in boats
	Chota jal	323	Gill net fixed horizontally on bottom to catch fish by spines
	Dara jal	329	Lift net and barrier used in canals or small rivers
Scoop Net	*Hat Tana*	287	Oval or triangular scoop nets used with pole and rope or by hand
	Ucha	263	Basket scoop on pole used by hand
	Tukri	296	Small basket scoop used by hand
	Afa/Hat bauli	321	Large thella jal, large mesh, used on boat
	Uttar jal	68	Like a cast net but hung from a boat drifting along river and lifted to catch fish
Clap Net	*Shangla jal*	234	Multifilament drifting bag net on bamboo frame boat used for hilsa fishing
FAD	*Katha*	270	Submerged brush shelter used to attract fish
	Boat Katha	314	Submerged boat filled with branches used to attract fish
	Horgra	149	Submerged basket filled with branches used to attract fish
	Kua	302	Fish pit on floodplain, invariably contains brush shelter

Appendix 1 Continued

Gear Type	Name	Code	Description
	Polo	222	Bell-shaped trap used to catch fish by hand
	Doiar trap	95	Small, oval or box traps used for prawns or small fish
Traps	*Deal*	286	Larger trap, bilaterally divided to catch fish on 2 sides of bana
	Kadum trap	311	Large box traps used to catch larger fish e.g. Koi, Taki
	Kakila bana	310	Bamboo fence pulled downstream to trap fish in small area
	Katra	326	Active trap: fish speared after entering trap
	Kalsi pata	299	Clay pot used to trap fish set in bank side.
	Kotta	318	Bunded area on floodplain used to trap fish as water recedes
	Char jal	322	Tidal fence trap
	Kharia/Kore	330	Fence trap used on floodplain during flood recession
	Malai pata	331	Coconut shell drilled with holes and baited to catch small fish
	Patar savar	332	Large active fence trap used to surround fish on flooplain
	Tui	334	Small polo-type trap used to catch fish in mud on floodplain
	Daun	272	Long line: many hooks set at intervals on one line
	Sip	30	Rod and line : usually one hook per line
Hook/ Lines	*Nol barsi*	278	Hook & line attached to bamboo floats. Many floats/hooks may be joined along line
	Tana barsi	152	Hand line (no rod) from bank or boat with or without groundbait
Spear	*Juti*	170	Spears of various types: fixed or detachable barbs
	Jhaki jal	164	Multifilament circular net thrown by hand
	Thella jal	255	Small triangular push net set on bamboo frame
	Urani	291	Various barrier nets/fences used to catch jumping fish.
	Akra	298	Pole with metal hooks used to catch mud-dwelling fish e.g. baim
Other	*Chunga*	301	Hollow bamboo rod shelter used to attract baim
	Thushi	317	Cloth/basket traps used to drive baim into them
	Hand fishing	307	Picking fish by hand but without dewatering
	By hand/Dewatering	97	Empty water and catch fish by hand in mud
	Net/Basket+Dewatering	98	Empty water through an outlet where net or basket used to trap fish
	Nimbaich	335	Large scale fishing by whole village using many different gears
	Canal dewatering	336	Large section of canal isolated by cross dams and emptied by pumping by other means to catch fish by various methods

Notes:

1. Local names of gears vary between different districts and regions in Bangladesh. Those listed in the table above are generally used in the North Central Region. If gears were not found in this region, the name from the region in which the gear was most recorded was used.
2. Some names e.g. juti (spear) doiar traps and hat tana were used to denote a group of similar gears. A more detailed list and description of individual gears is provided in the FAP 17 database.
3. FAD = Fish Aggregation Device.

APPENDIX 2

Appendix 2 List of fish species recorded by FAP 17 study

Species Code	Species name	
	Scientific	Bengali
Riverine species		
133	*Mystus gulio*	*Nuna tengra*
957	*Mystus punctatus*	*Gagur*
186	*Rita rita*	*Rita*
99	*Labeo angra*	*Angrot*
106	*Labeo pangusia*	*Longu*
963	*Osteochilus neilli*	
12	*Aspidoparia jaya*	*Piali*
13	*Aspidoparia morar*	*Piali*
17	*Barilius barila*	*Barali*
18	*Barilius barna*	*Bani koksa*
19	*Barilius bendelisis*	*Koksa*
218	*Barilius evezardi*	
21	*Barilius shacra*	*Koksa*
22	*Barilius tileo*	*Tila koksa*
23	*Barilius vagra*	*Koksa*
67	*Danio dangila*	*Nipati*
967	*Danio sp*	
20	*Raiamas bola*	*Bhol*
59	*Crossocheilus latius*	*Kalabata*
139	*Nemacheilus botia*	*Balichata*
941	*Neoeucirrhichthys maydelli*	*Gutum*
1	*Pangio pangia*	*Panga*
198	*Somileptes gongota*	*Gharpoia*
28	*Botia dario*	*Rani*
29	*Botia lohachata*	*Putul*
951	*Botia sp*	
94	*Ilisha motius*	*Choukka*
89	*Hilsa ilisha*	*Ilish*
90	*Hilsa toli*	*Chandana*
8	*Anodontostoma chacunda*	*Koi puti*
85	*Gonialosa manmina*	*Goni chapila*
58	*Corica soborna*	*Kachki*
70	*Eleotris fusca*	*Budh bailla*
71	*Eleotris lutea*	*Kuli*
193	*Setipinna phasa*	*Phasa*
194	*Setipinna taty*	*Teli phasa*
10	*Apocryptes bato*	*Chiring*
27	*Boleophthalmus boddarti*	*Dahuk*
159	*Parapocryptes batoides*	*Dali chewa*
170	*Pseudapocryptes lanceolatus*	*Chewa*
31	*Scartelaos histophorus*	*Dahuk*
190	*Scartelaos viridis*	*Dahuk*
952	*Awaous grammepomus*	*Nonda baila*
14	*Awaous stamineus*	*Bele*
940	*Awaous sp*	*Bele*
30	*Brachygobius nunus*	*Nunabailla*
964	*Dermogenys pussillus*	*Ke thota*
92	*Hyporhampus gaimardi*	*Ek thota*
112	*Lobotes surinamensis*	*Samudra koi*
125	*Moringua raitaborua*	*Rata boura*
127	*Liza melinoptera*	*Bata*
128	*Liza parsia*	*Bata*
126	*Liza subviridis*	*Bata*
922	*Liza sp*	*Bata*
185	*Rhinomugil corsula*	*Khorsula*
923	*Sicamugil cascasia*	*Bata*
163	*Pisodonophis boro*	*Kharu*
164	*Platycephalus indicus*	*Mur bailla*
165	*Plotosus canius*	*Gang magur*
167	*Polynemus paradiseus*	*Tapasi*
2	*Ailia coila*	*Kajuli*
3	*Ailia punctata*	*Kajuli*
51	*Clupisoma garua*	*Ghaura*
52	*Clupisoma naziri*	*Muri bacha*
196	*Silonia silondia*	*Shillong*
16	*Bagarius bagarius*	*Baghair*
74	*Erethistes pussilus*	*Kutakanti*
77	*Gagata cenia*	*Kauwa*
78	*Gagata gagata*	*Gang tengra*

(Contd.)

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Appendix 2 (Continued)

Species Code	Species name	
	Scientific	Bengali
79	*Gagata nangra*	*Gang tengra*
80	*Gagata viridescens*	*Gang tengra*
81	*Gagata youssoufi*	*Gang tengra*
84	*Glyptothorax telchitta*	*Telchitta*
958	*Glyptothorax sp*	*Lal moina*
87	*Hara hara*	*Kutakanti*
197	*Sisor rhabdophorus*	*Sisor*
93	*Ichthyocampus carce*	*Kumirer khil*
961	*Microphis deocata*	
95	*Johnius coitor*	*Koitor*
155	*Pama pama*	*Poa*
156	*Pampus argenteus*	*Fali chanda*
157	*Pampus chinensis*	*Rup chanda*
191	*Scatophagus argus*	*Bishtara*
195	*Sillaginopsis panijus*	*Tular dandi*
108	*Leiognathus equulus*	*Tak chanda*
192	*Secutor ruconius*	*Tak chanda*
45	*Chelonodon fluviatilis*	*Potka*
199	*Arius gagora*	*Gagla*
200	*Tachysurus nenga*	*Kata*
171	*Psilorhynchus balitora*	*Balitora*
172	*Psilorhynchus sucatio*	*Titari*
158	*Pangasius pangasius*	*Pangas*
26	*Batrachocephalus mino*	*Katabukha*
152	*Osteogeneiosus militaris*	*Apuia*
146	*Odontamblyopus rubicundus*	*Lal chewa*
202	*Taenioides buchanani*	*Raja chewa*
208	*Trypauchen vagina*	*Sada chewa*
953	*Cynoglossus cynoglossus*	*Khongi*
954	*Cynoglossus sp*	
956	*Euryglossa orientalis*	*Kathal pata*
969	*Euryglossa pan*	*Kathal pata*
968	*Himantura sp*	*Shangus*
955	*Amblyceps mangois*	*Magur*
962	*Olyra longicaudata*	
Migratory species		
7	*Anguilla bengalensis*	*Bamosh*
130	*Aorichthys aor*	*Ayre*
135	*Aorichthys seenghala*	*Guizza*
24	*Batasio batasio*	*Tengra*
25	*Batasio tengana*	*Tengra*
131	*Mystus bleekeri*	*Golsha tengra*
132	*Mystus cavasius*	*Kabashi*
134	*Mystus menoda*	*Ghagla*
909	*Carp sp*	*Carp*
32	*Catla catla*	*Catla*
47	*Cirrhinus mrigala*	*Mrigel*
48	*Cirrhinus reba*	*Raik*
100	*Labeo bata*	*Bata*
101	*Labeo boga*	*Bhangan*
102	*Labeo calbasu*	*Kalbaus*
103	*Labeo dero*	*Kursha*
104	*Labeo gonius*	*Goni*
105	*Labeo nandina*	*Nandina*
107	*Labeo rohita*	*Rui*
44	*Chela laubuca*	*Kash khaira*
965	*Chela sp*	
188	*Salmostoma bacaila*	*Katari*
189	*Salmostoma phulo*	*Fulchela*
154	*Securicula gora*	*Chora chela*
141	*Nemacheilus savona*	*Savon khorka*
86	*Gudusia chapra*	*Chapila*
54	*Coilia ramcarati*	*Olua*
76	*Eutropiichthys vacha*	*Bacha*
169	*Pseudeutropius atherinoides*	*Batasi*
944	*Ompok pabo*	*Pabda*
209	*Wallagu attu*	*Boal*
144	*Notopterus chitala*	*Chital*
140	*Nemacheilus corica*	*Koirka*
142	*Nemacheilus scaturigina*	*Dari*
216	*Nemacheilus zonalternans*	
161	*Pellona ditchela*	*Chouka*

(Contd.)

Appendix 2 (Continued)

Species Code	Species name	
	Scientific	Bengali
Floodplain resident species		
6	*Anabas testudineus*	*Koi*
136	*Mystus tengara*	*Bajari tengra*
137	*Mystus vittatus*	*Tengra*
942	*Rama chandramara*	*Laia*
61	*Ctenops nobilis*	*Neftani*
55	*Colisa fasciatus*	*Khalisha*
211	*Colisa labiosus*	*Khalisha*
56	*Colisa lalia*	*Lal khalisha*
57	*Colisa sota*	*Khalisha*
210	*Xenentodon cancila*	*Kaikka*
60	*Ctenopharyngodon idellus*	*Gheso carp*
62	*Cyprinus carpio*	*Karfu*
63	*Cyprinus communis*	*Scale carp*
64	*Cyprinus nudus*	*Leather carp*
65	*Cyprinus specularis*	*Mirror carp*
129	*Mylopharyngodon pisceus*	*Kalo carp*
187	*Osteobrama cotio cotio*	*Keti*
174	*Puntius chola*	*Chala puti*
175	*Puntius conchonius*	*Canchan puti*
173	*Puntius cosuatis*	*Kosuati*
176	*Puntius gelius*	*Giliputi*
970	*Puntius gonianotus*	*Thai sarputi*
177	*Puntius guganio*	*Mola puti*
178	*Puntius phutunio*	*Phutani puti*
179	*Puntius sarana*	*Sarputi*
180	*Puntius sophore*	*Puti*
181	*Puntius terio*	*Teri punti*
212	*Puntius ticto*	*Tit puti*
939	*Puntius sp.*	
183	*Rasbora elanga*	*Sephatia*
4	*Amblypharyngodon microlepis*	*Mola*
5	*Amblypharyngodon mola*	*Mola*
69	*Brachydanio rerio*	*Anju*
68	*Danio devario*	*Chebli*
75	*Esomus danricus*	*Darkina*
182	*Rasbora daniconius*	*Darkina*
184	*Rasbora rasbora*	*Leuzza darkina*
83	*Glossogobius giurus*	*Bailla*
11	*Aristichthys nobilis*	*Bighead carp*
91	*Hypophthalmichthys molitrix*	*Silver carp*
43	*Chela cachius*	*Chep chela*
920	*Lepidocephalus*	
219	*Lepidocephalus annandalei*	*Puiya*
109	*Lepidocephalus berdmorei*	*Puiya*
110	*Lepidocephalus guntea*	*Gutum*
111	*Lepidocephalus irrorata*	*Puiya*
217	*Lepidocephalus thermalis*	*Puiya*
9	*Aplocheilus panchax*	*Kanpona*
38	*Channa barca*	*Tila shol*
39	*Channa marulius*	*Gajar*
40	*Channa orientalis*	*Cheng*
41	*Channa punctatus*	*Taki*
42	*Channa striatus*	*Shol*
49	*Clarias batrachus*	*Magur*
50	*Clarias gariepinus*	*African magur*
150	*Oreochromis mossambica*	*Tilapia*
151	*Oreochromis nilotica*	*Nilotica*
88	*Heteropneustes fossilis*	*Shingi*
121	*Macrognathus aculeatus*	*Tara baim*
123	*Macrognathus pancalus*	*Guchi*
122	*Mastacembelus armatus*	*Baral baim*
138	*Nandus nandus*	*Bheda*
15	*Badis badis*	*Napit koi*
124	*Monopterus cuchia*	*Kuchia*
149	*Ophisternon bengalense*	*Bamosh*
147	*Ompok bimaculatus*	*Kani pabda*
148	*Ompok pabda*	*Madhu pabda*
220	*Ompok sp*	*Ompok sp.*
145	*Notopterus notopterus*	*Foli*
203	*Tetraodon cutcutia*	*Potka*
33	*Chaca chaca*	*Cheka*
911	*Colisa sp*	*Khalisha*
35	*Chanda baculis*	*Chanda*
36	*Chanda nama*	*Nama chanda*
37	*Chanda ranga*	*Lal chanda*
910	*Chanda sp*	*Chanda*
214	*Oryzias melastigma*	*Kanpona*
906	*Baim sp*	*Baim*